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NOTES ON THE TAXONOMY OF THE GENUS *CARABUS* L. (COLEOPTERA: CARABIDAE) IN CROATIA

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Abstract There are various opinions on the taxonomy of the genus *Carabus* Linnaeus 1758 and the taxonomic position of some species and lower taxa has still not been determined. The genus *Carabus* has 132 species in Europe, while 32 species, 53 subspecies and 81 forms and aberrations have been determined for Croatia. This paper provides a review of all species of the genus *Carabus* in Croatia, with a reference to the problems in taxonomy. One problem consists of the very large number of synonyms, particularly in older literature, and in the substitution of old with the new names, as well as the taxonomic status of certain taxa. The greatest number of synonyms is recorded for the subspecies of the species *C. catenulatus* Scopoli 1763. The subspecies *C. hortensis neumeyeri* Schaum 1856 is mentioned by some authors as subspecies of *C. preslii* Dejean 1830, because of certain similarities. Many authors agree that the species *C. croaticus* Dejean 1826, a Croatian endemic, has been insufficiently investigated and it is necessary to confirm its taxonomic status. Forms, aberrations and subspecies of certain species recorded in Croatia are not to be found in the latest checklists and atlases in Europe, and it is necessary to determine their taxonomic status within the genus. Redeterminations and reclassifications with the assistance of morphological and molecular biological methods are necessary for the taxonomic problems to be solved.

KEY WORDS: Coleoptera, Carabidae, *Carabus*, taxonomy, distribution, Croatia.

Izvleček ZAPISKI O TAKSONOMIJI RODU *CARABUS* L. (COLEOPTERA: CARABIDAE) V HRVAŠKI

O taksonomiji rodu *Carabus* Linnaeus 1758 obstajajo različna mnenja, taksonomski položaj nekaterih vrst in nižjih taksonov še ni določen. Rod *Carabus* šteje

132 vrst v Evropi, 32 vrst, 53 podvrst ter 81 oblik in različkov pa je bilo ugotovljenih v Hrvaški. V tem delu nudimo pregled vseh vrst rodu *Carabus* na Hrvaškem, z ozirom na težave v taksonomiji. Ena izmed težav je veliko število sinonimov, posebno v starejši literaturi, ter zamenjava starejših z novimi imeni, kot tudi taksonomski položaj nekaterih taksonov. Največje število sinonimov smo zabeležili za podvrste vrste *C. catenulatus* Scopoli 1763. Podvrsto *C. hortensis neumeyeri* Schaum 1856 nekateri avtorji zaradi določenih podobnosti omenjajo kot podvrsto *C. preslii* Dejean 1830. Mnogi avtorji se strinjajo, da je vrsta *C. croaticus* Dejean 1826, hrvaški endemit, premalo raziskana in je potrebno potrditi njen taksonomski položaj. Oblike, različki in podvrste določenih vrst, najdenih na Hrvaškem, ne najdemo v zadnjih seznamih in atlasih v Evropi, nujno je ugotoviti njihov taksonomski položaj v okviru rodu. Ponovne določitve in uvrstitve s pomočjo morfoloških in molekularno bioloških postopkov so nujne za rešitev taksonomskih težav.

KLJUČNE BESEDE: Coleoptera, Carabidae, *Carabus*, taksonomija, razširjenost, Hrvaška.

Introduction

The genus *Carabus* Linnaeus 1758 belongs to the subfamily *Carabinae*, family *Carabidae*, suborder *Adephaga* and order *Coleoptera*. According to Brezina (1999) there are 802 species of the genus worldwide and 132 species in Europe (Turin et. al. 1993). This work comprises records of 32 species of the genus recorded in Croatia (occurrence of three of them are dubious). Among them there are 53 subspecies and 81 forms and aberrations with a very large number of synonyms present, particularly in older literature. These results are based on data comprised from literature, collections from the Faculty of Science in Zagreb, and part of collection from the Croatian Natural History Museum in Zagreb. The data comprised from literature go back to 1763 and the majority of data found in literature was published before 1950. The first publications on the *Carabus* species in Croatia are the works of Scopoli (1763), Schlosser (1877), Apfelbeck (1905), Depoli (1929) etc. During the middle of the 19th century, Novak (1952) collected valuable data about their distribution in Croatia (mainly in the coastal region).

Several species of ground beetles (according to the data retrieved from Durbešić 1968, 1982, 1989, 1992; Drovenik & Peks 1994, 1999), present in Croatia, can be found on the European lists of endangered species. However, their distribution in Croatia is not known in detail. Because of endemic and endangered species of the genus *Carabus*, knowledge about their biology and habitats is important for preservation of biological diversity in Croatia. But, as the taxonomic position of some species and lower taxa has still not been determined and co-ordinated, we started with collecting and systematising of data about the genus *Carabus* with the aim of establishing present state of our knowledge and defining objectives for further research.

Because of great variability within species, many forms are described under various infrasubspecific categories that are not commonly used by entomologists. There are many names of taxa originally published as natio, morpha and aberration, or as a variety or form which is inconsistent with the ICZN (1999). Problem of uncritical description of variable specimens as new forms (etc.) was observed by Drovenik (1972) in his work about the genus in Slovenia.

This paper provides a critical review of preliminary list of all species of the genus *Carabus* in Croatia, with a reference to the problem of taxonomy.

Results and discussion

The map of distribution of the *Carabus* species in Croatia (Figure 1) points to the insufficiency of the exploration of the whole area. The uneven exploration on Croatian territory demands additional field explorations of the areas which are poorly or not at all explored.

The following list of the species in Croatia comprises 32 species with available data about their localities. Species with doubtful occurrence, according to the authors, are marked with asterisk (*) and discussed later in the text.

List of species:

- Carabus* (*Limnocarabus*) *clathratus* Linnaeus 1761
C. (*Morphocarabus*) *praececellens* Palliardi 1825
C. (*Morphocarabus*) *scheidleri* Panzer 1799
C. (*Morphocarabus*) *scabriusculus* Olivier 1795
C. (*Carabus*) *granulatus* Linnaeus 1758
 **C.* (*Carabus*) *menetriesi* Hummel 1827 - doubtful occurrence
C. (*Eucarabus*) *arvensis* Herbst 1784
C. (*Eucarabus*) *catenulatus* Scopoli 1763
C. (*Eucarabus*) *parreyssi* Palliardi 1825
C. (*Eucarabus*) *ullrichi* Germar 1824
C. (*Autocarabus*) *cancellatus* Illiger 1798
C. (*Archicarabus*) *montivagus* Palliardi 1825
C. (*Archicarabus*) *nemoralis* Mueller 1764
 **C.* (*Hemicarabus*) *nitens* Linnaeus 1758 - doubtful occurrence
C. (*Mesocarabus*) *problematicus* Herbst 1786
C. (*Orinocarabus*) *carinthiacus* Sturm 1815
C. (*Oreocarabus*) *glabratus* Paykull 1790
C. (*Oreocarabus*) *hortensis* Linnaeus 1758
 **C.* (*Oreocarabus*) *preslii* Dejean 1830 - doubtful occurrence
C. (*Tomocarabus*) *convexus* Fabricius 1775
C. (*Pachystus*) *cavernosus* Frivaldszky 1837
C. (*Hygocarabus*) *variolosus* Fabricius 1787
C. (*Chaetocarabus*) *intricatus* Linnaeus 1761

- C. (Platycarabus) creutzeri* Fabricius 1801
C. (Platycarabus) irregularis Fabricius 1792
C. (Megadontus) caelatus Fabricius 1801
C. (Megadontus) croaticus Dejean 1826
C. (Megadontus) germari Sturm 1815 - by several authors regarded as a subspecies of *C. violaceus* (e. g. Brezina 1994)
C. (Megadontus) violaceus Linnaeus 1758
C. (Chrysocarabus) auronitens Fabricius 1792
C. (Procrustes) coriaceus Linnaeus 1758
C. (Procerus) gigas Creutzer 1799

The greatest number of synonyms is recorded for the subspecies of the species *C. catenulatus* Scopoli 1763, *C. coriaceus* Linnaeus 1758, *C. caelatus* Fabricius 1801, *C. cancellatus* Illigeri 1798. There are a great number of permanently invalid names (e.g. *C. convexus latus* Depoli 1925 nec Linnaeus 1758), misspellings (e.g. *C. ullrichii* Germar 1824, *C. paraysi* Palliardi 1825) and substitutions of old names with the new ones. A correct name *C. arcensis* Herbst 1784 was substituted with more often used *C. arvensis* Herbst 1784.

In this research problem of taxonomic status of certain taxa is obvious because of many forms present within the genus.

C. praecellens Palliardi 1825 was described as a variety of *C. scheidleri* Panzer 1799. (e.g. Kuthy 1900). Drovenik (1972) and Drovenik & Peks (1999) treat it as a separate species. In the recent checklists and atlases (Brezina 1994, 1999) this taxon is treated as a subspecies of *C. scheidleri* Panzer 1799. In Croatia following taxa were recorded: *C. praecellens styriacus* Kraatz 1887 at Dilj Gora in Slavonia region (Koča 1905), *C. praecellens illigeri* Dejean 1826 (Apfelbeck 1905; Schlosser 1877), and *C. praecellens curtulus* Ganglbauer 1892 as endemics (Drovenik & Peks 1994).

**C. menetriesi* Hummel 1827 is a higrophylous species morphologically and ecologically very similar to *C. granulatus* Linnaeus 1758 (Casale et al. 1982), that can be found in Croatia in lowland areas beside rivers (Durbešić et al. 2000). *C. menetriesi* is present in Central Europe, Northern Russia, Finland, Byelorussia and Latvia (Brezina 1999). Some of its subspecies are recorded in eastern Austria (Brezina 1999) and in Bulgaria (Gueorguiev & Gueorguiev 1995). There are no other records for Croatia besides the single one from Valpovački park area. The specimen from the collection of the Faculty of Science in Osijek needs to be re-evaluated, because it was probably mistaken for *C. granulatus*.

C. catenulatus Scopoli 1763 was previously named and cited as *C. catenatus* Panzer 1805 (Casale et al. 1982). Therefore it was recorded in Croatia as *C. catenatus* found at Ogulin, Fužine, Velebit, Rijeka, Bakar and Gospić areas (Kuthy 1900). Information about the distribution of infraspecific forms of the species in Croatia were collected from 16 papers (Brezina 1994, 1999; Casale et al. 1982; Depoli 1929; Drovenik & Peks 1994, 1999; Durbešić 1982, 1992; Kuthy 1900; Magistretti 1965; Novak 1952, 1970; Rucner 1994; Schlosser 1877; Turin et al. 1993 and Winkler

1924-32). Following taxa were recorded: *ssp. catenulatus* Scopoli 1763, *n. catenulatus* Scopoli 1763, *v. herbsti* Dejean 1826, *hosti* Depoli 1929, *troyeri* Born 1911, *v. fontanellae* Reitter 1897, *v. mosorensis* Mueller 1930, *a. dinaricus* Apfelbeck 1904, *v. Padewiethi* Csiki 1906, *v. Gattereri* Gehin 1882, *aenescens* Depoli 1929, *f. alternatus* Houry 1885 and *f. subvirescens* Motschoulsky 1865 (names are cited as they were originally published). Turin et al. (1993) and Brezina (1999) treat taxa *herbsti*, *hosti*, *alternatus*, *troyeri*, *mosorensis* as synonyms, and *aenescens* as incorrect.

**C. nitens* Linnaeus 1758 is Central and Northern European species (Casale et al. 1982). Schlosser (1877) found this species at Velebit and in Dalmatia. This reference is the only source for this species found by now. Therefore, it should be checked by further research of literature and collections.

According to Casale et al. (1982) there are certain problems in the systematic position of the species *C. hortensis* Linnaeus 1758, that various authors tend to solve in different ways. Casale et al. (1982) considers this species not to be present in western and southern parts of the Balkan peninsula, where it is substituted by **C. preslii* Dejean 1830. The species *C. hortensis neumeyeri* Schaum 1856 is considered by some authors as subspecies of *C. preslii* Dejean 1830 (Casale et al. 1982; Taglianti 1993; Turin et al. 1993) (Figure 2). Winkler (1924-32), Brezina (1999), Drovenik & Peks (1994, 1999) cited *C. hortensis neumeyeri* Schaum 1856 as a Croatian endemic distributed in Dalmatia. Novak (1952) records it in southern Dalmatia near Dubrovnik, and taxon *a. Walteri* Reitter 1896 in central Dalmatia. Taxa *ostariensis* Born 1912 and *sarygradensis* Born 1912 are recorded at Velebit, Benkovac, Starigrad-Paklenica and Oštarije-Velebit (Novak 1952; Born 1912; Winkler 1924-32; Casale et al. 1982). Brezina (1999) cited these taxa as synonyms for infrasub-specific forms within *ssp. hortensis*, taxon *preslii* as a subspecies of *C. hortensis* Linnaeus 1758 distributed in northern Greece, and taxon *Walteri* as a synonym for *ssp. neumeyeri*.

C. caelatus Fabricius 1848 and *C. croaticus* Dejean 1826 are sister species, differentiated by way of geographic isolation for a long time and also by different ecological circumstances (Casale et al. 1982). Many infraspecific forms are recorded for Croatia. Brezina (1999) cites taxa *macretus*, *procerus* and *dinaricola* as synonyms ranked among *ssp. dalmatinus*, while Drovenik & Peks (1999) treat taxon *macretus* as a separate form within the *ssp. dalmatinus* and taxon *procerus* as a subspecies. Turin et al. (1993) consider its status doubtful. Taxon *schreiberi* is recorded as subspecies (see Turin et al. 1993; Brezina 1994, 1999), but some authors treat it as infrasub-specific form within *ssp. caelatus* (see Drovenik & Peks 1994, 1999).

The distribution map of *Carabus caelatus* taxa (Figure 3) suggests that *C. caelatus macretus* prefer north-western region with *caelatus* and *schreiberi*, while *C. caelatus dalmatinus*, *dinaricola* and *procerus* prefer southern regions. *C. caelatus dalmatinus* is distributed along the coastal region of the Adriatic Sea.

C. croaticus Dejean 1826 is an endemic species of the western part of the Balkan peninsula, distributed in SW Slovenia, Croatia, Bosnia and Herzegovina, Albania and NW Macedonia, excluding coastal region of the Adriatic sea (Durbešić 1982). It

was described in Croatia in Baške Oštarije region. Another form *frankenbergeri* Obenberger 1914 was described at Velika Kapela region. *C. croaticus* and *C. caelatus*, differentiated into separate species by their geographic isolation, can be found together in Gorski Kotar and Velebit (Figure 4). Many authors agree that *C. croaticus* Dejean 1826, a Croatian endemic, has been insufficiently explored and that it would be necessary to confirm its taxonomic status.

Forms, aberrations and subspecies of certain species recorded in Croatia are not to be found in the latest checklists and atlases in Europe, and it is necessary to examine and determine their taxonomic status within the genus. This overview should be supplemented by the detailed studies of each individual species, while the specimens in collections should be redetermined. Also, further studies on morphology and phylogeny with a molecular analysis are needed for further clarification of their status.

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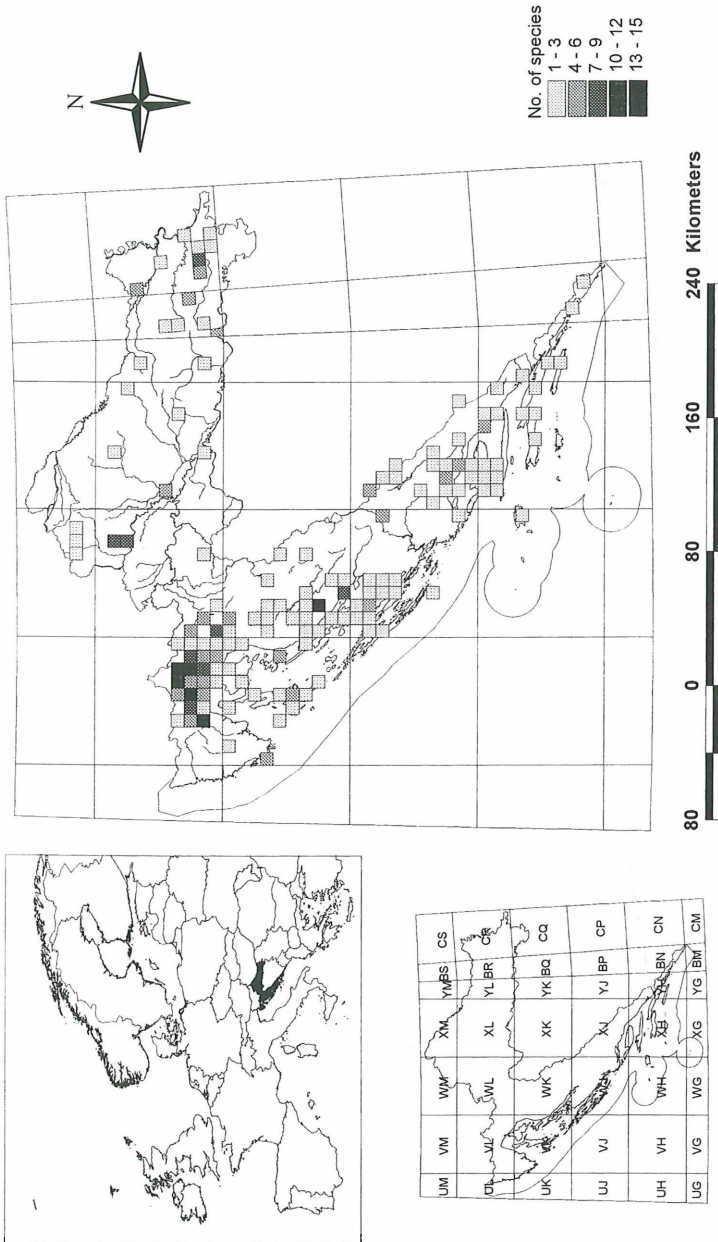


Fig. 1: Distribution of the genus *Carabus* L. in Croatia, based on literature and collections data displayed as number of present species/UTM 10 km² square.

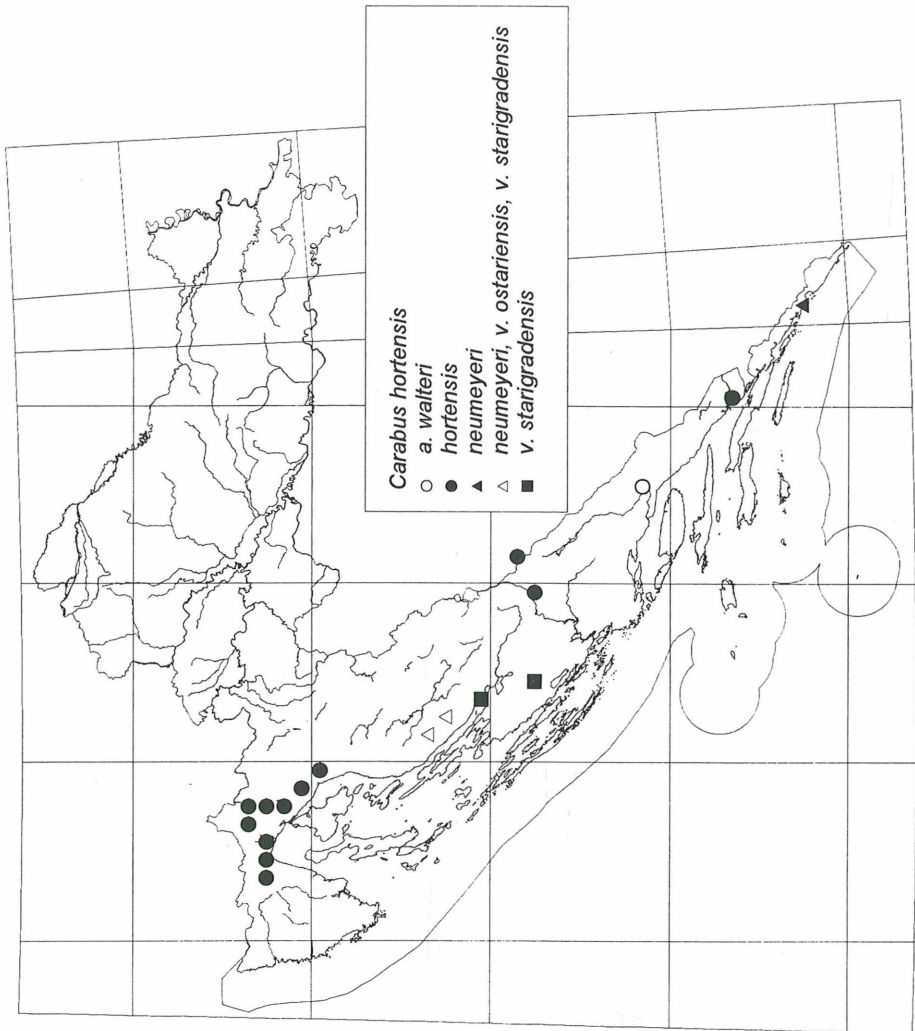


Fig. 2: Distribution of *Carabus hortensis* Linnaeus 1758 taxa in Croatia.

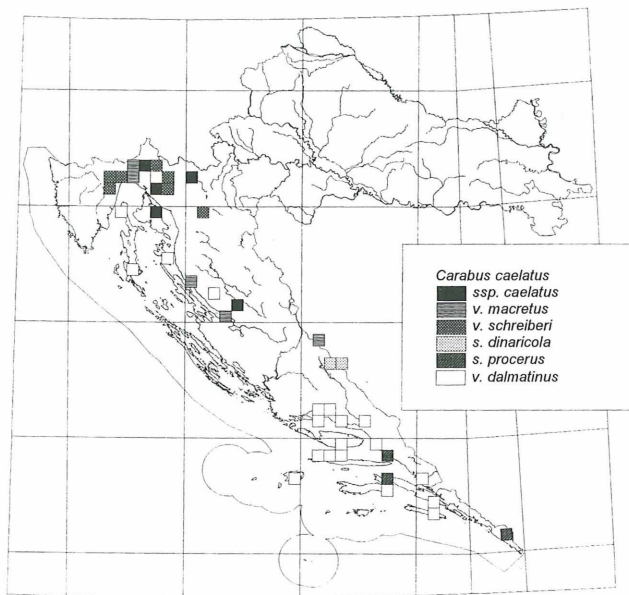


Fig. 3: Distribution of *Carabus caelatus* Fabricius 1801 taxa in Croatia.

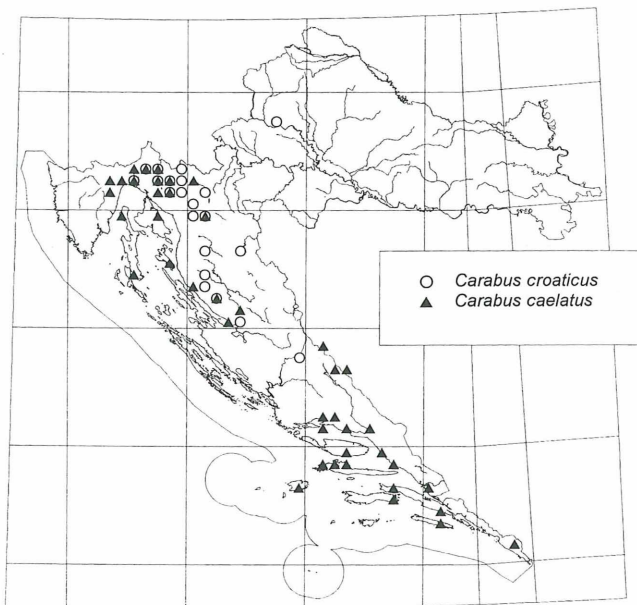


Fig. 4: Distribution of *Carabus croaticus* Dejean 1826 and *C. caelatus* Fabricius 1801 in Croatia.

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