

ENDEMIC CARABIDAE SPECIES IN THE WESTERN BLACK SEA REGION OF TÜRKİYE WITH NEW LOCALITY RECORDS

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Abstract. The Western Black Sea Region of Türkiye, comprising seven provinces, hosts forest ecosystems rich in biodiversity, along with nature parks, conservation areas, national parks, and wetlands. In this context, a comprehensive survey was conducted between 2022 and 2023 to document the distribution and conservation relevance of endemic Carabidae taxa. Specimens were collected by hand and pitfall trap method, subsequently pinned, labelled, and identified, while relevant literature from the region was also thoroughly reviewed. Based on combined field and literature data, a total of 17 endemic species and 30 endemic subspecies of the family Carabidae were identified, with new locality records added to the Western Black Sea Region. These findings not only provide critical faunistic data but also underscore the region's role as a biodiversity hotspot and a conservation priority area.

Keywords: *biodiversity, conservation priority areas, distribution records, endemism, ground beetles*

Introduction

Species native to a specific region that inhabit a clearly defined, restricted area is considered endemic (Kaya and Aksakal, 2005; Atik et al., 2010). This area may be a defined geographical region, an island, or a country (FAO, 2019). The term "endemic" refers to species whose entire global distribution is confined exclusively within the borders of Türkiye (Karaçetin and Welch, 2011).

The Western Black Sea Region (WBR) lies east of the Marmara Region and forms part of the Black Sea Region. The prevailing climate in the region reflects the typical characteristics of the Black Sea; notably wet, humid, and temperate conditions. Geographically, it features a mountainous terrain, with mountain ranges extending parallel to the coastline (URL-1, 2025). Approximately 64% of the region is covered by forests and shrub lands, the region ranks among the most forest-rich areas in Türkiye (BAKKA, 2025). The richness of the flora also induces an increase in the diversity of animal species that feed on these plants and use them as habitats, such as for shelter, nesting, or reproduction.

There are three national parks (Küre Mountains National Park, Ilgaz Mountain National Park and Kastamonu-İstiklal Road Historical National Park), 19 nature parks, seven nature monuments, and three nature conservation areas in this region (*Fig. 1*). Of

these, Küre Mountains National Park is one of the nine hot spots of the country's forests. It contains many endemic and endangered species (URL-2, 2025). It is the first national park in Türkiye to be included in the PAN Parks Network, a distinguished network of protected areas in Europe (URL-3, 2012). This region also hosts a wide variety of insect species that have adapted to the existing flora and are well-suited to its climatic conditions.



Figure 1. Protected areas in the WBR of Türkiye (adapted from URL-4, 2025)

There are 2,651 endemic plant taxa belonging to 63 families in Türkiye. Some species have endemic subspecies or varieties; therefore, at the subspecies and variety level, this number reaches 3,090. The endemism rate is 33.5%. The WBR of Türkiye is a biogeographically important transition zone between the Euro-Siberian and Irano-Turanian regions. In the Black Sea Region, the number of endemic plant species is 220. Additionally, this region hosts numerous relict plants, which are remnants of the Boreal–Tertiary flora that once covered large parts of Europe and Asia (Kaya and Aksakal, 2005). This study provides a focused assessment of the distributional records of endemic Carabidae taxa within this important region.

In Türkiye, numerous studies focusing on the Carabidae family have been conducted by various researchers across different regions, leading to the identification of several endemic species. More than 1,100 species belonging to the Carabidae Latreille, 1802 family have been recorded in Türkiye (Casale and Vigna Taglianti, 1999), and this number is estimated to be around 1,200 (Avgın and Cavazzuti, 2011). Endemic species constitute approximately 41% of the identified taxa (Casale and Vigna Taglianti, 1999).

Recent studies conducted in the WBR of Türkiye between 2021 and 2025 have substantially contributed to the knowledge of the Carabidae fauna of the region. Kara and Toper Kaygın (2021), in a study carried out in Bartın Province, recorded two species belonging to two genera of the subfamily Lebiinae, *Lebia* (*Lamprias*) *chlorocephala* Hoffmannsegg, 1803 and *Paradromius* (*Manodromius*) *linearis* Olivier, 1795. Both species were reported as new records for the fauna of Bartın Province, while *L. (L.) chlorocephala* was documented for the first time for the fauna of Türkiye. Subsequently, Kara et al. (2023) investigated forested areas in the Bartın region and identified two

genera and ten subspecies of the subfamily Carabinae, as well as three genera and three species of the subfamily Harpalinae. All recorded species and subspecies were reported as new records for Bartın Province. In addition, the subspecies *Carabus (Lamprostus) erenleriensis bithynicus* Heinz & Korge, 1967, *C. (L.) erenleriensis ahmetustaensis* Cavazzuti, 1987, *C. (Oxy-carabus) saphyrinus mengensis* Blumenthal & Breuning, 1967, *C. (O.) saphyrinus yenicensis* Lassalle, 1998, *C. (Procerus) scabrosus mentor* Blumenthal & Breuning, 1967, *C. (Procrustes) chevrolati internatus* Heinz & Korge, 1964, and *C. (Tomocarabus) convexus erzeliki* Schweiger, 1962 were evaluated as endemic taxa in that study. More recently, Kara and Toper Kaygın (2025) published a comprehensive study entitled “*Carabidae (Coleoptera) Species of Bartın Province*”, reporting a total of 44 species and subspecies belonging to 23 genera and 10 subfamilies of the family Carabidae. Among these taxa, two species were indicated as new records for the fauna of Türkiye.

However, despite these studies, comprehensive regional evaluations focusing on endemic *Carabus* taxa in the Western Black Sea Region remain limited. The aim of this study is to document endemic species and subspecies of the family Carabidae in the Western Black Sea Region (WBR). Endemic taxa occurring in the region are presented collectively and evaluated on a regional basis by integrating data obtained from the present study with previously published records.

Materials and methods

Study area

The study was conducted in the WBR of Türkiye, which comprises seven provinces: Zonguldak, Düzce, Sinop, Bolu, Karabük, Kastamonu, and Bartın. The region is characterized by extensive forested landscapes and includes numerous protected areas. Field surveys were carried out across representative forest stands within the WBR.

Field surveys and sampling sites

Field studies were conducted between 2022 and 2023 using pitfall traps installed at nine sampling sites located within the administrative boundaries of different Forest Management Directorates. Pitfall traps were placed at the following localities with their respective coordinates and deployment periods: Karamazak Village, Black pine seed orchard No. 70 (Bartın Forest Management Directorate; 41°34'48.09"N, 32°11'58.82"E; trap deployment: 23 May 2022–11 April 2023); Mahmutoğlu Village (Devrek Forest Management Directorate; 41°6'15.83"N, 32°0'24.42"E; 3 June 2022–18 April 2023); Mamiş Village (Dirgine Forest Management Directorate; 41°1'31.50"N, 31°50'43.21"E; 26 May 2022–20 April 2023); Sipahiler (Karabük Forest Management Directorate; 41°6'8.34"N, 32°29'19.04"E; 7 June 2022–8 April 2023); Ahmetcikler Neighborhood (Karadeniz Ereğli Forest Management Directorate; 41°17'54.52"N, 31°28'50.63"E; 1 June 2022–10 April 2023); Sofuoğlu Neighborhood (Safranbolu Forest Management Directorate; 41°23'5.75"N, 32°44'9.52"E; 13 June 2022–15 April 2023); Güneyören Village (Ulus Forest Management Directorate; 41°33'45.67"N, 32°45'13.69"E; 27 May 2022–12 April 2023); İncedere (Yenice Forest Management Directorate; 41°5'48.50"N, 32°14'24.66"E; 10 June 2022–6 April 2023); and Çaycuma–Esenyurt (Zonguldak Forest Management Directorate; 41°30'24.64"N, 32°1'15.00"E; 31 May 2022–13 April 2023). Geographic coordinates of all trap locations were recorded using a handheld GPS device.

Sampling design and pitfall trap method

Pitfall traps consisted of 1-L plastic containers buried flush with the soil surface and covered with 20 × 20 cm metal sheets to protect against rainfall and debris. An entrenching tool was used during installation. Traps were placed using a random parceling approach, with one trap installed every 20 m. At each of the nine sampling sites, 20 pitfall traps were deployed, resulting in a total of 180 traps (9 sites × 20 traps). Except for the winter period, pitfall traps were checked at intervals of 3–4 weeks, and captured specimens were collected during each visit.

Specimen collection and preservation

Specimens were collected from the study areas using both hand collection and pitfall trapping methods. Live specimens collected by hand were placed in glass containers containing ethyl acetate for killing. Specimens obtained from pitfall traps, which were already dead at the time of collection, were transferred to glass containers filled with 70% ethanol and transported to the laboratory. After laboratory processing, all specimens were preserved and stored in standard entomological boxes.

Specimen identification and data analysis

Specimen preparation and identification were carried out using standard entomological procedures. Detailed morphological examinations were performed under a stereomicroscope (Zeiss Stemi 2000). Male genitalia were photographed using macro photography to document diagnostic morphological characters. Identification of endemic species and subspecies of the family Carabidae inhabiting the WBR was achieved by integrating field observations with data obtained from an extensive review of previously published studies, including Casale and Vigna Taglianti (1999), Deuve (2004), Avgın (2006), Donabauer (2007), Avgın and Emre (2008), Avgın and Nodmar (2009, 2009a), Avgın and Cavazzuti (2011), Avgın and Prunier (2015), Kara (2016), Tezcan et al. (2018), and Kara et al. (2023).

Results

Based on the findings from field research carried out in the region, eight endemic subspecies (*Carabus (Lamprostus) erenleriensis ahmetustaensis* Cavazzuti, 1987, *Carabus (Lamprostus) erenleriensis bithynicus* Heinz et Korge, 1967, *Carabus (Lamprostus) erenleriensis karadagensis* S. Battoni & Blumenthal, 1973, *Carabus (Oxycarabus) saphyrinus mengenenensis* Blumenthal & Breuning, 1967, *Carabus (Oxycarabus) saphyrinus yenicensis* Lassalle, 1998, *Carabus (Procerus) scabrosus mentor* Blumenthal & Breuning, 1967, *Carabus (Procrustes) chevrolati internatus* Heinz et Korge, 1964 and *Carabus (Tomocarabus) convexus erzeliki* Schweiger, 1962) belonging to the subfamily Carabinae of the Carabidae family were identified. Information regarding these endemic subspecies and their distribution areas is provided below.

Subfamily Carabinae Latreille, 1802

***Carabus (Lamprostus) erenleriensis ahmetustaensis* Cavazzuti, 1987**

Distribution: Türkiye: Zonguldak (URL-5, 2025; URL-6, 2025); Karabük: Ahmetusta (Avgın and Prunier, 2015; URL-6, 2025); Karabük: Eflani (URL-6, 2025).

Examined material: Bartın: Ulus, Güneyören, 41°33'45.67"N, 32°45'13.69"E 4.IX.2023 (2♀, 2♂), 2.X.2023 (1♂), 5.X.2022 (2♀, 2♂) (Kara et al., 2023); Karabük: Safranbolu, Sofuoğlu, 41°23'5.75"N, 32°44'9.52"E 28.IV.2023 (2♀), 11.VI.2023 (1♀), 7.VII.2023 (2♀, 2♂), 19.VII.2022 (4♀, 3♂), 10.VIII.2023 (9♀, 9♂), 22.VIII.2022 (2♂), 13.IX.2023 (13♂), 26.IX.2022 (2♀, 3♂), 13.X.2023 (2♂), 20.X.2022 (2♀); Zonguldak: Çaycuma, Esenyurt, 41°30'24.64"N, 32°1'15.00"E 30.VI.2022 (1♀), 5.VII.2023 (1♀, 1♂), 28.VII.2022 (2♂), 4.VIII.2023 (1♀, 4♂), 24.VIII.2022 (8♀, 13♂), 7.IX.2023 (2♂), 28.IX.2022 (9♀, 8♂), 4.X.2023 (2♀, 3♂), 26.X.2022 (4♀, 3♂).

Figure 2 illustrates the habitus (Fig. 2a) and aedeagus (Fig. 2b) of *Carabus (Lamprostus) erenleriensis ahmetustaensis*.



Figure 2. *C. (L.) erenleriensis ahmetustaensis*: (a) adult; (b) aedeagus

***Carabus (Lamprostus) erenleriensis bithynicus* Heinz et Korge, 1967**

Distribution: Bolu (Avgın and Prunier, 2015; URL-5, 2025; URL-6, 2025), Düzce: Akçakoca (Avgın and Prunier, 2015; URL-6, 2025).

Examined material: Bartın: Ulus, Güneyören, 41°33'44.67"N, 32°45'11.29"E 21.VII.2023 (1♀, 2♂), 5.X.2022 (1♂) (Kara et al., 2023); Zonguldak: K. Ereğli, Ahmetcikler, 41°17'54.52"N, 31°28'50.63"E 4.VII.2022 (2♀, 2♂), 8.VII.2023 (4♀, 2♂), 2.VIII.2022 (7♀, 9♂), 8.VIII.2023 (2♀, 6♂), 30.VIII.2022 (2♀, 5♂), 8.IX.2023 (1♀).

The habitus and aedeagus of *C. (L.) erenleriensis bithynicus* are presented in Fig. 3.

***Carabus (Lamprostus) erenleriensis karadagensis* S. Battoni & Blumenthal, 1973**

Distribution: Bolu: Karadağ (Avgın and Prunier, 2015). It is a new record for Karabük and Zonguldak.

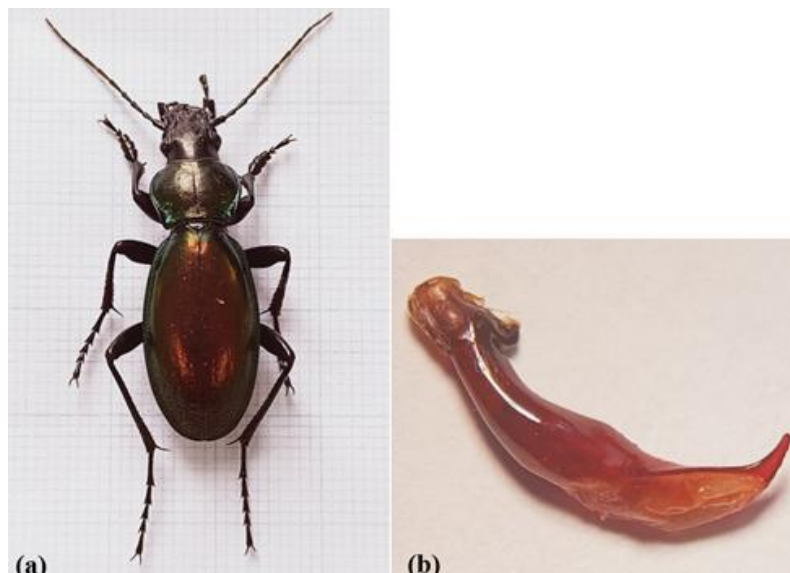


Figure 3. *C. (L.) erenleriensis bithynicus*: (a) adult; (b) aedeagus

Examined material: Karabük: Eğriova, Sipahiler, 41°6'8.34"N, 32°29'19.04"E 5.VI.2022 (1♀, 1♂), 5.VII.2022 (1♀), 4.VIII.2022 (1♂), 31.VIII.2022 (2♀, 2♂), 5.X.2023 (1♀); Yenice, İncedere, 41°5'48.50"N, 32°14'24.66"E 18.VII.2023 (5♀), 15.VIII.2023 (1♀, 4♂), 20.VIII.2022 (1♂), 11.IX.2023 (1♂), 23.IX.2022 (1♀), 6.X.2023 (3♂); Zonguldak: Devrek, Mahmutoğlu, 41°6'15.83"N, 32°0'24.42"E 20.VII.2023 (3♀, 2♂), 3.VIII.2022 (1♀, 2♂), 17.VIII.2023 (1♀, 4♂), 2.IX.2022 (2♀, 3♂), 11.IX.2023 (1♀), 14.IX.2023 (1♂), 30.IX.2022 (1♀, 2♂); Dirgine, Mamiş, 41°1'31.50"N, 31°50'43.21"E 24.VII.2023 (8♀, 7♂), 29.VII.2022 (12♂), 18.VIII.2023 (2♀, 1♂), 26.VIII.2022 (2♀, 6♂), 15.IX.2023 (1♀, 3♂), 27.IX.2022 (7♂), 12.X.2023 (3♂), 24.X.2022 (2♀).

The habitus and aedeagus of *C. (L.) erenleriensis karadagensis* are shown in Fig. 4.



Figure 4. *C. (L.) erenleriensis karadagensis*: (a) adult; (b) aedeagus

Carabus (Oxycarabus) saphyrinus mengenensis Blumenthal & Breuning, 1967

Distribution: Türkiye (locality not specified) (Casale and Vigna Taglianti, 1999); Bolu: Mengen (Lassalle, 1998).

Examined material: Bartın: Ulus, Güneyören, 41°33'45.67"N, 32°45'13.69"E 24.VI.2022 (2♀, 2♂), 24.VII.2022 (4♂), 2.X.2023 (1♂), 18.XI.2022 (2♀, 1♂) (Kara et al., 2023).

Figure 5 illustrates the habitus and aedeagus of *C. (O.) saphyrinus mengenensis*.



Figure 5. *C. (O.) saphyrinus mengenensis*: (a) adult; (b) aedeagus

Carabus (Oxycarabus) saphyrinus yenicensis Lassalle, 1998

Distribution: Türkiye (locality not specified) (Lassalle, 1998; Casale and Vigna Taglianti, 1999; Avgın and Cavazzuti, 2011); Karabük: Yenice (URL-6, 2025).

Examined material: Bartın: Karamazak, 41°34'48.09"N, 32°11'58.82"E 23.V.2023 (1♀), 14.VI.2023 (1♂), 1.VII.2022 (2♀), 25.X.2022 (2♀, 10♂), 25.X.2023 (5♀, 18♂); Saraylı, 41°37'08.04"N, 32°13'45.48"E 15.VIII.2023 (1♂), 17.VIII.2023 (1♂); Ulus, Güneyören, 41°33'45.67"N, 32°45'13.69"E 21.VII.2023 (2♀), 24.VII.2022 (1♀), 27.VIII.2022 (2♂), 4.IX.2023 (1♀), 2.X.2023 (1♂), 5.X.2022 (1♀, 2♂), 18.XI.2022 (1♂) (Kara et al., 2023); Karabük: Eğriova, Sipahiler, 41°6'8.34"N, 32°29'19.04"E 8.V.2023 (1♀), 5.VI.2022 (3♂), 7.VI.2023 (3♀, 1♂), 5.VII.2022 (1♀, 6♂), 3.VIII.2023 (1♂), 4.VIII.2022 (5♀, 5♂), 31.VIII.2022 (11♀, 11♂), 5.IX.2023 (1♀), 4.X.2022 (5♀, 13♂), 2.XI.2022 (3♀, 6♂); Safranbolu, Sofuoğlu, 41°23'5.75"N, 32°44'9.52"E 7.VII.2023 (1♀), 19.VII.2022 (5♀, 1♂), 10.VIII.2023 (1♀), 22.VIII.2022 (4♀, 3♂), 13.IX.2023 (1♂), 26.IX.2022 (1♀, 1♂), 13.X.2023 (3♂), 20.X.2022 (2♂); Yenice, İncedere, 41°5'48.50"N, 32°14'24.66"E 18.VII.2022 (1♀), 18.VII.2023 (1♂), 15.VIII.2023 (1♀); Zonguldak: Çaycuma, Esenyurt, 41°30'24.64"N, 32°1'15.00"E 11.V.2023 (1♀, 2♂), 5.VI.2023 (1♀, 2♂), 30.VI.2022 (1♀, 1♂), 5.VII.2023 (1♀, 2♂), 28.IX.2022 (4♂), 4.X.2023 (1♂), 26.X.2022 (2♀, 6♂); Devrek, Mahmutoğlu, 41°6'15.83"N, 32°0'24.42"E 20.VII.2023 (1♂), 17.VIII.2023 (1♀), 30.IX.2022 (1♂), 31.X.2022 (1♀, 3♂); Dirgine, Mamiş, 41°1'31.50"N, 31°50'43.21"E 9.VI.2023 (1♀), 23.VI.2022 (1♀), 24.X.2022 (1♀, 7♂); K. Ereğli, Ahmetcikler, 41°17'54.52"N, 31°28'50.63"E 6.VI.2023 (2♀), 4.VII.2022 (15♀,

12♂), 8.VII.2023 (7♀, 6♂), 8.IX.2023 (1♂), 29.IX.2022 (1♀), 9.X.2023 (1♀, 2♂), 27.X.2022 (2♀, 17♂).

The habitus and aedeagus of *C. (O.) saphyrinus yenicensis* are presented in Fig. 6.



Figure 6. *C. (O.) saphyrinus yenicensis*: (a) adult; (b) aedeagus

Carabus (Procerus) scabrosus mentor Blumenthal & Breuning, 1967

Distribution: Türkiye (locality not specified) (Casale and Vigna Taglianti, 1999; Avgın and Cavazzuti, 2011); Bolu: Gerede (Avgın and Nodmar, 2009).

Examined material: Bartın: Halatçı Yaması, 41°37'33.6"N, 32°20'35.1"E 31.X.2023 (1♀); Karamazak, 41°34'48.09"N, 32°11'58.82"E 21.IX.2023 (1♀), 22.IX.2022 (1♂), 9.X.2022 (1♂), 25.X.2023 (1♀, 1♂); Kemer Köprü, 41°37'26.1"N, 32°20'34.8"E 25.X.2023 (1♀); Ulus, Güneyören, 41°33'45.67"N, 32°45'13.69"E 27.V.2022 (1♀) (Kara et al., 2023); Zonguldak: Çaycuma, Esenyurt, 41°30'24.64"N, 32°1'15.00"E 5.VI.2023 (1♀), 30.VI.2022 (1♀); Devrek, Mahmutoğlu, 41°6'15.83"N, 32°0'24.42"E 7.VI.2023 (1♀), 6.VII.2022 (2♀), 20.VII.2023 (1♀), 3.VIII.2022 (1♂), 7.VIII.2023 (1♀), 2.IX.2022 (1♂, 1♀); Dirgine, Mamiş, 41°1'31.50"N, 31°50'43.21"E 23.VI.2022 (1♀); K. Ereğli, Ahmetcikler, 41°17'54.52"N, 31°28'50.63"E 8.IV.2023 (1♀), 4.VII.2022 (2♀, 1♂), 2.VIII.2022 (2♂) (Fig. 7).

Carabus (Procrustes) chevrolati internatus Heinz & Korge, 1964

Distribution: Türkiye (locality not specified) (Casale and Vigna Taglianti, 1999; Avgın and Cavazzuti, 2011); Bolu: Gerede, Esentepe, 1350 m (URL-7, 2025; URL-8, 2025).

Examined material: Bartın: Karamazak, 41°34'48.09"N, 32°11'58.82"E 1.VII.2022 (2♀, 1♂), 19.VII.2023 (1♂), 26.VII.2022 (1♂), 21.VIII.2023 (1♂), 25.X.2022 (2♀, 4♂), 25.X.2023 (6♂) (Kara et al., 2023); Zonguldak: Dirgine, Mamiş, 41°1'31.50"N, 31°50'43.21"E 23.VI.2022 (1♀).

The habitus and aedeagus of *C. (P.) chevrolati internatus* are presented in Fig. 8.



Figure 7. *C. (P.) scabrosus mentor*: (a) adult; (b) aedeagus



Figure 8. *C. (P.) chevrolati internatus*: (a) adult; (b) aedeagus

Carabus (Tomocarabus) convexus erzeliki Schweiger, 1962

Distribution: Türkiye (locality not specified) (Casale and Vigna Taglianti, 1999; Avgın and Cavazzuti, 2011); NW, NC-Türkiye: Bolu: Abant (URL-6, 2025; Lassalle, 2013); Ankara, Sinop (URL-6, 2025).

Examined material: Bartın: Ulus, Güneyören, 41°33'44.65"N, 32°45'12.13"E 24.VI.2022 (2♀, 1♂), 21.VII.2023 (1♀) (Kara et al., 2023); Karabük: Eğriova, Sipahiler, 41°6'8.34"N, 32°29'19.04"E 31.VIII.2022 (1♀); Safranbolu, Sofuoğlu, 41°23'5.75"N, 32°44'9.52"E 10.VIII.2023 (2♀, 1♂), 13.IX.2023 (1♀).

The habitus and aedeagus of *C. (T.) convexus erzeliki* are shown in Fig. 9.

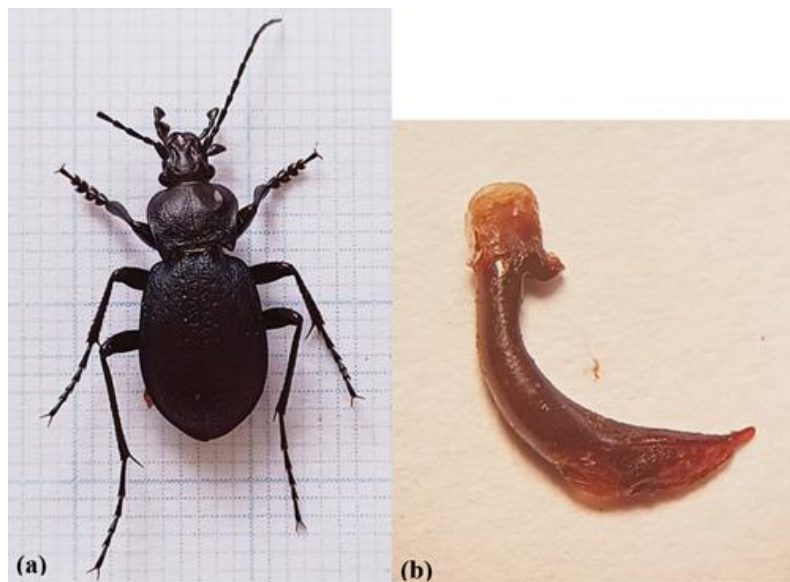


Figure 9. *C. (Tomocarabus) convexus erzeliki*: (a) adult; (b) aedeagus

Ecological characteristics, altitudinal ranges, habitat features, specimen numbers, and regional record status of the endemic *Carabus* taxa identified in the WBR are summarized in *Table 1*.

The endemic species previously identified and diagnosed by various researchers in the WBR are listed below.

Subfamily Carabinae Latreille, 1802

Carabus (Archicarabus) wiedemanni besucheti Schweiger, 1964

Distribution: Türkiye (locality not specified) (Casale and Vigna Taglianti, 1999; Avgın and Cavazzuti, 2011); Bolu: Bolu-Kaynaşlı (URL-6, 2025).

Carabus (Archicarabus) wiedemanni mengenicola Schweiger, 1969

Distribution: Türkiye (locality not specified) (Casale and Vigna Taglianti, 1999; Avgın and Cavazzuti, 2011); Bolu: Mengen (URL-6, 2025).

Carabus (Archicarabus) wiedemanni paphlagoniensis Breuning, 1954

Distribution: Türkiye (locality not specified) (Casale and Vigna Taglianti, 1999; Avgın and Cavazzuti, 2011); Kastamonu (Lassalle, 2013a; URL-6, 2025).

Carabus (Heterocarabus) marietti balboi Cavazzuti, 2006

Distribution: NW-Türkiye: Bolu: Bolu Mountain (URL-6, 2025; URL-9, 2022).

Carabus (Heterocarabus) marietti mouthiezi Lassalle, 1991

Distribution: NW-Türkiye: Zonguldak: Ahmetusta Pass (URL-6, 2025; URL-9, 2022).

Notes: Casale and Vigna Taglianti (1999) stated that this subspecies is a synonym of *C.(H.) marietti ormanensis* Blumenthal & Breuning, 1967.

Carabus (Heterocarabus) marietti muchei Breuning, 1961

Distribution: NW-Türkiye (URL-9, 2022); Kastamonu: Ilgaz Mountain (Avgın and Prunier, 2015; URL-6, 2025; URL-9, 2022).

Carabus (Heterocarabus) marietti ornatus Heinz, 1976

Distribution: NW-Türkiye: Kastamonu: Yaralıgöz (Avgın and Prunier, 2015; URL-6, 2025; URL-9, 2022), Çatalzeytin environment, Sinop: Çangal Mountain (URL-6, 2025; URL-9, 2022).

- Carabus (Heterocarabus) marietti pseudomarietti* Schweiger, 1964
Distribution: Türkiye: Bolu: Yedigöller, Yığılca, 1150 m (Avgın and Prunier, 2015).
- Carabus (Heterocarabus) marietti stefaniruspolii* Breuning, 1966
Distribution: Sinop: Dranaz Mountain (URL-6, 2025; URL-9, 2022).
- Carabus (Ischnocarabus) tenuitarsis balgoezensis* Deuve and Charet, 2004
Distribution: Sinop (Deuve, 2004 as cited in Avgın and Cavazzuti, 2011).
- Carabus (Lamprostus) erenleriensis erenleriensis* Heinz & Korge, 1967
Distribution: Bolu: Abant (Avgın and Prunier, 2015); Bolu Mountain (URL-10, 2022).
- Carabus (Lamprostus) erenleriensis fortépunctatus* Battoni & Blumenthal, 1973
Distribution: Türkiye (locality not specified) (Avgın and Cavazzuti, 2011); Zonguldak (URL-5, 2025); Bolu: Mengen (Avgın and Prunier, 2015; URL-6, 2025); Çankırı: Eskipazar; Bolu: Mengen, Yedigöller (URL-6, 2025).
- Carabus (Lamprostus) spinolae coeruleoviolaceus* Breuning & Ruspoli, 1970
Distribution: Sinop: Boyabat (Avgın and Prunier, 2015).
- Carabus (Lamprostus) spinolae lohsei* Heinz & Blumenthal, 1978
Distribution: Türkiye (locality not specified) (Avgın and Cavazzuti, 2011); Sinop: Zindan Mountain (Avgın and Prunier, 2015).
- Carabus (Lamprostus) spinolae pseudoducalis* Schweiger, 1964
Distribution: Türkiye (locality not specified) (Avgın and Cavazzuti, 2011); Kastamonu: Ilgaz Mnt. Massif (URL-6, 2025).
- Carabus (Lamprostus) spinolae sinopensis* Breuning, 1961
Distribution: Türkiye (locality not specified) (Avgın and Cavazzuti, 2011); Sinop: Dranaz Mountain (URL-6, 2025).
- Carabus (Lamprostus) spinolae usurpator* Cavazzuti, 1987
Distribution: Türkiye (locality not specified) (Avgın and Cavazzuti, 2011); Kastamonu (URL-5, 2025); Kastamonu: Devrekani, 1250 m (Avgın and Prunier, 2015; URL-6, 2025).
- Carabus (Oreocarabus) porrectangulus* Géhin, 1885
Distribution: Türkiye (locality not specified) (Avgın and Cavazzuti, 2011); between Ordu and İspir, Bolu, Kastamonu (Deuve, 2004 as cited in Avgın and Prunier, 2015); Trabzon, Bayburt, Giresun, Ordu (URL-6, 2025).
- Carabus (Oxycarabus) saphyrinus pseudosaphyrinus* Schweiger, 1964
Distribution: Bolu (Lassalle, 1998); Bolu: Abant, 1000 m (Avgın and Prunier, 2015); Bolu: Seben, Aladağ, 1500 m (URL-11, 2025); Bolu, Kastamonu, Sinop and notes it as “~*pseudosaphyrinus* Schweiger, 1962” un Bolu: Abant Mts., “=*kainashensis* Schweiger, 1964” Bolu: pass betw. Bolu/Kaynasli (URL-6, 2025).
- Carabus (Oxycarabus) saphyrinus rabaronianus* Breuning, 1964
Distribution: Türkiye (locality not specified) (Avgın and Cavazzuti, 2011); Sinop: Dranaz Mountain, Kastamonu: İnebolu, Yaralığöz (URL-6, 2025).
- Carabus (Sphodristocarabus) biroii leonardoi* Deuve, 2005
Distribution: Sinop (Avgın and Cavazzuti, 2011); Sinop: Ayancık, 30 km East (URL-6, 2025).
- Carabus (Sphodristocarabus) macrogonus drannadaghensis* Breuning, 1964
Distribution: NW-Türkiye: Sinop: Dranaz Mountain and Cangal Mountain, Kastamonu: Ilgaz, Yaralığöz (URL-6, 2025); Sinop: Dranaz (URL-12, 2025).
- Carabus (Sphodristocarabus) macrogonus schweigerinae* Schweiger, 1962
Distribution: Bolu: Abant Lake Province (Avgın and Prunier, 2015; Tezcan et al., 2018; URL-6, 2025).

Table 1. Ecological characteristics and record status of endemic *Carabus* taxa in the WBR

Taxon	Asp.	Alt. (m)	Slope (%)	Soil type	Veg. comp.	Dom. tree species (%)	No.	New record	Previous record
<i>Carabus</i> (L.) <i>erenleriensis</i> <i>ahmetustaensis</i>	NW	870	37	Clayey sandy loam	Beech, fir, rhod., shrubs	<i>Fagus</i> sp. 63.9%; <i>Abies</i> sp. 31.8%	9	Ulus-Bartın	Bartın (Ulus), Karabük (Ahm., Eflani), Zong.
	W	810	40	Sandy loam	Black pine, oak, Scots pine, beech, fir, hornbeam, apple, shrubs	<i>Pinus nigra</i> 60%; <i>Quercus petraea</i> 35%	56	Safr.-Karabük	
	S	320	25	Clayey sandy loam	Beech, oak, chestnut, elm, hornbeam, fern, shrubs	<i>Fagus</i> sp. 65%; <i>Q. petraea</i> 30%	62	Çaycuma-Zong.	
<i>Carabus</i> (L.) <i>erenleriensis</i> <i>bithynicus</i>	NW	870	37	Clayey sandy loam	Beech, fir, rhod., shrubs	<i>Fagus</i> sp. 63.9%; <i>Abies</i> sp. 31.8%	4	Ulus- Bartın	Bartın (Ulus), Bolu, Düzce
	S	180	22	Clay, clayey sandy	Beech, oak, chestnut, rhod., shrubs	<i>Fagus</i> sp. 58.3%; <i>Q. petraea</i> 39.6%	42	K. Ereğli- Zong.	
<i>Carabus</i> (L.) <i>erenleriensis</i> <i>karadagensis</i>	NE	1200	30	Clayey sandy loam	Scots pine, black pine, fir and shrubs	<i>P. sylvestris</i> 49.9%; <i>P. nigra</i> 36.9%	9	Eğriova-Karabük	Bolu
	SE	440	32	Clayey sandy loam	Oak, beech, hornbeam and shrubs	<i>Q. petraea</i> 45%; <i>Fagus</i> sp. 35%; <i>Carpinus</i> sp. 20%	16	Yenice-Karabük	
	S	650	35	Clayey, clayey sandy	Oak, black pine, beech, fir, shrubs	<i>Q. petraea</i> 65%; <i>P. nigra</i> 30%	23	Devrek-Zong.	
	NW	287	23	Sandy loam	Oak, black pine, hornbeam, linden, shrubs	<i>Q. petraea</i> 60%; <i>P. nigra</i> 35%	54	Dirgine-Zong.	
<i>C.(O.) saphyrinus</i> <i>mengenensis</i>	NW	870	37	Clayey sandy loam	Beech, fir, rhod., shrubs	<i>Fagus</i> sp. 63.9 %; <i>Abies</i> sp. 31.8%	12	Ulus- Bartın	Bartın (Ulus), Bolu
<i>C.(O.) saphyrinus</i> <i>yenicensis</i>	SE	120	10	Clay	Black pine seed orchard; hornbeam, oak, shrubs in surroundings	<i>P. nigra</i> 100%	41	Krm.-Bartın	Bartın (Centrum, Ulus), Karabük (Yenice)

Taxon	Asp.	Alt. (m)	Slope (%)	Soil type	Veg. comp.	Dom. tree species (%)	No.	New record	Previous record
	NW	870	37	Clayey sandy loam	Beech, fir, rhod., shrubs	<i>Fagus</i> sp. 63.9%; <i>Abies</i> sp. 31.8%	11	Ulus- Bartın	
	NE	1200	30	Clayey sandy loam	Scots pine, black pine, fir and shrubs	<i>P. sylvestris</i> 49.9%; <i>P. nigra</i> 36.9%	76	Eğriova-Karabük	
	W	810	40	Sandy loam	Oak, black pine, beech, elm, hornbeam	<i>P. nigra</i> 60%; <i>Q. petraea</i> 35%	23	Safr.- Karabük	
	SE	440	32	Clayey sandy loam	Oak, beech, hornbeam and other shrub vegetation	<i>Q. petraea</i> 45%; <i>Fagus</i> sp. 35%; <i>Carpinus</i> sp. 19.5%	3	Yenice-Karabük	
	S	320	25	Clayey sandy loam	Beech, oak, chestnut, elm, hornbeam, poplar, ferns	<i>Fagus</i> sp. 65%; <i>Q. petraea</i> 30%	24	Çaycuma-Zong.	
	S	650	35	Clayey, clayey sandy	Oak, black pine, beech, fir and shrubs	<i>Q. petraea</i> 65%; <i>P. nigra</i> 30%	7	Devrek-Zong.	
	NW	287	23	Sandy loam	Oak, black pine, hornbeam, linden, ferns and shrubs	<i>Q. petraea</i> 60%; <i>P. nigra</i> 35%	10	Dirgine-Zong.	
	S	180	22	Clayey, clayey sandy	Beech, oak, chestnut, rhod., shrubs	<i>Fagus</i> sp. 58.3%; <i>Q. petraea</i> 39.6%	66	K. Ereğli- Zong.	
<i>Carabus (P.) scabrosus mentor</i>	SE	120	10	Clay	Black pine seed orchard; hornbeam, oak, shrubs in surroundings	<i>P. nigra</i> 100%	7	Krm.-Bartın	Bartın (Centrum, Ulus), Bolu
	NW	870	37	Clayey sandy loam	Beech, fir, rhod., shrubs	<i>Fagus</i> sp. 63.9%; <i>Abies</i> sp. 31.8%	1	Ulus-Bartın	
	S	320	25	Clayey sandy loam	Beech, oak, chestnut, elm, ferns, shrubs	<i>Fagus</i> sp. 65%; <i>Q. petraea</i> 30%	2	Çaycuma-Zong.	
	S	650	35	Clayey, clayey sandy	Oak, black pine, beech, fir and shrubs	<i>Q. petraea</i> 65%; <i>P. nigra</i> 30%	8	Devrek-Zong.	
	NW	287	23	Sandy loam	Oak, black pine, linden, ferns, rhod., shrubs	<i>Q. petraea</i> 60%; <i>P. nigra</i> 35%	1	Dirgine-Zong.	
	S	180	22	Clayey, clayey sandy	Beech, oak, chestnut, rhod., shrubs	<i>Fagus</i> sp. 58.3%; <i>Q. petraea</i> 39.6%	6	K. Ereğli- Zong.	

Taxon	Asp.	Alt. (m)	Slope (%)	Soil type	Veg. comp.	Dom. tree species (%)	No.	New record	Previous record
<i>Carabus (P.) scabrosus mentor</i>									
<i>Carabus (P.) chevrolati internatus</i>	SE	120	10	Clay	Black pine seed orchard; hornbeam, oak, shrubs in surroundings	<i>P. nigra</i> 100%	18	Krm.-Bartın	Bartın (Centrum), Bolu
	NW	287	23	Sandy loam	Oak, black pine, linden, fern, rhod., and shrubs	<i>Q. petraea</i> 60%; <i>P. nigra</i> 35%	1	Dirgine-Zong.	
<i>Carabus (T.) convexus erzeli</i>	NW	870	37	Clayey sandy loam	Beech, fir, oak and shrubs	<i>Fagus</i> sp. 63.9%; <i>Abies</i> sp. 31.8%	4	Ulus-Bartın	Bartın (Ulus), Bolu
	NE	1200	30	Clayey sandy loam	Scots pine, black pine, fir and shrubs	<i>P. sylvestris</i> 49.9%; <i>P. nigra</i> 36.9%	1	Eğriova-Karabük	
	W	810	40	Sandy loam	Black pine, oak, Scots pine, beech, fir, apple, pear, shrubs	<i>P. nigra</i> 60%; <i>Q. petraea</i> 35%	4	Safr., Karabük	

Abbreviations: Asp., Aspect; Alt., altitude; Veg. comp., vegetation composition; Dom. tree spp., dominant tree species; No., number of specimens, rhod., rhododendron; Zong., Zonguldak; Safr., Safranbolu; Ahm., Ahmetusta; Krm., Karamazak. *Note:* Scientific names of plant taxa are given in full at first mention and abbreviated thereafter.

Subfamily Harpalinae Linnaeus, 1758

Licinus (Licinus) merkii J. Frivaldszky, 1880

Distribution: Türkiye (locality not specified) (Casale and Vigna Taglianti, 1999); URL-13, 2022); Bolu: Gerede (Avgın and Nodmar, 2009a).

Subfamily Pterostichinae Bonelli, 1810

Aganipterus (Hypogearius) akcakocai Giachino et al., 2024

Distribution: Bolu, Düzce: Akçakoca (Giachino et al., 2024).

Aganipterus (Hypogearius) boluensis Giachino et al., 2024

Distribution: Bolu: Yedigöller (Giachino et al., 2024).

Hypogearius casalei Giachino et al., 2024

Distribution: Bolu: Yedigöller, 1400-1500 m (URL-14, 2025).

Poecilus (Poecilus) ilgazdagensis Jedlicka, 1961

Distribution: Bolu: Gerede, Kastamonu (Avgın and Nodmar, 2009a).

Tapinopterus (Molopsis) relegatus Lohaj et al., 2012

Distribution: Asian Türkiye: Bolu: Mengen, Dorukhan Pass (Lohaj et al., 2012).

Subfamily: Trechinae Bonelli, 1810

Duvalius (Duvalius) bruschii Vigna Taglianti, 1999

Distribution: Zonguldak: Ereğli, İnsırtı (Oğlankız) Cave (Casale and Vigna Taglianti, 1999).

Trechus amasraensis Donabauer, 2004

Distribution: Küre Mountains West: Bartın: Amasra environment (Donabauer, 2007).

Trechus besucheti Pawlowski, 1977

Distribution: Küre Mountains Central (Donabauer, 2007).

Trechus boludagensis Donabauer, 2006

Distribution: Bolu: Bolu Mountains (Donabauer, 2007).

Trechus diogenes Pawlowski, 1979

Distribution: Küre Mountains East (Donabauer, 2007).

Trechus ilgazensis Donabauer, 2006

Distribution: Kastamonu: Ilgaz Mountains (Donabauer, 2007).

Trechus ilgazicus Pawlowski, 1976

Distribution: Kastamonu: Ilgaz Mountains (Donabauer, 2007).

Trechus paphlagonicus Maran, 1940

Distribution: Kastamonu: Ilgaz Mountains (Donabauer, 2007).

Trechus safranboluensis Donabauer, 2004

Distribution: Küre Mountains West: N of Safranbolu (Donabauer, 2007).

Trechus zonguldakensis Donabauer, 2004

Distribution: Zonguldak environment (Donabauer, 2007).

Based on all the data obtained, 47 endemic taxa belonging to the subfamilies Carabinae, Harpalinae, Pterostichinae, and Trechinae within the Carabidae family were identified in the WBR.

These include 1 species and 30 subspecies from the subfamily Carabinae Latreille, 1802; 1 species from Harpalinae Linnaeus, 1758; 5 species from Pterostichinae Bonelli, 1810; and 10 species from Trechinae Bonelli, 1810, all belonging to the family Carabidae. In previous studies, the subspecies *Carabus (Lamprostus) erenleriensis ahmetustaensis* was recorded from Zonguldak (Avgın and Prunier, 2015; URL-5, 2025; URL-6, 2025);

Karabük: Ahmetusta (Avgin and Prunier, 2015; URL-6, 2025) and Karabük: Eflani (URL-6, 2025). In our study, this subspecies was also recorded from Karabük: Safranbolu, Bartın: Ulus (Kara et al., 2023) and Zonguldak: Çaycuma.

The compiled data show that endemic Carabidae taxa are primarily concentrated in Bolu, Kastamonu, Sinop, Bartın, and Zonguldak, reflecting the region's ecological richness and the intensity of entomological surveys (Fig. 10).

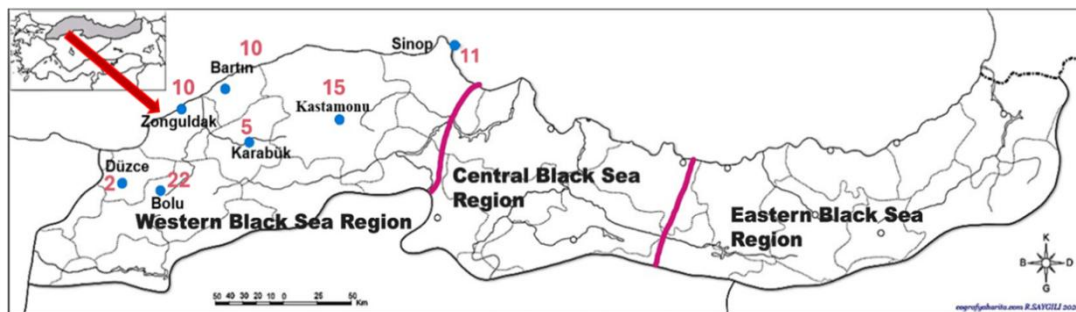


Figure 10. Subregions of the Black Sea Region and provinces within the WBR, showing endemic taxa per province (adapted from URL-15, 2025 and URL-16, 2017)

The overall ranking of provinces in endemic taxa richness is: Bolu, Kastamonu, Sinop, Bartın, Zonguldak, Karabük, and Düzce. The values shown in the figure correspond to the presently available records; however, it should be emphasized that these numbers are not definitive, as additional endemic taxa may be identified in future faunistic studies. This pattern likely results from a combination of habitat heterogeneity, altitudinal gradients, forest cover, and anthropogenic influences, with mountainous areas, forests, and river valleys serving as key habitats. However, as some taxa have not been recorded recently, their current population status remains uncertain and requires further field research.

Discussion

This study provides a regional synthesis of endemic Carabus species and subspecies recorded in the Western Black Sea Region by integrating newly obtained field data with previously published records. The findings reveal spatial variation in the occurrence of endemic taxa across the region. As summarized in Table 1, endemic taxa were recorded across a range of habitat types and altitudinal levels, reflecting the environmental heterogeneity of the Western Black Sea Region. In the following paragraph, these findings are discussed in the context of previous faunistic studies and regional endemism.

C. (Lamprostus) erenleriensis bithynicus has been previously identified in Bolu (Avgin and Prunier, 2015; URL-5, 2025; URL-6, 2025); Düzce: Akçakoca (Avgin and Prunier, 2015; URL-6, 2025) and Bartın: Ulus (Kara et al., 2023). In our study area, it was recorded from Zonguldak: Karadeniz Ereğli. *C. (L.) erenleriensis erenleriensis* has been found in Bolu: Abant Mountain (Avgin and Prunier, 2015) and Bolu Mountain (URL-10, 2022). The endemic subspecies *C. (L.) erenleriensis fortepunctatus* has been reported from Bolu: Mengen (Avgin and Prunier, 2015) and Zonguldak (URL-5, 2025). *C. (L.) erenleriensis karadagensis* was identified in Bolu: Karadağ (Avgin and Prunier, 2015). According to our findings, it is also distributed in Karabük: Eğriova, Yenice and

Zonguldak: Devrek, Dirgine. The subspecies *C. (Oxy-carabus) saphyrinus mengensis* was previously recorded from Bolu: Mengen (URL-6, 2025), while in our study, it was observed in Bartın: Ulus (Kara et al., 2023). *C. (O.) saphyrinus pseudosaphyrinus* has been reported from Bolu: Abant at 1000 m (Avgın and Prunier, 2015) and Bolu: Seben, Aladağ at 1500 m (URL-11, 2025). The subspecies *C. (O.) saphyrinus yenicensis* has previously been recorded from Karabük: Yenice (URL-6, 2025). In addition, *C. (O.) saphyrinus yenicensis* was identified in our study from the following localities: Bartın: Centrum, Ulus; Karabük: Eğriova, Safranbolu, Yenice and Zonguldak: Çaycuma, Devrek, Dirgine, and Karadeniz Ereğli. The subspecies *C. (Procerus) scabrosus mentor* was previously recorded from Bolu: Gerede (Avgın and Nodmar, 2009). In our study, this subspecies was observed in Bartın: Centrum and Ulus, as well as in Zonguldak: Çaycuma, Devrek, Dirgine, and Karadeniz Ereğli. The subspecies *C. (P.) chevrolati internatus* has been previously reported from Türkiye (locality not specified) (Casale and Vigna Taglianti, 1999; Avgın and Cavazzuti, 2011), as well as from Bolu: Gerede, Esentepe at 1350 m (URL-7, 2025; URL-8, 2025). In our study, this subspecies was identified in Bartın: Centrum and Zonguldak: Dirgine. The subspecies *C. (Tomocarabus) convexus erzeliki* has been reported from Türkiye (locality not specified) (Casale and Vigna Taglianti, 1999; Avgın and Cavazzuti, 2011); and from NW, NC-Türkiye: Bolu: Abant (URL-6, 2025; Lassalle, 2013), Ankara, Sinop (URL-6, 2025), and Bartın: Ulus, Güneyören (Kara et al., 2023). In our study, this subspecies was observed in Bartın: Ulus, Güneyören; Karabük: Eğriova, Sipahiler; and Karabük: Safranbolu, Sofuoğlu.

Several taxa exhibit restricted distributions within the region. For example, *C. (A.) wiedemanni mengicola* is known primarily from Mengen, Bolu. Similarly, *C. (L.) spinolae sinopensis* has been reported from Sinop: Dranaz Mountain, a locality that represents a unique forested corridor for this taxon. These narrow distributions, particularly when linked to single mountain ranges or valleys, point to the potential for micro-endemism in the WBR. Besides, some species identified in this study are confined to the WBR. The ecological and geographical constraints within the country define their limited distribution. This reinforces the necessity of integrating regional studies into national biodiversity assessments, particularly for conservation planning and policy-making.

The taxonomic placement and authorship of *Carabus (Lamprostus) pseudoducalis* Schweiger, 1964 have been treated inconsistently in the literature. Avgın and Cavazzuti (2011) reported the subspecies as *C. (L.) spinolae pseudoducalis*, without specifying a precise locality in Türkiye. In contrast, URL-6 (2025) listed the taxon under “*Carabus torosus*” as “ssp. *pseudoducalis* Heinz & Korge, 1967”, with records from northwestern Türkiye (Kastamonu, Ilgaz Mountain Massif), while simultaneously referring to “*pseudoducalis* Schweiger, 1964” as an uncertain name associated with the same locality. Similarly, Stan (2024), citing Březina et al. (2017), treated the taxon as *Carabus torosus pseudoducalis* Heinz & Korge, 1967, reporting its occurrence from the Ilgaz Mountains (Kastamonu, Türkiye).

The taxonomic treatment of *Carabus (Archicarabus) wiedemanni paphlagoniensis* has also varied among different authors. Casale and Vigna Taglianti (1999) and Avgın and Cavazzuti (2011) reported this subspecies as *Carabus (Archicarabus) wiedemanni paphlagoniensis* Breuning, 1954, indicating its occurrence in Türkiye without specifying a precise locality. In contrast, Lassalle (2013) treated “*paphlagoniensis*” under *Carabus (Archicarabus) victor*, listing it as “ssp. *paphlagoniensis* Breuning, 1954” and “n. *paphlagoniensis* Breuning, 1954”, with locality information provided for Türkiye

(Kastamonu). Similarly, URL-6 (2025) placed *paphlagoniensis* within the “*Carabus victor*”, referring to it as a synonym of “*Carabus victor* ssp. *wiedemanni* Ménéttriés, 1836”, and reporting its distribution from northwestern and north-central Türkiye, including Kastamonu.

A similar inconsistency is observed in the taxonomic treatment of *Carabus (Lamprostus) spinolae sinopensis*. Avgın and Cavazzuti (2011) listed this subspecies as *Carabus (Lamprostus) spinolae sinopensis* Breuning, 1961, without specifying a precise locality in Türkiye. In contrast, URL-6 (2025) attributed the taxon to “*Carabus torosus*”, recording it as *Carabus (Lamprostus) torosus* ssp. *sinopensis* Breuning & Ruspoli, 1970, with locality information from Sinop (Dranaz Mountain), while also referring to “*sinopensis* Breuning, 1961” as an uncertain name associated with the same region.

Taken together, these examples illustrate persistent inconsistencies in the taxonomic treatment of several endemic *Carabus* taxa across different sources, particularly with respect to species-level assignment, subspecific status, and authorship. Such discrepancies underscore the importance of critically reconciling historical taxonomic records with updated taxonomic revisions and highlight the need for further integrative taxonomic studies based on detailed morphological reassessments and, where possible, molecular data.

Conclusion

A total of 47 endemic taxa (17 species and 30 subspecies) belonging to the subfamilies Carabinae, Harpalinae, Pterostichinae, and Trechinae of the family Carabidae were identified in the Western Black Sea Region. These findings highlight the importance of the region in contributing to the understanding of Türkiye’s role as a major center of diversity for Carabidae. Conservation efforts should prioritize habitats within the region that support endemic or range-restricted taxa, particularly in the face of increasing habitat degradation and climate change. The results underline the value of integrating regional faunistic studies into national biodiversity assessments and conservation planning. Future research should focus on detailed ecological investigations, population monitoring, and habitat mapping to support the long-term conservation of these taxa and the habitats they depend on.

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