

Ground beetles (Coleoptera: Carabidae) from the Sakar-Tundzha biogeographical region in Bulgaria

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Abstract. The present study compiles a list of Carabidae species from the Sakar-Tundzha biogeographical region. The species list is completed on the basis of the available bibliographic data with little support from material collected during field trips in 2012 – 2022. A total of 162 species are reported, including several endemic taxa (7 species and 8 subspecies), two relicts, and some rare and stenotopic beetles, such as the myrmecophile *Paussus turcicus*, xerophiles *Carterus gilvipes* and *C. dama*, mesophiles *Cylindera germanica* and *Amara communis*, or some riparian species living near the Tundzha riverbank. *Carabus scabrosus* is included in the Red Data Book of Bulgaria as Vulnerable. Beetles belong to 56 genera and 23 tribes. This represents, respectively, about 21% of all established for Bulgarian carabid fauna species, 45% of the genera and 64% of the tribes. There are five species reported for the first time in the Sakar Mountain. The richest tribes are Harpalini (47 species), Pterostichini and Lebiini (16 species each), Carabini, Bembidiini and Amarini (13 species each). Zoogeographical analysis shows that the Mediterranean and the European-Asiatic complexes prevail. Ground beetles are also characterised and classified according to their life forms, wing morphology and humidity preferences. The insufficient research in the area suggests that future targeted studies would contribute to the enrichment of the species list presented here.

Key words: carabids, check list, regional study, Sakar Mountain, Tundzha riverbanks.

Introduction

Sakar-Tundzha biogeographical region corresponds with the Tundzha Hilly Plain, which is a part of the Middle Bulgarian biogeographical region (Gruev & Kuzmanov 1999). Here, it is considered in the terms of the zoogeographical zoning used in research on the ground beetle (Coleoptera: Carabidae) fauna of Bulgaria, as presented in the last published catalogue of Bulgarian carabids (Guéorguiev & Guéorguiev 1995). The region of study lays in southern Bulgaria and is bordering the Sliven Valley, Sarnena Sredna Gora Mountains, and Eastern Stara Planina Mts to the North-West, North and North-East, Thracian Lowland and Eastern Rhodope Mts to the West, and Bakadzhik-Burgas regions and Strandzha Mts to the East.

Geographical location, climate features (relatively high annual average temperatures and higher humidity along the banks of the river of Tundzha) and natural landscapes in the region are a prerequisite for a great faunistic diversity (Teofilova *et al.* 2016, Teofilova 2017). However, in the past decades, most of the territory has been converted into agricultural lands (Gruev & Kuzmanov 1999) and natural forest habitats have shrunk into small patches in the Sakar Mountain or along the coastline of the river. The valley of the Tundzha River represents an original corridor for the penetration of a number of Mediterranean and Neareastern species, as well. Thus, it holds a high potential for scientific interest, but the

weak exploration of the area does not allow the evaluation of its true conservational value and the degree of the influence of the human factors (Teofilova *et al.* 2016).

Ground beetles are relatively well studied in Bulgaria and from the beginning of the 20th century until now many authors have published data concerning the carabid fauna. However, the Sakar-Tundzha region, although specific and important for the biodiversity, has never been thoroughly researched. The lack of reliable faunistic studies impedes the overall assessment of the species abundance, size of the populations, nature of their spatial distribution, biodiversity and extent of anthropogenic impact. Most studies of the carabids from the Sakar-Tundzha region contain only scattered taxonomic and faunistic data. The first report includes seven species, including the type specimen of *Elaphropus krueperi* described in 1904 (Apfelbeck 1904). In the work of Rambousek (1912), 40 species are given for this region. In the first huge medley uniting data about all Bulgarian carabids, Hieke & Wrase (1988) report 38 species. In the last published catalogue of Bulgarian carabids, around 90 species are been reported (Guéorguiev & Guéorguiev 1995). Later, almost 60 new species were added from a research on the biodiversity of two Nature Reserves along the Tundzha River, where a total of 88 carabid species were collected, and it was stated that forests seem to maintain a greater abundance and diversity of carabids than open habitats (Teofilova *et al.* 2016, Teofilova 2017). Currently, the number of species known from the region of study is 157 (Teofilova *in prep.*).

The aim of the present study is to compile a list and to assess the zoogeographical and ecological structures of Carabidae fauna from the Sakar-Tundzha region, an area that has never been subjected to such detailed investigations.

Material and Methods

The species list is completed on the basis of the available bibliographic data. Some material has been collected during random field trips in 2012 – 2022. During these expeditions, 14 species were collected. Captured animals are deposited in the author's collection in the Institute of Biodiversity and Ecosystem Research (Bulgarian Academy of Sciences, Sofia).

According to their zoogeographical belonging, the ground beetle species were classified in zoogeographical categories and complexes according to the classification adopted in the work of Teofilova & Kodzhabashev (2020c). The life forms analysis is following the classification of Sharova (1981), and the following codes are used, where the first figure in the index shows the class of life form, the second shows the subclass, and the third indicates the life form group; the figure in brackets after the subclass shows the series, if any: Class: 1 – Zoophagous; Life form subclass: 1.1 – Phytobios; 1.1.3 – Leaf-dwelling dendrohortobionts; Life form subclass: 1.2 – Epigeobios; 1.2.2 – Large walking epigeobionts, 1.2.2(1) – Dendroepigeobionts, 1.2.3 – Running epigeobionts, 1.2.4 – Flying epigeobionts; Life form subclass: 1.3 – Stratobios; Series: 1.3(1) – Crevice-dwelling stratobionts; 1.3(1).1 – Surface & litter-dwelling, 1.3(1).2 – Litter-dwelling, 1.3(1).3 – Litter & crevice-dwelling, 1.3(1).4 – Endogeobionts, 1.3(1).5 – Litter & bark-dwelling, 1.3(1).6 – Bothrobionts; Series: 1.3(2) – digging stratobionts, 1.3(2).1 – Litter & soil-dwelling; Life form subclass: 1.4 – Geobionts, 1.4.1(1) – Narrow-headed running & digging geobionts, 1.4.2(1) – Small digging geobionts, 1.4.2(2) – Large digging geobionts; Class: 2 – Mixophytophagous; Life form subclass: 2.1 – Stratobios; 2.1.1 – Crevice-dwelling stratobionts; Life form subclass: 2.2 – Stratohortobios; 2.2.1 – Stratohortobionts; Life form subclass: 2.3 – Geohortobios; 2.3.1 – Harpaloid geohortobionts, 2.3.1(1) – Crevice-dwelling harpaloid geohortobionts; 2.3.2 – Zabroid geohortobionts; 2.3.3 – Dytomeoid geohortobionts; Class: 3 – Symphilous-myrmeophilous; 3.1 – Symphiles-myrmeophiles.

According to their hind wing development, species are classified into three groups: macropterous (always possessing wings), wing dimorphic/polymorphic (only part of the

population being fully winged), and brachypterous (short-winged/wingless) (Den Boer *et al.* 1980). According to their ecological requirements in terms of humidity, the recorded carabid species were divided into six categories: hygrophilous, mesohygrophilous, mesophilous, mesoxerophilous, xerobionts and eurybionts.

The systematic list follows Kryzhanovskij *et al.* (1995).

Results and Discussion

The results from the study revealed that in Sakar-Tundzha biogeographical region 162 species of ground beetles occur. They belong to 56 genera and 23 tribes. This represents, respectively, about 21% of all established for Bulgarian carabid fauna species, 45% of the genera and 64% of the tribes (Teofilova *in prep.*). The richest tribes are Harpalini (47 species), Pterostichini and Lebiini (16 species each), Carabini, Bembidiini and Amarini (13 species each). Such taxonomic composition corresponds with the variety of habitats and environmental conditions, both anthropogenised and natural. There are five species reported for the first time in the Sakar Mountain. Another four species are reported here as doubtful (marked with '?'). Brief annotation about each carabid species' ecology is given in the list, as the following abbreviations are used: life form class: Z – Zoophagous, M – Mixophytophagous; wings development: m – macropterous, D – wing di(poly)morphic, b – brachypterous, n.a. – no data; humidity preferences: H – hygrophilous, MH – mesohygrophilous, M – mesophilous, MX – mesoxerophilous, X – xerobiont, E – eurybiont.

Species list:

Carabidae Latreille, 1802
Cicindelinae Latreille, 1802
Cicindelini Latreille, 1802

1. ***Cylindera (Cylindera) germanica germanica* (Linnaeus, 1758)**

Data from the literature: Guéorguiev & Guéorguiev (1995), Teofilova (2017). Ecology: Z, m, M.

2. ***Cicindela (Cicindela) hybrida* Linnaeus, 1758**

Data from the literature: Guéorguiev & Guéorguiev (1995). Ecology: Z, m, MX.

3. ***Cicindela (Cicindela) campestris campestris* Linnaeus, 1758**

Data from the literature: Kantardjieva (1928), Guéorguiev & Guéorguiev (1995), Teofilova (2017). Ecology: Z, m, MX.

Nebriinae Laporte, 1834
Nebriini Laporte, 1834

4. ***Leistus (Leistus) ferrugineus* (Linnaeus, 1758)**

Data from the literature: Teofilova *et al.* (2016), Teofilova (2017). Ecology: Z, D, M.

5. ***Nebria (Nebria) brevicollis* (Fabricius, 1792)**

Data from the literature: Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995), Teofilova (2017). Ecology: Z, m, MH.

Notiophilini Motschulsky, 1850

6. ***Notiophilus palustris* (Duftschmid, 1812)**

Data from the literature: Teofilova (2017). Ecology: Z, D, MH.

7. ***Notiophilus rufipes* Curtis, 1829**

Data from the literature: Teofilova (2017). Ecology: Z, D, M.

Carabinae Latreille, 1802
Carabini Latreille, 1802

8. ***Calosoma (Calosoma) sycophanta sycophanta* (Linnaeus, 1758)**

Data from the literature: Teofilova *et al.* (2016), Teofilova (2017). Ecology: Z, m, M. Note: CORINE, ESC Red list.

9. ***Calosoma (Calosoma) inquisitor inquisitor* (Linnaeus, 1758)**
Data from the literature: Guéorguiev & Guéorguiev (1995), Teofilova *et al.* (2016), Teofilova (2017). Ecology: Z, m, MX.
 10. ***Carabus (Eucarabus) ulrichii rhilensis* Kraatz, 1876**
Data from the literature: Guéorguiev (1989), Guéorguiev & Guéorguiev (1995), Teofilova *et al.* (2016), Teofilova (2017). Ecology: Z, b, M. Material: N Elhovo, Dolna Topchiya Reserve, 42°12'16.2"N, 26°34'15.1"E, 112 m, near Tundzha River, 1♂ (found dead), 11.05.2021, leg. Dragan Chobanov.
 11. ***Carabus (Tachypus) cancellatus intermedius* Dejean, 1826**
Data from the literature: Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995), Turin *et al.* (2003), Teofilova *et al.* (2016), Teofilova (2017). Ecology: Z, b, MH. Note: Balkan endemic subspecies.
 12. ***Carabus (Carabus) granulatus granulatus* Linnaeus, 1758**
Data from the literature: Teofilova *et al.* (2016), Teofilova (2017). Ecology: Z, D, MH.
 13. ***Carabus (Trachycarabus) scabriusculus bulgarus* Lapouge, 1908**
Data from the literature: Apfelbeck (1904), Rambousek (1912), Breuning (1928), Buresch & Kantardzhieva (1928), Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995). Ecology: Z, b, X. Note: Balkan endemic subspecies.
 14. ***Carabus (Archicarabus) montivagus montivagus* Palliardi, 1825**
Data from the literature: Guéorguiev & Guéorguiev (1995), Guéorguiev *et al.* (1997). Ecology: Z, b, M. Note: Balkan endemic subspecies.
 15. ***Carabus (Archicarabus) wiedemanni wiedemanni* Ménéttriés, 1836**
Data from the literature: Rambousek (1912), Buresch & Kantardzhieva (1928), Guéorguiev (1989), Guéorguiev & Guéorguiev (1995), Guéorguiev *et al.* (1997). Ecology: Z, b, MX. Note: Balkan endemic subspecies.
 16. ***Carabus (Tomocarabus) convexus gracilior* Géhin, 1885**
Data from the literature: Guéorguiev & Guéorguiev (1995), Teofilova (2017, 2021a). Ecology: Z, b, MX. Note: Balkan-Carpathian endemic subspecies.
 17. ***Carabus (Pachystus) hortensis hortensis* Linnaeus, 1758**
Data from the literature: Guéorguiev (1992), Guéorguiev & Guéorguiev (1995). Ecology: Z, b, M. Note: Relict. The species is known from higher parts of the region (above 300 m a.s.l.) (Teofilova *in prep.*).
 18. ***Carabus (Pachystus) morio morio* Mannerheim, 1830**
Ecology: Z, b, MX. Note: First record in the Sakar Mts. Material: Bukelon Fortress near Matochina vill., 41°51'13"N, 26°32'49"E, 178 m, 1♀, 25.05.2022, leg. MN; SE Dripchevo vill., 41°58'24.4"N, 26°13'39.2"E, 398 m, 1♂, 27.05.2022, leg. Maria Naumova.
 19. ***Carabus (Procrustes) coriaceus kindermanni* Waltl, 1838**
Data from the literature: Kryzhanovskij (unpubl.), Guéorguiev & Guéorguiev (1995), Teofilova (2017, 2021a). Ecology: Z, b, E. Note: Balkan endemic subspecies.
Material: Yambol, about 150 m, 1♀, 2.06.2021, obs. Mariyan Kondov.
 20. ***Carabus (Procerus) scabrosus scabrosus* Olivier, 1790**
Data from the literature: Kryzhanovskij (unpubl.), Teofilova *et al.* (2016), Teofilova (2017). Ecology: Z, b, M. Note: Red Data Book of Bulgaria ('Vulnerable'). Balkan endemic subspecies.
- Elaphrinae Latreille, 1802
Elaphrini Erichson, 1837
21. ***Elaphrus (Elaphroterus) aureus aureus* P. W. J. Müller, 1821**
Data from the literature: Teofilova (2017). Ecology: Z, m, H.
- Scaritinae Bonelli, 1810
Scaritini Bonelli, 1810
22. ***Scarites (Parallelomorphus) terricola terricola* Bonelli, 1813**
Data from the literature: Teofilova (2017). Ecology: Z, m, H.
- Clivinini Rafinesque, 1815
23. ***Clivina (Clivina) fossor fossor* (Linnaeus, 1758)**
Data from the literature: Teofilova (2017). Ecology: Z, D, MH.

Dyschiriini W. Kolbe 1880

24. ***Dyschiriodes (Eudyschirius) globosus* Herbst, 1784**
Data from the literature: Rambousek (1912), Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995), Kryzhanovskij (unpubl.), Teofilova (2017). Ecology: Z, D, MH.
25. ***Dyschiriodes (Dyschiriodes) nitidus nitidus* (Dejean, 1825)**
Data from the literature: Rambousek (1912), Guéorguiev & Guéorguiev (1995). Ecology: Z, m, H.
26. ***Dyschiriodes (Dyschiriodes) chalybaeus gibbifrons* Apfelbeck, 1899**
Data from the literature: Rambousek (1912), Guéorguiev & Guéorguiev (1995). Ecology: Z, m, H.

Apotominae LeConte, 1853

Apotomini LeConte, 1853

27. ***Apotomus clypeonitens adanensis* Jedlička, 1961**
Data from the literature: Teofilova (2017). Ecology: Z, m, MH.

Trechinae Bonelli, 1810

Trechini Bonelli, 1810

28. ***Trechus (Calotrechus) obtusus thracicus* Pawłowski, 1973**
Data from the literature: Guéorguiev (1990), Guéorguiev & Guéorguiev (1995), Guéorguiev *et al.* (1998), Beron (2015). Ecology: Z, D, M.
29. ***Trechus (Trechus) quadristriatus* (Schränk, 1781)**
Data from the literature: Rambousek (1912), Guéorguiev & Guéorguiev (1995), Beron (2015), Teofilova (2017). Ecology: Z, m, E.
30. ***Trechus [species incertae sedis] irenis* Csiki, 1912**
Data from the literature: Guéorguiev & Guéorguiev (1995), Guéorguiev *et al.* (1997), Beron (2015). Ecology: Z, b, M. Note: Balkan endemic.

[Tachyini Motschulsky 1862]

31. ***Tachyura (Sphaerotachys) hoemorroidalis* (Ponza, 1805)**
Data from the literature: Rambousek (1912), Guéorguiev & Guéorguiev (1995). Ecology: Z, m, H.
32. ***Elaphropus krueperi* (Apfelbeck, 1904)**
Data from the literature: Apfelbeck (1904), Rambousek (1912), Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995), Guéorguiev *et al.* (1997). Ecology: Z, n.a., H. Note: Bulgarian local endemic.
33. ***Tachyta (Tachyta) nana nana* (Gyllenhal, 1810)**
Data from the literature: Guéorguiev & Guéorguiev (1995). Ecology: Z, m, M.

Bembidiini Stephens, 1827

34. ***Asaphidion flavipes* (Linnaeus, 1760)**
Data from the literature: Teofilova (2017). Ecology: Z, m, MH.
35. ***Bembidion (Odontium) striatum* (Fabricius, 1792)**
Data from the literature: Rambousek (1912), Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995). Ecology: Z, m, MH.
36. ***Bembidion (Metallina) lampros* (Herbst, 1784)**
Data from the literature: Teofilova (2017). Ecology: Z, D, M.
37. ***Bembidion (Metallina) properans* (Stephens, 1828)**
Data from the literature: Teofilova (2017). Ecology: Z, D, MH.
38. ***Bembidion (Princidium) punctulatum punctulatum* Drapiez, 1820**
Data from the literature: Rambousek (1912), Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995). Ecology: Z, m, H.
39. ***Bembidion (Notaphus) varium* (Olivier, 1795)**
Data from the literature: Rambousek (1912), Guéorguiev & Guéorguiev (1995). Ecology: Z, m, H.
40. ***Bembidion (Philochthus) decolor* Apfelbeck, 1911**
Data from the literature: Teofilova *et al.* (2016, 2020), Teofilova (2017). Ecology: Z, n.a., MH. Note: Balkan endemic.
41. ***Bembidion (Philochthus) inoptatum* Schaum, 1857**
Data from the literature: Teofilova *et al.* (2016), Teofilova (2017). Ecology: Z, m, H.

42. ***Bembidion (Philochthus) lunulatum* (Geoffroy in Fourcroy, 1785)**
Data from the literature: Teofilova (2017). Ecology: Z, m, H.
43. ***Bembidion (Philochthus) guttula* (Fabricius, 1792)**
Data from the literature: Rambousek (1912), Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995). Ecology: Z, D, MH.
- ? ***Bembidion (Emphanes) tenellum tenellum* Erichson, 1837**
Data from the literature: "Sliven – Tundzha" (Rambousek 1912). Note: Probably this record concerns the Sliven Valley, which is a part of the Podbalkan (Transbalkan) region or even the Sarnena Sredna Gora Mts, which outskirts are extending on the opposite bank of the river.
- ? ***Bembidion (Bembidion) quadrimaculatum quadrimaculatum* (Linnaeus, 1760)**
Data from the literature: "Sliven – Tundzha" (Rambousek 1912). Note: See the above species.
44. ***Bembidion (Peryphus) bualei bualei* Jacquelin du Val, 1852**
Data from the literature: Rambousek (1912), Guéorguiev & Guéorguiev (1995). Ecology: Z, m, H.
45. ***Bembidion (Peryphus) subcostatum vau* Netolitzky, 1913**
Data from the literature: Rambousek (1912), Guéorguiev & Guéorguiev (1995). Ecology: Z, b, H.
46. ***Bembidion (Peryphanes) castaneipenne* Jacquelin du Val, 1852**
Data from the literature: Teofilova *et al.* (2016), Teofilova (2017). Ecology: Z, m, H.

Harpalinae Bonelli, 1810
Pterostichini Bonelli, 1810

47. ***Stomis (Stomis) pumicatus pumicatus* (Panzer, 1796)**
Data from the literature: Teofilova *et al.* (2016), Teofilova (2017). Ecology: Z, b, MH.
48. ***Myas (Myas) chalybaeus* Palliardi, 1825**
Data from the literature: Guéorguiev & Guéorguiev (1995). Ecology: Z, b, M. Note: Relict.
49. ***Poecilus (Poecilus) cupreus cupreus* (Linnaeus, 1758)**
Data from the literature: Teofilova (2017). Ecology: Z, m, E.
50. ***Poecilus (Poecilus) cursorius cursorius* (Dejean, 1828)**
Data from the literature: Teofilova (2017). Ecology: Z, m, MH.
51. ***Poecilus (Poecilus) versicolor* (Sturm, 1824)**
Data from the literature: Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995). Ecology: Z, m, M.
52. ***Pterostichus (Platysma) niger niger* (Schaller, 1783)**
Data from the literature: Guéorguiev & Guéorguiev (1995). Ecology: Z, D, MH.
53. ***Pterostichus (Argutor) cursor* (Dejean, 1828)**
Data from the literature: Guéorguiev & Guéorguiev (1995). Ecology: Z, m, H.
54. ***Pterostichus (Adelosia) macer macer* (Marsham, 1802)**
Data from the literature: Apfelbeck (1904), Rambousek (1912), Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995), Guéorguiev *et al.* (1997). Ecology: Z, m, M. Note: Balkan endemic subspecies.
55. ***Pterostichus (Pseudomaseus) anthracinus anthracinus* (Illiger, 1798)**
Data from the literature: Guéorguiev & Guéorguiev (1995), Teofilova (2017). Ecology: Z, D, MH.
56. ***Pterostichus (Pseudomaseus) minor minor* (Gyllenhal, 1827)**
Data from the literature: Rambousek (1912), Guéorguiev & Guéorguiev (1995). Ecology: Z, D, H.
57. ***Pterostichus (Phonias) ovoideus ovoideus* (Sturm, 1824)**
Data from the literature: Teofilova (2017). Ecology: Z, D, MH.
58. ***Pterostichus (Bothriopterus) oblongopunctatus* (Fabricius, 1787)**
Data from the literature: Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995). Ecology: Z, m, MH.
59. ***Pterostichus (Feronidius) melas* (Creutzer, 1799)**
Data from the literature: Teofilova (2017). Ecology: Z, b, E.
60. ***Pterostichus (Pterostichus) bruckii* Schaum, 1859**
Data from the literature: Rambousek (1912), Guéorguiev (1992), Guéorguiev & Guéorguiev (1995), Guéorguiev *et al.* (1998). Ecology: Z, b, M. Note: Balkan endemic.
61. ***Pterostichus (Pterostichus) merkliei* J. Frivaldszky, 1879**
Data from the literature: Guéorguiev (1992), Guéorguiev & Guéorguiev (1995), Guéorguiev *et al.* (1997). Ecology: Z, b, M. Note: Balkan endemic.
62. ***Abax (Abacopercus) carinatus carinatus* (Duftschmid, 1812)**
Data from the literature: Teofilova (2017). Ecology: Z, b, M.

Sphodrini Laporte, 1834

63. ***Calathus (Calathus) fuscipes fuscipes* (Goeze, 1777)**
Data from the literature: Teofilova (2017). Ecology: Z, D, E.
64. ***Calathus (Neocalathus) ambiguus ambiguus* (Paykull, 1790)**
Data from the literature: Rambousek (1912), Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995). Ecology: Z, m, MX.
65. ***Calathus (Neocalathus) melanocephalus melanocephalus* (Linnaeus, 1758)**
Data from the literature: Teofilova (2017). Ecology: Z, D, M.
66. ***Calathus (Neocalathus) cinctus* Motschulsky, 1850**
Data from the literature: Teofilova (2017). Ecology: Z, D, MX. Material: NE Matochina vill., Bukelon Fortress, 41°51'16.1"N, 26°32'47.8"E, 179 m, 1♀♂, 25.05.2022, leg. Maria Naumova.
67. ***Dolichus halensis* (Schaller, 1783)**
Data from the literature: Guéorguiev & Guéorguiev (1995). Ecology: Z, m, MX.
68. ***Laemostenus (Laemostenus) venustus* (Dejean, 1828)**
Data from the literature: Teofilova (2017). Ecology: Z, m, M.
69. ***Laemostenus (Pristonychus) terricola punctatus* (Dejean, 1828)**
Data from the literature: Guéorguiev & Guéorguiev (1995), Teofilova (2021b). Ecology: Z, D, M.
70. ***Laemostenus (Pristonychus) cimmerius* (Fischer von Waldheim, 1823)**
Data from the literature: Guéorguiev *et al.* (1997), Beron (2015), Teofilova (2021b). Ecology: Z, b, M. Material: Sakar Mt., Kostur vill., 41°58'22"N, 26°17'10"E, 455 m, under stone, 1♂, 15.04.2012, 15:30, leg. Vasil Genchev.

Platynini Bonelli, 1810

71. ***Limodromus assimilis* (Paykull, 1790)**
Data from the literature: Teofilova (2017). Ecology: Z, m, MH.
72. ***Anchomenus dorsalis dorsalis* (Pontoppidan, 1763)**
Data from the literature: Teofilova (2017). Ecology: Z, m, MX.

Zabrini Bonelli, 1810

73. ***Amara (Zezea) reflexicollis reflexicollis* Motschulsky, 1844**
Data from the literature: Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995). Ecology: M, m, X.
74. ***Amara (Zezea) tricuspidata* Dejean, 1831**
Data from the literature: Teofilova (2017). Ecology: M, m, M.
75. ***Amara (Zezea) fulvipes* (Audinet-Serville, 1821)**
Data from the literature: Teofilova (2017). Ecology: M, m, MX.
76. ***Amara (Amara) aenea* (De Geer, 1774)**
Data from the literature: Hieke & Wrase (1988), Teofilova (2017), Teofilova (2021c). Ecology: M, m, E. Material: NE Matochina vill., Bukelon Fortress, 41°51'16.1"N, 26°32'47.8"E, 179 m, 1♀, 25.05.2022, leg. Maria Naumova.
77. ***Amara (Amara) convexior* Stephens, 1828**
Data from the literature: Teofilova (2017, 2021c). Ecology: M, m, MX.
78. ***Amara (Amara) communis* (Panzer, 1797)**
Data from the literature: Teofilova (2017). Ecology: M, m, M.
79. ***Amara (Amara) lucida* (Duftschmid, 1812)**
Data from the literature: Teofilova *et al.* (2016), Teofilova (2017). Ecology: M, m, M.
80. ***Amara (Amara) similata* (Gyllenhal, 1810)**
Data from the literature: Apfelbeck (1904), Hieke & Wrase (1988). Ecology: M, m, MX.
81. ***Amara (Bradytus) apricaria* (Paykull, 1790)**
Data from the literature: Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995). Ecology: M, m, MX.
82. ***Amara (Bradytus) crenata* Dejean, 1828**
Data from the literature: Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995). Ecology: M, m, MX.
83. ***Zabrus (Zabrus) tenebrioides* (Goeze, 1777)**
Data from the literature: Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995), Teofilova (2017). Ecology: M, m, MX.
84. ***Zabrus (Pelor) spinipes spinipes* (Fabricius, 1798)**
Data from the literature: Guéorguiev & Guéorguiev (1995). Ecology: M, b, MX.
85. ***Zabrus (Pelor) balcanicus* Heyden, 1883**
Data from the literature: Guéorguiev *et al.* (1997). Ecology: M, b, M. Note: Balkan endemic.

86. ***Anisodactylus (Anisodactylus) binotatus (Fabricius, 1787)***
Data from the literature: Teofilova (2017). Ecology: M, m, MH.
87. ***Anisodactylus (Pseudanisodactylus) signatus (Panzer, 1796)***
Data from the literature: Guéorguiev & Guéorguiev (1995). Ecology: M, m, M.
88. ***Gynandromorphus etruscus (Quensel en Schönherr, 1806)***
Data from the literature: Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995), Teofilova (2017). Ecology: M, m, MX.
89. ***Diachromus germanus (Linnaeus, 1758)***
Data from the literature: Teofilova (2017). Ecology: M, m, MH.
- ? ***Stenolophus (Stenolophus) skrimshirani* Stephens, 1828**
Data from the literature: Guéorguiev & Guéorguiev (1995). Note: Probably this refers to the record "Slivenski bani" from Hieke & Wrase (1988), which actually falls within the Sarnena Sredna Gora Mts.
90. ***Acupalpus (Acupalpus) meridianus (Linnaeus, 1760)***
Data from the literature: Apfelbeck (1904), Rambousek (1912), Guéorguiev & Guéorguiev (1995). Ecology: M, m, MH.
91. ***Parophonus (Parophonus) laeviceps (Ménétriés, 1832)***
Data from the literature: Teofilova (2017). Ecology: M, m, M.
92. ***Parophonus (Parophonus) mendax (P. Rossi, 1790)***
Data from the literature: Teofilova (2017). Ecology: M, m, MH.
93. ***Parophonus (Ophonomimus) hirsutulus (Dejean, 1829)***
Data from the literature: Teofilova (2017). Ecology: M, m, MH.
94. ***Harpalus (Pseudoophonus) rufipes (De Geer, 1774)***
Data from the literature: Rambousek (1912), Guéorguiev & Guéorguiev (1995). Ecology: M, m, E.
- ? ***Harpalus (Pseudoophonus) griseus* (Panzer, 1796)**
Data from the literature: Guéorguiev & Guéorguiev (1995). Note: Probably this refers to the record "Slivenski bani" from Hieke & Wrase (1988), which actually falls within the Sarnena Sredna Gora Mts.
95. ***Harpalus (Platus) calceatus (Duftschmid, 1812)***
Data from the literature: Rambousek (1912), Guéorguiev & Guéorguiev (1995). Ecology: M, m, X.
96. ***Harpalus (Semiophonus) signaticornis (Duftschmid, 1812)***
Ecology: M, m, MX. Note: First record in the Sakar Mts. Material: SE Dripchevo vill., 41°58'24.4"N, 26°13'39.2"E, 398 m, 1♂, 27.05.2022, leg. Maria Naumova.
97. ***Harpalus (Drymoharpalus) atratus Latreille, 1804***
Data from the literature: Teofilova (2017). Ecology: M, D, MX.
98. ***Harpalus (Amblystus) rubripes (Duftschmid, 1812)***
Data from the literature: Teofilova (2017). Ecology: M, m, E.
99. ***Harpalus (Amblystus) honestus (Duftschmid, 1812)***
Data from the literature: Teofilova (2017), Teofilova (2021c). Ecology: M, D, MX. Material: N Dripchevo vill., 41°59'14.5"N, 26°13'03.2"E, 416 m, 1♀, 27.05.2022, leg. Maria Naumova.
100. ***Harpalus (Amblystus) sulphuripes sulphuripes Germar, 1823***
Ecology: M, D, M. Note: First record in the Sakar Mts. Material: N Dripchevo vill., 41°59'14.5"N, 26°13'03.2"E, 416 m, 2♀, 27.05.2022, leg. Maria Naumova.
101. ***Harpalus (Actephilus) pumilus Sturm, 1818***
Data from the literature: Guéorguiev & Guéorguiev (1995). Ecology: M, D, MX.
102. ***Harpalus (Isoharpalus) flavicornis flavicornis Dejean, 1829***
Data from the literature: Guéorguiev & Guéorguiev (1995), Teofilova (2017). Ecology: M, D, MX.
103. ***Harpalus (Ooistus) anxius (Duftschmid, 1812)***
Data from the literature: Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995). Ecology: M, m, MX.
104. ***Harpalus (Ooistus) subcylindricus Dejean, 1829***
Data from the literature: Teofilova (2017). Ecology: M, m, X. Material: SW Sakartsi vill., 42°02'05.8"N, 26°16'33.2"E, 487 m, 1♂, 25.05.2022, leg. Maria Naumova.
105. ***Harpalus (Anamblystus) latus (Linnaeus, 1758)***
Data from the literature: Teofilova (2017). Ecology: M, m, E.
106. ***Harpalus (Homaloharpalus) tardus (Panzer, 1796)***
Data from the literature: Teofilova (2017). Ecology: M, m, E.
107. ***Harpalus (Homaloharpalus) albanicus Reitter, 1900***

- Data from the literature: Apfelbeck (1904), Rambousek (1912), Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995), Teofilova (2017). Ecology: M, m, X.
108. ***Harpalus (Brachyharpalus) autumnalis (Duftschmid, 1812)***
Data from the literature: Guéorguiev & Guéorguiev (1995). Ecology: M, D, MX.
 109. ***Harpalus (Caloharpalus) cupreus fastuosus Faldermann, 1836***
Data from the literature: Guéorguiev & Guéorguiev (1995), Teofilova (2017). Ecology: M, m, MX.
 110. ***Harpalus (Baryharpalus) dimidiatus (P. Rossi, 1790)***
Data from the literature: Guéorguiev & Guéorguiev (1995), Teofilova (2017), Teofilova (2021c). Ecology: M, m, MX.
 111. ***Harpalus (Artabas) punctatostriatus Dejean, 1829***
Data from the literature: Rambousek (1912), Guéorguiev & Guéorguiev (1995). Ecology: M, m, H.
 112. ***Harpalus (Proteonus) distinguendus distinguendus (Duftschmid, 1812)***
Data from the literature: Rambousek (1912), Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995). Ecology: M, m, E.
 113. ***Harpalus (Proteonus) saxicola Dejean, 1829***
Data from the literature: Guéorguiev & Guéorguiev (1995), Teofilova (2021c). Ecology: M, m, MX.
 114. ***Harpalus (Paraharpalus) oblitus oblitus Dejean, 1829***
Data from the literature: Rambousek (1912), Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995). Ecology: M, m, MX.
 115. ***Harpalus (Harpalus) affinis (Schränk, 1781)***
Data from the literature: Teofilova (2021c). Ecology: M, m, MX.
 116. ***Ophonus (Metoponon) laticollis Mannerheim, 1825***
Data from the literature: Teofilova (2017). Ecology: M, D, MX.
 117. ***Ophonus (Metoponon) puncticollis (Paykull, 1798)***
Data from the literature: Rambousek (1912), Guéorguiev & Guéorguiev (1995). Ecology: M, m, X.
 118. ***Ophonus (Metoponon) rufibarbis (Fabricius, 1792)***
Data from the literature: Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995), Teofilova (2017). Ecology: M, m, MX.
 119. ***Ophonus (Metoponon) melletii melletii (Heer, 1837)***
Data from the literature: Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995), Teofilova (2017). Ecology: M, m, MX.
 120. ***Ophonus (Hesperophonon) azureus (Fabricius, 1775)***
Data from the literature: Guéorguiev & Guéorguiev (1995), Teofilova (2017). Ecology: M, D, MX.
 121. ***Ophonus (Hesperophonon) cribricollis (Dejean, 1829)***
Data from the literature: Teofilova (2017). Ecology: M, m, MX. Material: N Dripchevo vill., 41°59'14.5"N, 26°13'03.2"E, 416 m, 1♂, 27.05.2022, leg. Maria Naumova.
 122. ***Ophonus (Ophonon) stictus Stephens, 1828***
Data from the literature: Rambousek (1912), Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995). Ecology: M, m, MX.
 123. ***Ophonus (Ophonon) sabulicola (Panzer, 1796)***
Data from the literature: Rambousek (1912), Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995), Teofilova (2017). Ecology: M, m, MX.
 124. ***Pangus scaritides (Sturm, 1818)***
Ecology: M, m, MX. Note: First record in the Sakar Mts. Material: NE Matochina vill., Bukelon Fortress, 41°51'16.1"N, 26°32'47.8"E, 179 m, 1♀, 25.05.2022, leg. Maria Naumova.
 125. ***Acinopus (Oedematicus) megacephalus (P. Rossi, 1794)***
Data from the literature: Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995), Teofilova (2017). Ecology: M, m, MX.
 126. ***Carterus (Carterus) gilvipes (Piochard de la Brûlerie, 1873)***
Data from the literature: Guéorguiev & Guéorguiev (1995). Ecology: M, m, X.
 127. ***Carterus (Carterus) dama (P. Rossi, 1792)***
Data from the literature: Teofilova (2017). Ecology: M, m, X.
 128. ***Ditonus calydonius calydonius (P. Rossi, 1790)***
Data from the literature: Rambousek (1912), Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995). Ecology: M, m, MX.
 129. ***Dixus clypeatus (P. Rossi, 1790)***
Data from the literature: Rambousek (1912), Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995). Ecology: M, m, X.
 130. ***Dixus eremita (Dejean, 1825)***
Data from the literature: Teofilova (2017). Ecology: M, m, X.

131. ***Dixus obscurus* (Dejean, 1825)**
Data from the literature: Guéorguiev & Guéorguiev (1995), Teofilova (2017), Teofilova (2021c).
Ecology: M, m, X. Material: NE Matochina vill., Bukelon Fortress, 41°51'16.1"N, 26°32'47.8"E, 179 m, 1 ex., 25.05.2022, leg. Maria Naumova.
132. ***Amblystomus niger* (Heer, 1841)**
Data from the literature: Teofilova et al. (2016), Teofilova (2017). Ecology: M, m, MH.
- Chlaeniini Brullé, 1834
133. ***Chlaenius (Dinodes) decipiens* (L. Dufour, 1820)**
Data from the literature: Guéorguiev & Guéorguiev (1995), Teofilova (2017). Ecology: Z, m, MX.
134. ***Chlaenius (Chlaenius) festivus festivus* (Panzer, 1796)**
Data from the literature: Guéorguiev & Guéorguiev (1995). Ecology: Z, m, H.
135. ***Chlaenius (Chlaeniellus) nitidulus* (Schrank, 1781)**
Data from the literature: Teofilova (2017). Ecology: Z, m, H.
136. ***Chlaenius (Chlaeniellus) nigricornis* (Fabricius, 1787)**
Data from the literature: Teofilova (2017). Ecology: Z, m, H.
- Oodini LaFerté-Sénectère, 1851
137. ***Oodes (Oodes) gracilis* A. Villa et G. B. Villa, 1833**
Data from the literature: Vasilev (1992), Guéorguiev & Guéorguiev (1995). Ecology: Z, m, MH.
- Licinini Bonelli, 1810
138. ***Licinus (Licinus) depressus* (Paykull, 1790)**
Data from the literature: Teofilova (2017), Guéorguiev & Guéorguiev (1995), Vasilev (1988).
Ecology: Z, b, M.
139. ***Licinus (Licinus) cassideus cassideus* (Fabricius, 1792)**
Data from the literature: Rambousek (1912), Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995). Ecology: Z, b, X.
- Lebiini Bonelli, 1810
140. ***Lebia (Lamprias) cyanocephala cyanocephala* (Linnaeus, 1758)**
Data from the literature: Rambousek (1912), Guéorguiev & Guéorguiev (1995). Ecology: Z, m, M.
141. ***Lebia (Lebia) cruxminor cruxminor* (Linnaeus, 1758)**
Data from the literature: Rambousek (1912), Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995). Ecology: Z, m, M.
142. ***Lebia (Lebia) humeralis* Dejean, 1825**
Data from the literature: Rambousek (1912), Guéorguiev & Guéorguiev (1995). Ecology: Z, m, M.
143. ***Paradromius (Manodromius) linearis linearis* (Olivier, 1795)**
Data from the literature: Guéorguiev & Guéorguiev (1995). Ecology: Z, D, MH.
144. ***Philorhizus notatus* (Stephens, 1827)**
Data from the literature: Teofilova (2017). Ecology: Z, D, MX.
145. ***Syntomus obscuroguttatus* (Duftschmid, 1812)**
Data from the literature: Teofilova (2017). Ecology: Z, m, M.
146. ***Syntomus pallipes* (Dejean, 1825)**
Data from the literature: Rambousek (1912), Hieke & Wrase (1988), Vasilev & Necheva (1985), Guéorguiev & Guéorguiev (1995), Teofilova (2021d). Ecology: Z, D, MX.
147. ***Microlestes fissuralis* (Reitter, 1901)**
Data from the literature: Teofilova (2017). Ecology: Z, D, M.
148. ***Microlestes fulvibasis* (Reitter, 1901)**
Data from the literature: Teofilova et al. (2016), Teofilova (2017). Ecology: Z, b, M.
149. ***Microlestes maurus maurus* (Sturm, 1827)**
Data from the literature: Rambousek (1912), Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995). Ecology: Z, D, MX.
150. ***Microlestes minutulus* (Goeze, 1777)**
Data from the literature: Teofilova (2017). Ecology: Z, D, MX.
151. ***Microlestes negrita negrita* (Wollaston, 1854)**
Data from the literature: Teofilova (2017). Ecology: Z, D, MX.

152. ***Lionychus (Lionychus) quadrillum (Duftschmid, 1812)***
Data from the literature: Guéorguiev & Guéorguiev (1995). Ecology: Z, m, H.
153. ***Cymindis (Cymindis) axillaris axillaris (Fabricius, 1794)***
Ecology: Z, b, MX. Note: First record in the Sakar Mts. Material: N Dripchevo vill., 41°59'14.5"N, 26°13'03.2"E, 416 m, 1♂, 27.05.2022, leg. Maria Naumova.
154. ***Cymindis (Cymindis) lineata (Quensel in Schonherr, 1806)***
Data from the literature: Rambousek (1912), Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995). Ecology: Z, m, MX.
155. ***Cymindis (Menas) miliaris (Fabricius, 1801)***
Data from the literature: Guéorguiev & Guéorguiev (1995). Ecology: Z, D, MX.

Zuphiini Bonelli, 1810

156. ***Zuphium olens (Rossi, 1790)***
Data from the literature: Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995). Ecology: Z, m, H.

Brachininae Bonelli, 1810

Brachinini Bonelli, 1810

157. ***Brachinus (Brachinus) crepitans (Linnaeus, 1758)***
Data from the literature: Rambousek (1912), Guéorguiev & Guéorguiev (1995), Teofilova (2017). Ecology: Z, m, MX.
158. ***Brachinus (Brachinus) ejaculans Fischer von Waldheim, 1828***
Data from the literature: Rambousek (1912), Hieke & Wrase (1988), Guéorguiev & Guéorguiev (1995), Kryzhanovskij (unpubl.). Ecology: Z, D, MX.
159. ***Brachinus (Brachinus) psophia Audinet-Serville, 1821***
Data from the literature: Teofilova (2017). Ecology: Z, m, MX.
160. ***Brachinus (Brachynidius) bodemeyeri Apfelbeck, 1904***
Data from the literature: Rambousek (1912), Guéorguiev & Guéorguiev (1995), Teofilova *et al.* (2016), Teofilova (2017). Ecology: Z, n.a., M.
161. ***Brachinus (Brachynidius) explodens Duftschmid, 1812***
Data from the literature: Guéorguiev & Guéorguiev (1995), Teofilova (2017). Ecology: Z, m, MX.

Paussinae Latreille, 1807

Paussini Latreille, 1807

162. ***Paussus (Scaphipausus) turcicus I. Frivaldszky von Frivald, 1835***
Data from the literature: Lapeva-Gjonova *et al.* (2011). Ecology: Z, b, X.

Among the 162 species reported, there are some carabids of scientific and conservational importance. *Carabus morio*, *Harpalus signaticornis*, *H. sulphuripes*, *Pangus scaritides* and *Cymindis axillaris* are new for the studied region. They have different ranges, but they are all inhabitants of relatively dry open habitats, including steppes (based on personal observations) and their discovering in the Sakar Mountain is not very unexpected. The list also includes seven endemic species and eight endemic subspecies, two relicts, as well as some rare and stenotopic beetles, such as the myrmecophile *Paussus turcicus*, xerophiles *Carterus gilvipes* and *C. dama*, mesophiles *Cylindera germanica* and *Amara communis*, or some typical riparian species living near the Tundzha riverbank. *Carabus scabrosus* is included in the Red Data Book of Bulgaria as Vulnerable.

The obtained data about the ground beetles from the Sakar-Tundzha region demonstrate that the species belong to 25 categories from the five main faunal types of Bulgarian carabids (Fig. 1), which reflects the variety of the habitats. As a comparison, similar number of categories (22) has been found in a region with grate habitats diversity in the foot of the Rhodope Mountains (Teofilova & Kodzhabashev 2025a), but only 18 were established for the relatively homogeneous territory where the protected *Carabus hungaricus* Fabricius, 1792 lives in Bulgaria (Teofilova & Kodzhabashev 2025b).

The specific climate and geography indeed suggest the occurrence of diverse ground beetle forms and complexes, such as it was found in the neighbouring region of the Sarnena Sredna Gora Mts (Teofilova & Kodzhabashev 2020b). The relative proximity of the studied region to the Black Sea, Asia Minor and the Mediterranean, combined with the migration corridors and peculiar refugia of the river system of the Tundzha River, are a prerequisite for a strongly increased presence of southern Pontic, Anatolian and Mediterranean species. Actually, the results confirm that. The Mediterranean (*sensu lato*) (50 species, 31%) and European-Asiatic steppe complex (49 species, 30%) prevail, followed by the Northern Holarctic European-Siberian (41 species, 25%). Species from the European (15 species, 9%) and Endemic (7 species, 5%) complexes are less represented. According to the concept for separation of the categories (adopted in Teofilova & Kodzhabashev 2020c), Mediterranean (*sensu lato*) complex includes species distributed in the region of the ‘Ancient Mediterranean’; European-Asiatic complex includes mostly steppe species which ranges lie between the Eurosiberian and Mediterranean zones; Northern Holarctic and European-Siberian complex includes species distributed mainly in the northern regions of the Holarctic, mostly in Europe and Siberia; European complex includes mostly forest dwelling species connected to the middle and southern parts of Europe; Endemic complex includes species with limited ranges. The Mediterranean and Steppe complexes (containing >60% of the species) also prevailed in the xerothermophilous region of the Eastern Rhodope Mts (Teofilova & Kodzhabashev 2020a) and in the complex landscape area at the Karkariya Ridge of the Western Rhodope Mts near the villages of Vetren Dol and Patalenitsa (Teofilova & Kodzhabashev 2025a), and to lesser extent in the Sarnena Sredna Gora Mts (Teofilova & Kodzhabashev 2020b).

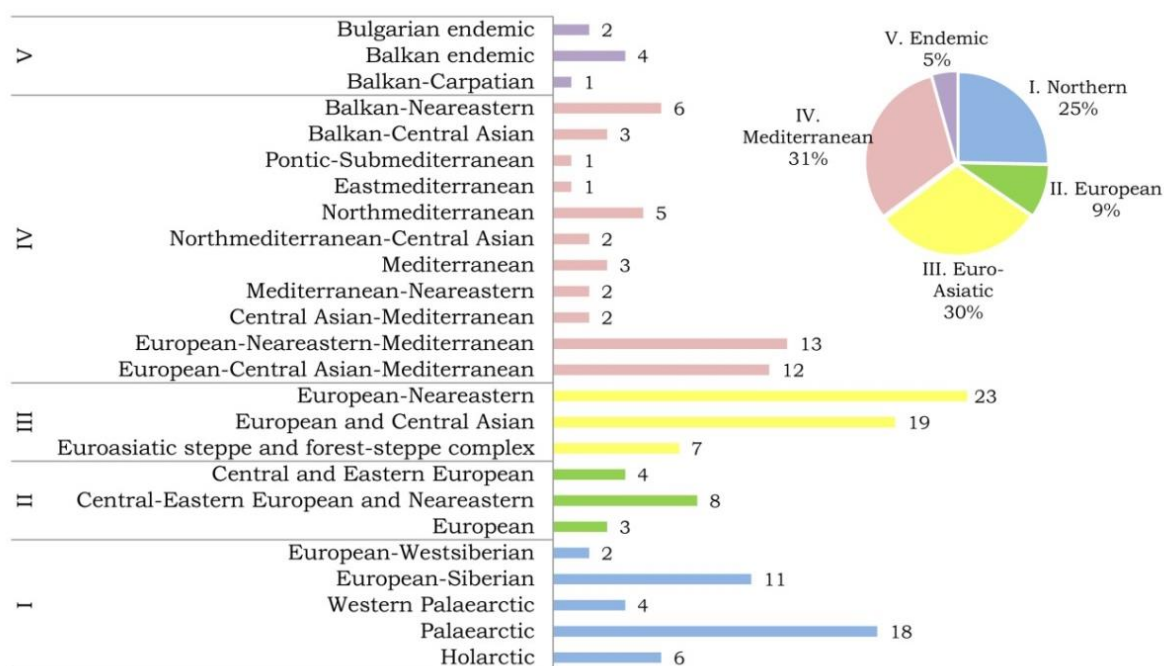


Fig. 1. Zoogeographic structure (number of species) of the carabids from the Sakar-Tundzha region.

Most rich in species are the European-Neareastern (23 species, 14%), European-Central Asian (19 species, 12%) and Palaearctic (18 species, 11%) zoogeographical elements (Fig. 1). These three categories were the most numerous also in the carabid complexes from the karst steppes in Western Bulgaria (Teofilova & Kodzhabashev 2025b), highly urbanised region of the city and surroundings of Plovdiv (Central Bulgaria, Thracian Lowland)

(Teofilova 2022), Zlatiya loess plateau in the Western Danubian Plane (Teofilova & Kodzhabashev 2020c) and from the xerothermophilic region of the Eastern Rhodopes (Teofilova & Kodzhabashev 2020a), but there they had different ratios.

The ground beetles from the studied region relate to the three classes of life forms proposed by Sharova (1981), since the myrmecophilous *Paussus turcicus* lives here, as well (Lapeva-Gjonova *et al.* 2011). Class Zoophagous contains 101 species, (62%) and the class Mixophytophagous has 60 species (37%) (Fig. 2). According to Sharova (1981), this ratio between the classes is more close to the characteristic of the forest-steppe zone of Eurasia (65%: 35%) and less to that of the semidesert zone (58%: 42%). The results are very similar with those from the neighbouring Sarnena Sredna Gora Mts, where the analysis of the life forms showed a predominance of the zoophages over mixophytophages with ratio 61%: 39% (Teofilova & Kodzhabashev 2021). Quite close were also the values from the urbanised region of the city and surroundings of Plovdiv in the Thracian Lowland (57%: 43%) (Teofilova 2022) and the Eastern Rhodopes (56.5%: 43.5%) (Teofilova & Kodzhabashev 2020a). The proximity of the Upper Thracian Lowland and the substantial transformation of much of the territory into agricultural land and pastures are the reason for the significant preponderance of life forms specialising in living in open, secondary stepped spaces, which was also ascertained in the Sarnena Sredna Gora Mts (Teofilova & Kodzhabashev 2021). The ratio between the classes of life forms differs from the established in the typical mountain regions in Bulgaria (based on own research). A total of 22 life form groups are established – 15 zoophagous, six mixophytophagous and one symphilous. The most numerous life form groups are the harpaloid geohortobionts from class Mixophytophaga (28 species, 17% of all species) and the surface & litter crevice-dwelling stratobionts (22 species, 14%) from class Zoophaga (Fig. 2). Very similar results about the life form groups were obtained for the Eastern Rhodopes (Teofilova & Kodzhabashev 2020a).

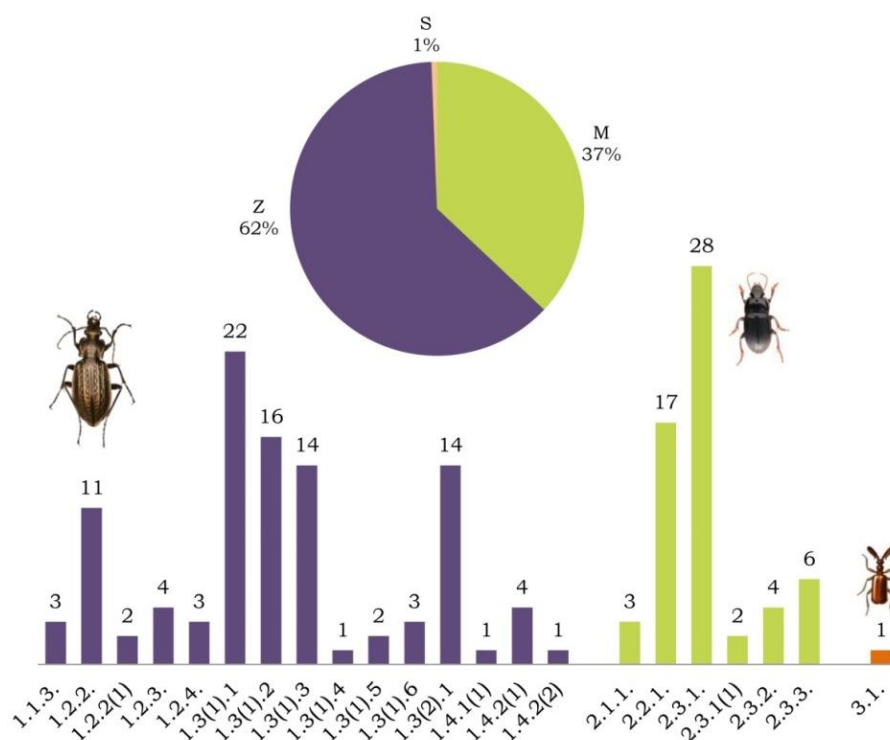


Fig. 2. Life forms (number of species) of the carabids from the Sakar-Tundzha region (explanations of the codes are given in Material and Methods section).

The analysis of the degree of hind wing development of carabids from the study area (Fig. 3) shows that macropterous are 98 of the species (60%), di(poly)morphic (some

individuals have fully developed wings, others only vestigial ones) are 35 species (22%) and brachypterous (hind wings shorter than elytra, or missing) are 26 species (16%). For three species (2%) there is no data about their wing morphology. Almost the same results were found for the carabids from the Sarnena Gora Mts (Teofilova & Kodzhabashev 2021), and similar, with a larger share of the wingless species – for the carabids from the Karkariya Ridge (Teofilova & Kodzhabashev 2025a). Based on previous results, smaller shares of the winged carabids have been found only in typical mountain territories and montane steppes (e.g. Teofilova & Kodzhabashev 2025c). As a comparison, the values of winged, dimorphic and wingless species were, respectively, 67%, 21% and 6% in the urbanised region of the city of Plovdiv (Teofilova 2022), and 69%, 22% and 8% in the Zlatiya Plateau (Teofilova & Kodzhabashev 2020c). Wingless carabids are characteristic of ecologically homogeneous and stable environments, and the proportion of flight-capable pioneer species increases with increasing disturbance (see Teofilova & Kodzhabashev 2020c).

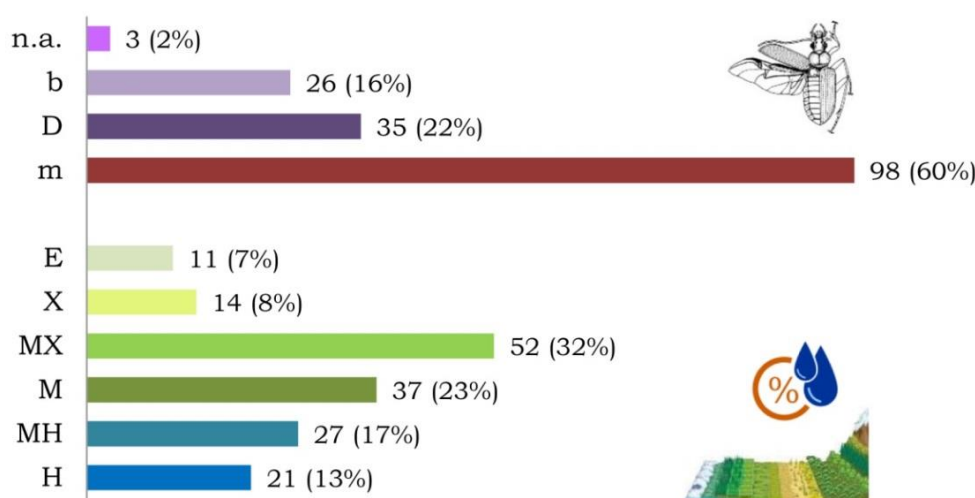


Fig. 3. Wing morphology and humidity preferences (number of species) of the carabids from the Sakar-Tundzha region: m – macropterous, D – wing di(poly)morphic, b – brachypterous, n.a. – no data; H – hygrophilous, MH – mesohygrophilous, M – mesophilous, MX – mesoxerophilous, X – xerobiont, E – eurybiont.

The analysis of the humidity preferences (Fig. 3) of carabids shows that in the region of study, the mesoxerophilous species have the largest share (52 species, 32% of all). They are mostly inhabitants of open areas, such as arable lands, pastures, hay meadows and clearings in the Sakar Mountain. However, the share of the mesophilous carabids is also significant – 37 species (23%). Mesohygrophilous beetles include 27 species (17%), and hygrophiles comprise 21 species (13%). The group of the xerophilous species includes 14 species (8%), and 11 species (7%) are eurybiontic in relation to the humidity. These results demonstrate both the xerothermic conditions of the Sakar Mountain, and the hygrophilic nature of the riparian habitats, as well. Undoubtedly, the large share of mesophilous and hygrophilous carabids is due to the greater part of the species list being added from the study of the two Reserves along the Tundzha River (Teofilova *et al.* 2016, Teofilova 2017). Similarly, the mesophilous complex prevailed in the Sarnena Gora Mts (Teofilova & Kodzhabashev 2021) and in the Karkariya Ridge, where a variety of habitats was studied (Teofilova & Kodzhabashev 2025a). More xeric conditions seem to determine the carabid complexes in the Eastern Rhodopes (Teofilova & Kodzhabashev 2020a), relatively dry regions of the city and surroundings of Plovdiv (Teofilova 2022), and karstic steppes in Western Bulgaria (Teofilova & Kodzhabashev 2025c).

Conclusions

The study reveals that about one-fifth of the Bulgarian carabid fauna is to be found in the Sakar-Tundzha region. However, diverse habitats and highly insufficient research in the area suggest that future targeted studies would contribute to the enrichment of the species list presented here. Taxonomic composition corresponds with the variety of habitats and environmental conditions, both anthropogenised and natural.

Zoogeographical analysis shows a predominantly Mediterranean and Euro-Asiatic xeric nature of the established carabid fauna, supported by the high presence of species with larger ranges and ecological tolerance, most of which are winged. The richness and diversity of the zoogeographical categories and life form groups reflect the variety of the habitat types in the studied region.

The present study also demonstrates the predominantly mesoxerophilic nature of the habitats, probably resulting from the large percentage of open territories, occupied mainly by agricultural lands. In the same time, a large share of mesophilous and hygrophilous species survives in dense riparian forests along the Tundzha River (mostly preserved in the proclaimed Nature Reserves).

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References

- Apfelbeck, V. (1904) *Die Käferfauna der Balkanhalinsel, mit Berücksichtigung Klein-Asiens und der Insel Kreta. Erstes Band: Familienreihe Caraboidea*. R. Friedlander und Sohn, Berlin, 422 pp.
- Beron, P. (2015) *Cave Fauna of Bulgaria*. East-West Publishing, Sofia, 434 pp.
- Breuning, S. (1928) Beitrag zur Carabenfauna von Bulgarien (Carabidae, Col.) mit Berücksichtigung der angrenzenden Gebiete. *Izvestiia na Tsarskitia Prirodonauchni Instituti v Sofiia (Mitteilungen aus den Konigl. Naturwissenschaftlichen Instituten in Sofia, Bulgarien = Bulletin des Institutions Royales d'Histoire Naturelle à Sofia, Bulgarie)*, 1-2: 108-117.
- Buresch, I. & Kantardzhieva, S. (1928) Vidovete ot podsemeystvo Carabinae (Carabidae, Coleoptera) v Balgaria, tyahnoto razpoznavane i razprostranenie (Species from subfam. Carabinae in Bulgaria, their recognition and distribution). *Fauna Bulgarica*, 2. *Izvestiia na Tsarskite Prirodonauchni Instituti v Sofiia (Bulletin des Institutions Royales d'Histoire Naturelle à Sofia, Bulgarie)*, 1: 45-107 (in Bulgarian).
- Den Boer, P. J., Van Huizen, T. H. P., Den Boer-Daanje, W., Aukema, B. & Den Bieman, C. F. M. (1980) Wing polymorphism and dimorphism in ground beetles as a stage in an evolutionary process (Coleoptera: Carabidae). *Entomologia Generalis*, 6: 107-134.
- Gruev, B. & Kuzmanov, B. (1999) *General biogeography*. Plovdiv University Press, Plovdiv, 344 pp. (in Bulgarian).
- Guéorguiev, V. (1989) Prinos kam izuchavaneto na predstavitelite na semeystvo Carabidae (Coleoptera) ot Balgariya. II. *Acta Zoologica Bulgarica*, 38: 82-84 (in Bulgarian).
- Guéorguiev, V. (1990) Coleoptera (Insecta, Coleoptera) from the orophyte zone of Vitoša. In: *Fauna of Southwestern Bulgaria, Part 3*. Publishing house of the BAS, Sofia, pp.134-145.
- Guéorguiev, V. (1992) Prinos kam izuchavaneto na predstavitelite na semeystvo Carabidae (Coleoptera) v Balgariya. II. *Acta Zoologica Bulgarica*, 43: 61-68.
- Guéorguiev, V. B. & Guéorguiev, B. V. (1995) *Catalogue of the ground-beetles of Bulgaria (Coleoptera: Carabidae)*. PENSOFT Publishers, Sofia-Moscow, 279 pp.

- Guéorguiev, V. B., Sakalian, V. P. & Guéorguiev, B. V. (1997) *Biogeography of the Endemic Balkan Ground-Beetles (Coleoptera: Carabidae) in Bulgaria*. PENSOFT Publishers, Sofia-Moscow, 73 pp.
- Guéorguiev, V. B., Beshovski, V. L., Russev, B. K., Kumanski, K. P., Josifov, M. V. & Sakalian, V. P. (1998) *Insects of Bulgaria, Part 1: Odonata, Ephemeroptera, Plecoptera, Homoptera (Auchenorrhyncha), Heteroptera, Coleoptera*. In: Bulgaria's Biological Diversity: Conservation Status and Needs Assessment, pp. 163-209.
- Hieke, F. & Wrase, D. W. (1988) Faunistik der Laufkäfer Bulgariens (Coleoptera, Carabidae). *Deutsche Entomologische Zeitschrift, N. F.*, 35 (1-3): 1-71.
- Kantardjieva, S. (1928) Die arten der familie Cicindelidae (Col.) in Bulgarien. *Izvestiia na Balgarskoto Entomologichno Druzhestvo (Bulletin of the Bulgarian Entomological Society)*, 4: 91-114.
- Kryzhanovskij, O. L. (unpublished data) *Fauna Bulgarica, Carabidae*. Manuscript. (in Russian)
- Kryzhanovskij, O. L., Belousov, I. A., Kabak, I. I., Kataev, B. M., Makarov, K. V. & Shilenkov, V. G. (1995) *A checklist of the ground-beetles of Russia and adjacent lands (Insecta, Coleoptera, Carabidae)*. PENSOFT Publishers, Sofia-Moscow, 272 pp.
- Lapeva-Gjonova, A., Kostova, R. & Guéorguiev, B. V. (2011) New records of myrmecophilous beetle *Paussus turcicus* (Coleoptera, Carabidae) in Southeastern Balkans. *ZooNotes*, 21: 1-3.
- Rambousek, F. G. (1912) Fauna Coleopterorum Bulgarica. *Travaux de la Société Bulgare des Sciences Naturelles*, 5: 57-113 (in Bulgarian).
- Sharova, I. Ch. (1981) *Life forms of carabids (Coleoptera: Carabidae)*. Nauka, Moskow, 360 pp. (in Russian).
- Teofilova, T. (2017) Ground beetles (Coleoptera: Carabidae) and some other invertebrates from the managed nature reserves "Dolna Topchiya" and "Balabana" (Lower valley of the river of Tundzha, Bulgaria). *Ecologia Balkanica*, 9(1): 63-77.
- Teofilova, T. M. (2021a) New data about Bulgarian ground beetles from subfamilies Nebriinae, Carabinae and Cicindelinae (Coleoptera: Carabidae). *Historia Naturalis Bulgarica*, 43 (6): 79-86. <https://doi.org/10.48027/hnb.43.061>.
- Teofilova, T. (2021b) New and unpublished data about Bulgarian ground beetles from the tribes Pterostichini, Sphodrini and Platynini (Coleoptera: Carabidae). *Acta Biologica Sibirica*, 7: 125-141. <https://doi.org/10.3897/abs.7.e67015>.
- Teofilova, T. (2021c) New and unpublished data about the ground beetles from tribes Zabryini and Harpalini (Coleoptera: Carabidae) of Bulgaria. *Biharean Biologist*, 15(2): 131-138.
- Teofilova, T. (2021d) New and unpublished data about Bulgarian ground beetles of the tribe Lebiini (Coleoptera: Carabidae). *ZooNotes*, 174: 1-4.
- Teofilova, T. M. (2022) Ground beetles (Coleoptera: Carabidae) found in the city and surroundings of Plovdiv (Central Bulgaria). In: Mollov, I., Georgiev, D. & Todorov, O. (Eds.), *Faunistic Diversity of the City of Plovdiv (Bulgaria), Vol. 2 – Vertebrates & Invertebrates*. Bulletin of the Natural History Museum – Plovdiv, Supplement 2, pp. 65-81.
- Teofilova, T. M. (in prep.) *Updated annotated checklist of the Bulgarian ground beetles (Coleoptera: Carabidae)*. Unpublished results.
- Teofilova, T. M. & Kodzhabashev, N. D. (2020a) Ecological, faunistic and zoogeographical notes on the ground beetles (Coleoptera: Carabidae) from the Eastern Rhodope Mts. of Bulgaria. *Forestry Ideas*, 26(1): 77-96.
- Teofilova, T. M. & Kodzhabashev, N. D. (2020b) Ground beetles (Coleoptera: Carabidae) from the Sarnena Sredna Gora Mts. In: Georgiev, D., Bechev, D. & Yancheva, V. (Eds.),

- Fauna of Sarnena Sredna Gora Mts, Part 1*. ZooNotes, Supplement 9, Plovdiv University Press, pp. 95-114.
- Teofilova, T. M. & Kodzhabashev, N. D. (2020c) The ground beetles (Coleoptera: Carabidae) from a significant, but poorly studied region in NW Bulgaria. Part 1: Taxonomic, faunistic and zoogeographic notes. *Forestry Ideas*, 26(2): 302-325.
- Teofilova, T. M. & Kodzhabashev, N. D. (2021) Ecological structure of the Carabidae complex (Coleoptera) from the Sarnena Sredna Gora Mts., Bulgaria. *Ecologia Balkanica*, Special Edition 4: 29-47.
- Teofilova, T. & Kodzhabashev, N. (2025a) Ground beetle (Coleoptera: Carabidae) communities from various habitats in a region where nature and people collide. *Forestry Ideas*, 31 (Special Issue 1): 237-254.
- Teofilova, T. M. & Kodzhabashev, N. D. (2025b) The endangered and protected *Carabus hungaricus* Fabricius, 1792 (Coleoptera: Carabidae) in Bulgaria: Distributional patterns and conservation status. *Conservation (MDPI)*, 5(2): 18 (13 p.). <https://doi.org/10.3390/conservation5020018>.
- Teofilova, T. M. & Kodzhabashev, N. D. (2025c) The endangered and protected *Carabus hungaricus* Fabricius, 1792 (Coleoptera: Carabidae), in Bulgaria: Communities and ecological parameters of populations from the southernmost refugium of the Eurasian steppe biome. *Ecologies (MDPI)*, 6(2): 40 (24 p.). <https://doi.org/10.3390/ecologies6020040>.
- Teofilova, T. M., Guéorguiev, B. V. & Kodzhabashev, N. D. (2020) New and interesting data on the ground beetles (Coleoptera: Carabidae) from Bulgaria. *Acta Zoologica Bulgarica*, 72(2): 225-233.
- Teofilova, T., Mecheva, S. & Pilarska, D. (2016) The lower valley of the Tundzha river and the adjacent protected areas and zones – conservation significance in terms of the invertebrate fauna. *Annuaire de l'Universite de Sofia "St. Kliment Ohridski", Faculte de Biologie*, 101(4): 71-84.
- Turin, H., Penev, L. & Casale, A. (Eds.) (2003) *The genus Carabus in Europe. A synthesis*. Co-published by PENSOFT Publishers, Sofia-Moscow & European Invertebrate Survey, Leiden: xvi + 512 pp.
- Vasilev, I. B. (1988) Prinosa kam faunata na begachite (Coleoptera, Carabidae) ot Balgariya. *Acta Zoologica Bulgarica*, 36: 85-87 (in Bulgarian).
- Vasilev, I. (1992) New and rare species of Carabidae, Coleoptera from Bulgaria. *Annuaire de l'Universite de Sofia "St. Kliment Ohridski", Faculte de Biologie*, 81(1): 25-27 (in Bulgarian, English summary).
- Vasilev, I. & Necheva, V. (1985) Investigation on the carabid's fauna (Carabidae, Coleoptera) from Bulgaria. *Annuaire de l'Universite de Sofia "St. Kliment Ohridski", Faculte de Biologie*, 79(1): 49-52 (in Bulgarian, English summary).