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Carabus (Pachystus) hungaricus luisacaldonae n. ssp. from western Bulgaria (Coleoptera Carabidae)

Ivan Rapuzzi

Muséum d'Histoire Naturelle (MHN) Geneve (Swiss) - Via Cialla, 47, 33040 Prepotto (Udine), Italy; e-mail: info@ronchidicialla.it; https://orcid.org/0000-0002-5644-6218

ABSTRACT In this article, a new subspecies of the steppe-dwelling stenobiont *Carabus (Pachystus) hungaricus* Fabricius, 1792 from western Bulgaria is described and illustrated: *C. (Pachystus) hungaricus luisacaldonae* n. ssp. Remarkably, this new taxon exhibits a strong morphological affinity with the eastern subspecies *C. (Pachystus) scythus* Motschulsky, 1847, particularly with specimens from localities of the Volga River, rather than with the geographically closed nominotypical subspecies typical of Central Europe.

KEY WORDS Coleoptera; Carabidae; *Carabus hungaricus*; new subspecies; Bulgaria.

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INTRODUCTION

Carabus (Pachystus) hungaricus Fabricius, 1792 is a stenotopic, steppe-dwelling ground beetle with a remarkably wide yet discontinuous distribution across the Eurasian continent. Its range extends from Central Europe (Austria, Hungary, Czech Republic, Slovakia, Serbia, Romania) to Eastern Siberia and includes several geographically and morphologically distinct subspecies (Bérces et al., 2008, 2023; Prunar et al., 2021; Turin et al., 2003). This strong fragmentation is primarily the result of the species' strict ecological specialization - it is confined to relictual, open, xerothermic steppe habitats, which are increasingly threatened by anthropogenic pressures.

Taxonomic interpretations of the *C. (P.) hungaricus* complex remain partially unresolved. In this study, a conservative approach is adopted by treating *C. (P.) cribellatus* Adams, 1812 as a subspecies of *C. (P.) hungaricus*, in contrast to the classification proposed by Turin et al. (2003), who consider it a distinct species. Molecular and morphological data supporting either position is still limited, and further integrative studies are necessary to clarify the group's phylogenetic structure.

Below, a new subspecies of *C. (P.) hungaricus* from western Bulgaria is described and illustrated.

MATERIAL AND METHODS

The specimens of this study were found during a field survey carried out in the surroundings of Dragoman and Slivnitsa (western Bulgaria). These specimens were found with direct hand collection under stones and nocturnal sampling using a light source. Specimen identification was conducted using a binocular microscope (Wild TYP 308700). The taxonomic framework adopted follows Deuve (2021).

For comparative purposes, additional specimens of *C. (P.) hungaricus* from I. Rapuzzi collection (Prepotto, Udine, Italy) were examined.

Acronyms. Spm: specimen/s; a.s.l.: above sea level; MHNG: Natural History Museum of Geneva, Swiss.

Carabus (Pachystus) hungaricus hungaricus Fabricius, 1792. Hungaria: Taborfalva; Örkény; Budapest; Budatètèny. Austria: Burgenland; Jois; Burgenland; Neusiedersee; Niederösterreich; Leithagebirge bei Winden, 150–250 m; Czech Republic: southern Moravia, Tabulova hora Mt., Mikulov, Kletnice env., 130 m; southern Moravia, Pouzdrany; southern Moravia, Palava; southern Moravia, Pavlovské kopce; southern Moravia, Hustopece. Croatia. Romania: Dolj, Murta. Serbia: Ruma.

Carabus (Pachystus) hungaricus viennensis Kraatz, 1877. Austria: umg. Wien; Wien; Laaerberg.

Carabus (Pachystus) hungaricus frivaldskyanus Breuning, 1933. Serbia: Vojvodina; Kovin; Deliblato Peščara.

Carabus (Pachystus) hungaricus mingens Quensel, 1806 (= *vomax* Dejean, 1826). Russia: N Caucasus, Ingushetia, Sunzha vill. env.; Kabarda; Krasnodar, Taman vill.; N-Caucasus, Karachaevo-Cherkessia region, 2 km NE Kardoninskaya; N-Caucasus, Karachaevo-Cherkessia region, Pastbishniy Mt. Rng., near Eltarkach village, 1340 m; Stavropol city, Strizhament Mt., 200 m; Stavropol city, Russkiy Les, 520 m; Kislovdsk env.; Daghestan, Rutul, 2800 m; Kalmykia, Cholun Khamur village.

Carabus (Pachystus) hungaricus gastridulus Fischer, 1823 (= *maeotis* Fischer, 1823). Crimea: Kerchensky peninsula, Leninskoe, Tashiy-Oba Mt.; Donuzlav lake (upper part); Donuzlav, Krasnojanskoje village; Feodosija district, Ordzhonikidze, Dzhan-Kutaran Mt.; Tarchankut peninsula, Bolshoy Kastel ravine; Krasnoyarskoe village; Bachtshisaraj; Tarkhankut peninsula, Krasnosel'skoje village.

Carabus (Pachystus) hungaricus scythus Motschulsky, 1847. Ukraine: Zaporozhia; Zaporizhia, near Vasylivka, Lysa Gora; Zaporizhia, Upper Khortysya; Dnipropetrovsk, Chapli village; Askania Nova; Rostov, Sholokhovskiy district, Matveevskiy village; Rostov, Sholokhovskiy district, Vesenskaya village; Rostov, near Zernograd, Zapolosny; Volgograd region, Dubovka, Peskovatka gorge; Russia: Volgograd, Peskovatka ravine.

Carabus (Pachystus) hungaricus cribellatus Adams, 1812 (= *perforatus* Fischer, 1822; = *thoracicus* Germar, 1824, nec Thunberg, 1784; = *variolaris* Ménétriés, 1849). Russia: Cetr. Uralsk, Uzun-Kul lake; Orenburg, Pervomaisky district, Talovskaya steppe; Siberia, Altai, Klyvan; Siberia, Altai, Kucherla valley; Altayskiy Kray, Ploskoe village, 400–600 m; Siberia, Khakassia, Cheryomushki village; Siberia, Krasnojarsk, Karakusha river; Siberia, Krasnojarsk, Stolby; East Siberia, Irkutsk, Kharat; Kazakhstan: Astana region, Enbekshilder district, Burevestnik village

RESULTS

Systematics

Ordo COLEOPTERA Linnaeus, 1758
Subordo ADEPHAGA Schellenberg, 1806
Familia CARABIDAE Latreille, 1802
Subfamilia CARABINAE Latreille, 1802
Genus *Carabus* Linnaeus, 1758
Subgenus *Pachystus* Motschulsky, 1865

***Carabus* (*Pachystus*) *hungaricus luisacaldonae* n. ssp.**
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TYPE MATERIAL. Holotype. BULGARIA • 1 spm male; Sofia Region, North from Slivnitsa, Tri Ushi hills; 800 m a.s.l.; 2 Jun. 2023; author's collection. Paratypes. BULGARIA • 19 spm males, 43 spm females; same data as the holotype; author's collection • 9 spm males, 8 spm females; Sofia Region, Dragoman, Chepan Planina; 1010 m a.s.l.; 2 Jun. 2023; author's collection. The holotype is temporarily housed in the author's collection (Prepotto, Udine, Italy) and will be permanently deposited in a public institution.

DESCRIPTION OF HOLOTYPE. Male (Fig. 1). Body elongate-oval, broad and robust. Total length (including mandibles): 29.6 mm; maximum elytral width: 11.3 mm. Dorsal surface uniformly glossy black; ventral surface black. Legs black, with tibiae somewhat lighter, showing a brownish tinge.

Head large and distinctly thickened; eyes large and prominent. Frons and vertex nearly flat. Surface deeply punctate and strongly wrinkled. Neck very broad and relatively long. Clypeus bisetose, with distinct lateral impressions. Labrum bilobed. Mandibles large and elongate. Median tooth of the mentum sharp, with an acuminate apex, approximately as long as the lateral lobes; gular setae present. Palps short and slender; penultimate segment of the labial palps bearing two or three setae.

Antennae short and slender, exceeding the base of the pronotum with the three apical segments. Antennomeres 2, 3, and 4 distinctly grooved and dorsally swollen. Pronotum large and transverse (1.45 times broader than long); widest just anterior to mid-length. Sides not sinuated, evenly margined and slightly upturned. Hind angles strongly projecting beyond the base, forming acute, triangular lobes with slightly rounded tips. Disc coarsely punctate and transversely wrinkled; median sulcus distinct and complete; basal impressions very shallow. Elytra ovate but distinctly elongate and convex, widest at the middle of their length. Shoulders prominent and rounded. Elytral sculpture consists of weakly raised, non-aligned granules. Primary foveae are fairly large but shallow, vaguely square in shape. The first two rows of foveae are clearly visible; the third, more lateral row is faint and barely discernible. Legs of normal length and rather stout. Protarsi with four strongly dilated segments, each bearing a ventral pad of adhesive setal soles.

Aedeagus. Distinctive and diagnostic for the subspecies, differing clearly from both Central and Eastern European forms. In lateral view (Fig. 3), it is larger and more robust than in Central European subspecies, with a longer and thinner apex. A slight but well-defined ventral swelling is present in the preapical region. In frontal view (Fig. 4), this ventral preapical swelling appears even more pronounced; the apical lobe is shorter and distinctly dentiform, rather than expanded.

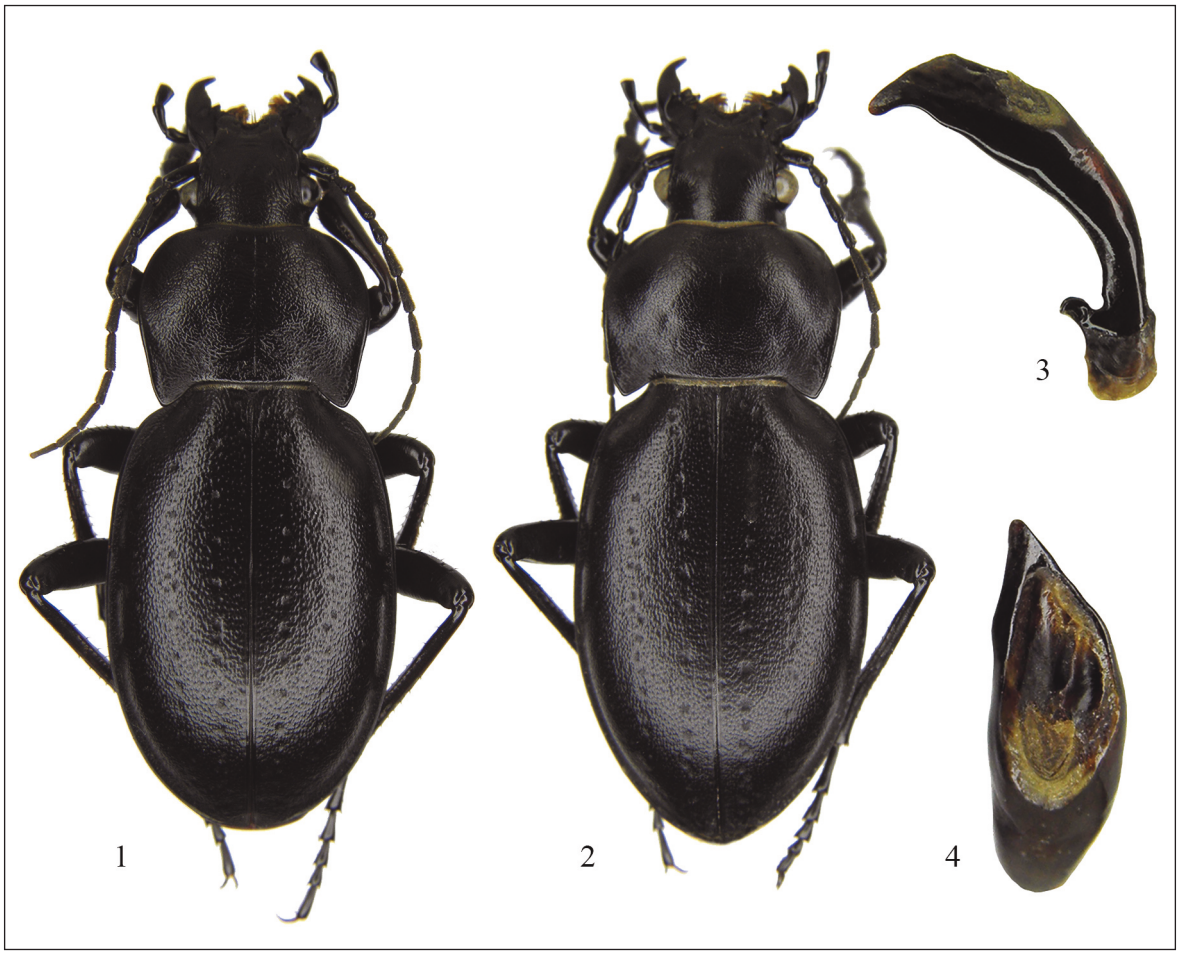


Figure 1. *Carabus (Pachystus) hungaricus luisacaldonae* n. ssp., holotype male, 29.6 mm, habitus dorsal view. Figure 2. *Carabus (Pachystus) hungaricus luisacaldonae* n. ssp., paratype female, 32 mm, habitus dorsal view. Figure 3. *Carabus (Pachystus) hungaricus luisacaldonae* n. ssp., aedeagus of holotype, lateral view (dorsal side up). Figure 4. *Carabus (Pachystus) hungaricus luisacaldonae* n. ssp., aedeagus of holotype, frontal view.

VARIABILITY. The variability within the subspecies is relatively modest and primarily concerns body size, which ranges in males from 26.8 to 29.2 mm, and in females from 28.3 to 32.4 mm (total length including mandibles). Minor differences are also observed in the elytral sculpture, which may appear more or less granulate.

ETYMOLOGY. The new subspecies is affectionately dedicated to Mrs. Luisa Caldon (Udine, Italy), in recognition of her enduring presence as my inseparable companion in both scientific exploration and life. This dedication is a heartfelt tribute to her unwavering support, intellectual curiosity, and deep love for nature - qualities that have always inspired and enriched our shared journey. The name *luisacaldonae* not only honors her as a person, but also symbolizes the profound connection we share through a life devoted to nature, travel, and the search for beauty in its rarest and most fragile forms.

REMARKS. Across its broad European range - including southwestern Slovakia, southeastern Moravia, eastern Austria, Hungary, eastern Croatia, eastern Serbia, and southwestern Romania - *C. (P.) hungaricus* displays a relatively homogeneous morphology. Slight, though consistent, differences are observed only in *C. (P.) hungaricus frivaldskyanus* (Figs. 5–7) from eastern Serbia and southwestern Romania, where specimens tend to show larger primary elytral foveae and slightly more pronounced sculpture, resulting in a somewhat duller appearance. However, individuals from Ruma (Serbia) clearly conform to the nominotypical form.

The subspecies *C. (P.) hungaricus viennensis*, typically found around Vienna, comprises smaller, glossy individuals with smooth elytra, characteristics that fall within the natural variation of the nominotypical form. Multiple authors (e.g., Freude, 1976; Turin et al., 2003) have already questioned the validity of *C. (P.) hungaricus viennensis* and *C. (P.) hungaricus frivaldskyanus* as distinct subspecies, and Breuning (1932–1936) considered them simple "natio" of *C. (P.) hungaricus hungaricus* due to the weak discriminatory value of their defining traits.

By contrast, *C. (P.) hungaricus luisacaldonae* n. ssp. exhibits a combination of distinct morphological features that readily separate it from all Central European forms (*hungaricus*, *viennensis*, *frivaldskyanus*), including: markedly larger body size, glossier dorsal surface, very stout and enlarged head with dense punctation and deep wrinkling, longer mandibles, antennomeres 2–4 distinctly grooved and swollen dorsally (not merely depressed), less transverse pronotum with sharply angled, blunt but non-rounded basal lobes, coarse punctation and strong transverse wrinkling on the head and pronotum, reddish-brown tibiae.

When compared with the Eastern subspecies, *C. (P.) hungaricus luisacaldonae* n. ssp. also shows notable differences.

From *C. (P.) hungaricus gastridulus*, Crimea peninsula: larger and more robust head, denser punctation, sharper pronotal lobes, more globose elytra, and brownish tibiae.

From *C. (P.) hungaricus mingens*, north of the Caucasus: less stocky appearance, shinier body, sharper and more protruding pronotal angles, smoother elytral sculpture, and reddish tibiae.

From *C. (P.) hungaricus scythus*, Dniester–Don steppe (Figs. 8–10): less transverse pronotum, more pointed pronotal lobes, ovate elytra, and absence of secondary foveae. Black tibiae are consistent in *scythus* across this range, with only the Volga population showing brownish tibiae and a more enlarged head - features aligning it somewhat closer to *cribellatus*.

From *C. (P.) hungaricus cribellatus*: significantly larger body, smoother elytral sculpture, wider spacing of primary foveae, complete absence of secondary and tertiary foveae, and sharply pointed pronotal lobes. *Carabus (P.) hungaricus cribellatus* is consistently smaller and more irregularly sculptured, with brownish tibiae across its entire range.
The presence of a very enlarged head and brownish tibiae in *C. (P.) hungaricus luisacaldonae* n. ssp. - traits considered by Turin et al. (2003) as diagnostic at the species level in distinguishing *C. (P.) hungaricus hungaricus* from *C. (P.) hungaricus cribellatus* - further highlights its taxonomic singularity.

Compared to these Eastern subspecies (*mingens*, *gastridulus*, *scythus*, and *cribellatus*), the aedeagus of *C. (P.) hungaricus luisacaldonae* n. ssp. is more voluminous and consistently arcuate throughout its length. In *mingens*, *gastridulus*, and *scythus*, the apical lobe is much longer and broadly spatulate in frontal view, whereas in *C. (P.) hungaricus cribellatus* it is smaller, more slender, and nearly straight, lacking the distinctive dentiform profile observed in *C. (P.) hungaricus luisacaldonae* n. spp.

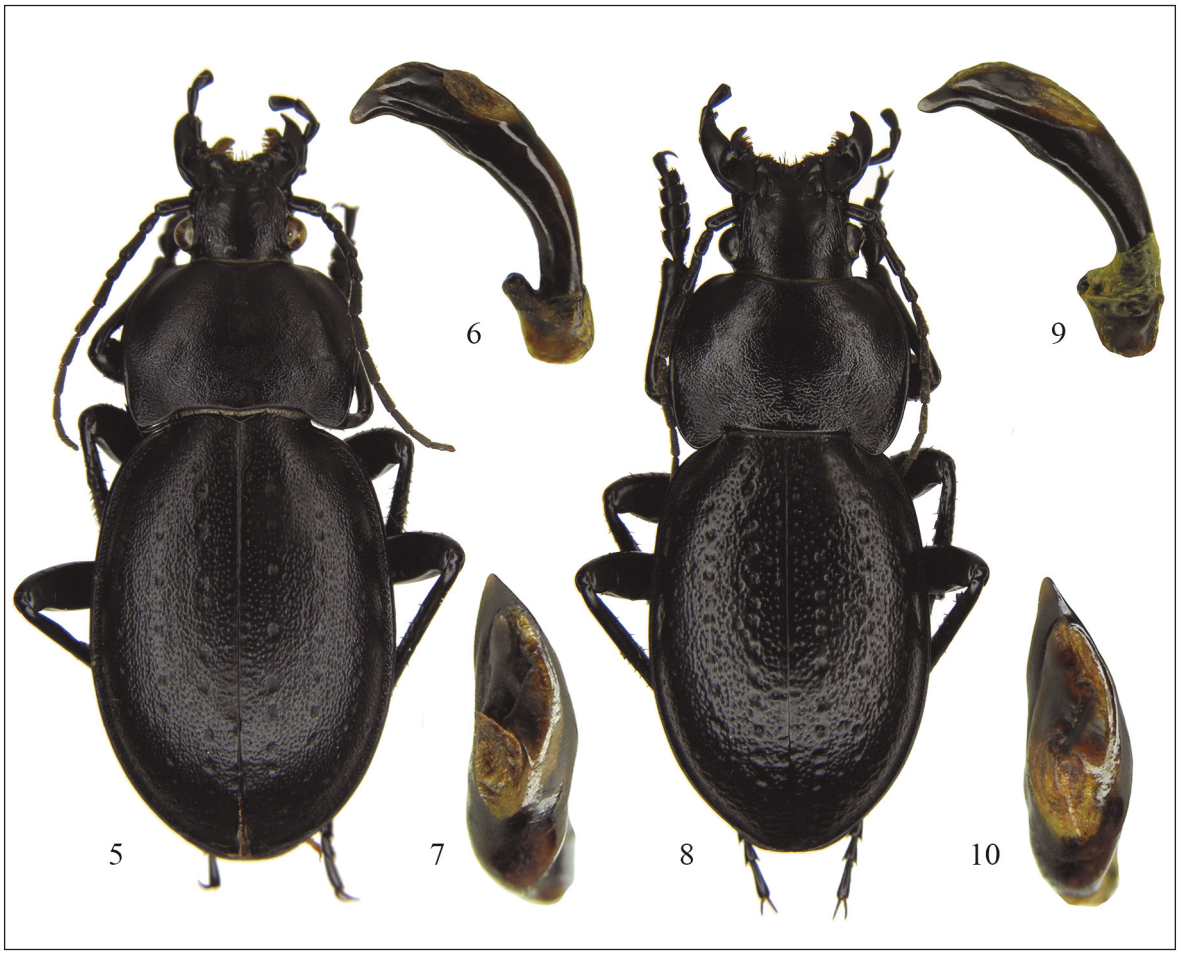
A dichotomous key to the identification of the currently recognized subspecies of *C. (P.) hungaricus* is provided below.

1. Tibiae brownish or reddish-brown at least in part; head strongly thickened.....2
- Tibiae uniformly black; head less thickened.....4

2. Elytral sculpture fine and regular; primary foveae widely spaced; secondary and tertiary foveae absent; large body size (27–33 mm); pronotal lobes sharply pointed; pronotal surface coarsely punctate and transversely wrinkled; antennomeres 2–4 dorsally swollen; found in western Bulgaria (Dragoman region).....
.....*C. (P.) hungaricus luisacaldonae* n. ssp.
- Elytral sculpture irregular or denser; body size smaller; distribution more eastern.....3

3. Elytra irregularly sculptured; primary foveae close together; smaller body size (22–28 mm); pronotal lobes less acuminate; overall duller appearance; found in Central-Eastern Siberia and Northern Kazakhstan.....
.....*C. (P.) hungaricus cribellatus* Adams, 1812
- Elytra smoother; head strongly thickened; tibiae usually black, occasionally brownish in easternmost populations (Volga). Larger body size (28–33 mm) (Dnieper to Volga).....
.....*C. (P.) hungaricus scythus* Motschulsky, 1847

4. Elytral sculpture dull, granular or wrinkled; in-



Figures 5–7. *Carabus (Pachystus) hungaricus frivaldskyanus* Breuning, 1933: Serbia, Vojvodina, Kovin, Deliblato Peščara. Fig. 5: male, 27.1 mm, dorsal view. Fig. 6: aedeagus, lateral view (dorsal side up). Fig. 7: aedeagus, frontal view. Figures 8–10. *Carabus (Pachystus) hungaricus scythus* Motschulsky, 1847: Ukraine, Zaporizhia, Upper Khortysya. Fig. 8: male, 29 mm, dorsal view. Fig. 9: aedeagus, lateral view (dorsal side up). Fig. 10: aedeagus, frontal view.

tervals raised; basal pronotal impressions nearly obsolete.....5
- Elytral sculpture smooth or finely punctate; intervals flat; basal pronotal impressions distinct.....6

5. Elytral surface coarsely granulate; primary intervals slightly elevated; body compact and dull. (28–33 mm). Steppe regions of the North Caucasus.....
.....*C. (P.) hungaricus mingens* Quensel, 1806
- Elytral surface dull but not granular; elytral intervals flat and not elevated; pronotal and head punctation shallow; basal impressions faint. (28–33 mm). Crimea.....
.....*C. (P.) hungaricus gastridulus* Fischer, 1823

6. Pronotal lobes obtuse and rounded; head small; elytra smooth and glossy; body small to medium-sized (22-28 mm); primary foveae small and less distinct; widespread across Central Europe.....
C. (P.) hungaricus hungaricus hungaricus Fabricius, 1792 (including *viennensis* Kraatz, 1877)
- Elytra duller; primary foveae larger and more distinct; found in eastern Serbia and southwestern Romania.....
..*C. (P.) hungaricus frivaldskyanus* Breuning, 1933

Although Deuve (2021) attributes subspecific rank to *C. (P.) hungaricus viennensis*, specimens from the Vienna area exhibit only very weak and inconsistent distinguishing features. They tend to be slightly smaller in body size and show somewhat reduced primary elytral foveae compared to other populations of *C. (P.) hungaricus* s. str. However, these differences lie within the range of intraspecific variability and are not sufficient to justify recognition as a valid subspecies.

DISCUSSION AND CONCLUSIONS

The new subspecies represents the southernmost known population of *C. (P.) hungaricus* in Europe and is geographically isolated from the nearest populations in Serbia and Romania. It was discovered in an extremely localized and isolated population in western Bulgaria, specifically in the karstic steppe enclaves of the Chepan Planina and Tri Ushi Mountains, within the Natura 2000 site “Dragoman”, located in the westernmost portion of the Balkan Mountains. This area represents a southern relict enclave of the Eurasian steppe and is of notable biogeographical interest. The coexistence of this new taxon with *Carabus (Tomocarabus) bessarabicus tangra* Teofilova, Rapuzzi et Kodzhabashev, 2025 - another steppe-dwelling stenoendemic species recently described from the same locality - reinforces the status of the Dragoman basin as a microrefugium of exceptional conservation value.

This isolated steppe habitat is of great ecological significance, hosting several rare and localized endemic taxa. It has recently been the subject of detailed ecological and conservation studies by Teofilova & Kodzhabashev (2025), whose comprehensive work has greatly advanced our understanding of the distribution, habitat requirements, and conservation priorities for *C. hungaricus* in Bulgaria. Based on an extensive multi-year field survey and supported by ecological and zoogeographic analyses, their research has documented the extreme specialization and vulnerability of these populations, which persist only in highly specific karstic steppe conditions. Their findings have underscored the urgent need for targeted conservation measures, as the Dragoman region harbors one of the last intact steppe refugia in southwestern Europe.

The present description of *C. (P.) hungaricus luisacaldonae* n. ssp. represents a taxonomic advancement that builds upon and complements the ecological and conservation framework established by Teofilova & Kodzhabashev (2025). It further reinforces the importance of the Dragoman karst basin as a critical center of endemism, evolutionary significance, and conservation concern for steppe-adapted taxa in the Balkans.

Of particular interest - and somewhat unexpected - is the clearly closer morphological affinity of *C. (P.) hungaricus luisacaldonae* n. ssp. with the eastern subspecies *scythus* Motschulsky, 1847, especially with specimens from the Volga River basin, rather than with the geographically closer subspecies of Central Europe, which occurs in nearby areas of Serbia and Romania.

This biogeographic pattern, together with the sympatric presence of *C. bessarabicus* a typically East European–Siberian element, suggests that *C. (P.) hungaricus luisacaldonae* n. ssp. may have originated from an independent colonization event from the east, possibly during a different historical

period than that of the other European populations of *C. (P.) hungaricus*.

This scenario warrants further phylogenetic investigation, ideally incorporating molecular data, to clarify the evolutionary relationships of both *luisacaldon*ae and *tangra*.

It is also worth noting that Bulgaria is the only European country to host five of the six *Pachystus* species present in Europe: *C. cavernosus* Frivaldsky, 1837; *C. graecus* Dejean, 1826; *C. hortensis* Linnaeus, 1758; *C. hungaricus* Fabricius, 1792; and *C. preslii* Dejean, 1830. Only *C. glabratus* Paykull, 1790 is absent from the Bulgarian fauna.

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