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(Coleoptera: Carabidae)**

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# The *Carabus* fauna of Israel – updated identification key, faunistics, and habitats (Coleoptera: Carabidae)

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## Abstract

This key to the *Carabus* species of Israel is an updated identification key with notes on the distribution and habitats of the species. Substantial additions, corrections and taxonomic changes on the *Carabus* fauna of the Middle East generated the need of an update of the knowledge of the genus *Carabus* in Israel. The classification and the identification of sibling taxa of the subgenus *Lamprostus* are still a problem: A zone of sympatry supports the species status of both *C. sidonius* and *C. hemprichi*. The lack of any evidence of sympatry for the taxa in species rank of the *C. syrus* group and their variability of the exoskeleton (mentum tooth, tip of aedeagus) requires further systematic and taxonomic studies.

## Keywords

*Carabus*, *Lamprostus*, identification key, faunistical records, habitat characteristics, Israel

## Introduction

Despite the fact that Israel is a small country (about 22,000 km<sup>2</sup>), it displays an enormous ecological diversity originating from its peculiar biogeographic location in south-western Asia and its great physical variety (Furth, 1975; Por, 1975; Yom-Tov & Tchernov, 1988): It links the desert Sahara-Arabia belt, the Mediterranean region and the high Asian mountains. The ground beetle genus *Carabus* with its preference for humid habitats reaches its southern distribution limit in Israel, and only some species are distributed there (cf. Bousquet et al., 2003).

The *Carabus* fauna of Israel was first described in a fundamental work by Schweiger (1970). Substantial additions, corrections and taxonomic changes were made by Kleinfeld & Rapuzzi (2004) and Deuve (2004; 2005) in the last years. Additional records of some species demonstrate the need of an update of our knowledge on the genus *Carabus* in Israel. Moreover, the increasing interest in the conservation biology, ecology, evolutionary biology and faunistics of ground beetles in Israel (Bar, 1978; Chikatunov et al., 2006; Chikatunov et al., 1999; 2004; Finkel et al., 2002; Mienis, 1978a; 1978b; 1978c; 1978d; 1988; Pavliček & Nevo, 1996) demands a new identification key and a short synopsis of the present day knowledge of the distribution, faunistics and habitats of Israeli *Carabus* species. The taxonomic confusion in this group prevents us from presenting a final identification key. However, we hope that this short overview stimulates further studies to solve some systematic problems of the *Carabus* fauna of the Middle East.

## Material and methods

The *Carabus* collection of The National Collections of Natural History of the Tel Aviv University and material from Upper and Lower Galilee, Carmel Ridge, Samaria (incl. Gilboa Mountains), Judea, Negev, Golan Heights and Mount Hermon collected by Anika Timm (Lüneburg), David W. Wrase (Berlin), Peer Schnitter (Halle) and Thorsten Assmann (Bleckede) were studied (altogether about 800 specimens). The relevant literature on *Carabus* species from Israel and neighbouring countries was evaluated (Alfieri, 1976; Bousquet et al., 2003; Casale & Vigna Taglianti, 1999; Deuve, 2004a; 2005; Kleinfeld & Rapuzzi, 2004; Schweiger, 1970).

Nomenclature of vegetation types for a characterisation of the habitats follows Danin (1988).

Total body length (BL) is measured from the tip of the mandibles to the apex of the elytra as the maximum linear distance.

Line drawings were prepared using a drawing tube attached to a Leica MZ 95 stereobinocular microscope. Dissections were made with standard techniques; genitalia were preserved in euparal or in polyvinylpyrrolidone containing mixture on acetate labels (Lompe, 1989) or without embedding in dried condition.

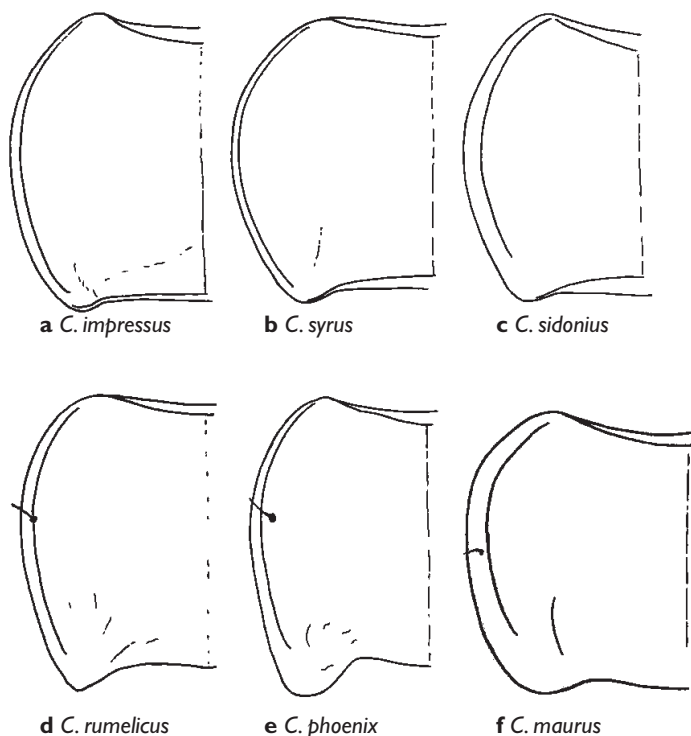
The aim of this study is not a revision of the subspecific taxa. The classifications given by various authors are strikingly different (e.g. Brežina, 1999; Deuve, 2004b; Kleinfeld & Rapuzzi, 2004). The listed subspecies follow the Palaearctic Catalogue (Bousquet et al., 2003) and Deuve (2004a; 2004b; 2005).

## Identification key with notes on distribution and habitats of the species

The members of the genus *Carabus* are easily recognizable by the lack of a typical antennal cleaner, posterior coxae contiguous in midline of body, mandibles not transversally furrowed, and third antennal segment without keel. Moreover, the species living

in Israel are characterized by their body size (BL > 15 mm) and entirely black colour (without any spots or markings or metallic luster). For a general characterisation of ground beetles see Trautner & Geigenmüller (1987) and Ball (2001).

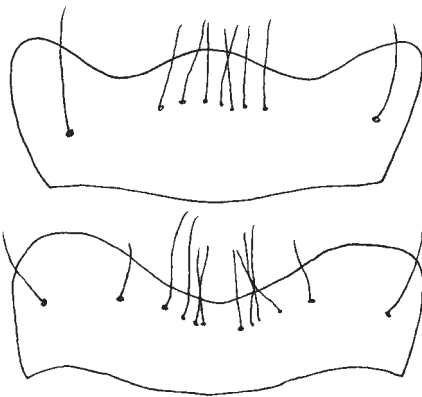
- 1 (15) Pronotum without marginal setiferous pores (Fig. 1a, b, c) ..... 2  
2 (3) Labrum divided into three lobes (Fig. 2). Elytra with or without punctuation  
and granulation, habitus variable. BL: 25-36 mm. An eurytopic species in  
woodlands (Fig. 15), forests, batha (open and semi-open habitats, Fig. 16),  
arable land, dunes (Fig. 17), steppe and desert-like, overgrazed, semi-arid habi-  
tats of the northern Negev (Fig. 18), up to 1200 m above sea level. In northern  
and central Israel southwards to the northern Negev south of Be'er Sheva (e.g.  
Noqdim Plateau).<sup>1</sup> Fig. 1a, 7a and 8.....  
..... *C. (Procrustes) impressus* Klug, 1832;  
in Israel: ssp. *carmelita* Lapouge, 1907  
ssp. *palaestinus* Lapouge, 1907  
ssp. *hybridus* Ganglbauer, 1887  
ssp. *negevensis* Schweiger, 1970



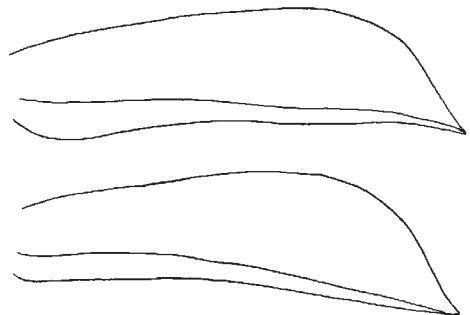
**Fig. 1.** Pronotum without (a, b, c) and with (d, e, f) marginal setiferous pores.

<sup>1</sup> All records of *Carabus* specimens from the Sinai Peninsula may refer to this species (cf. Alfieri 1976; cf. Schweiger 1970).

- 3 (2) Labrum divided into two lobes (Fig. 2) ..... 4
- 4 (5) Larger in size (BL: 37-44mm). Head and pronotum rugously wrinkled. Protarsus in male not dilated. Last segment of maxillary palpi triangular or axe-shaped. In open and semi-open habitats (up to 1600 m above sea level). Exclusively in the north (Mount Hermon, Golan Heights, Upper Galilee) and very rare. Fig. 7b and 9 ..... *C. (Procerus) syriacus* Kollar, 1843  
in Israel only ssp. *galilaeus* Schweiger, 1970
- 5 (4) Smaller in size (BL: < 37 mm), if larger then at least head and pronotum smooth, not rugously wrinkled. Three segments of protarsus in male dilated. Last segment of maxillary palpus not triangular or axe-shaped ..... 6
- 6 (7) Elytral sculpture with punctures and striae. Slender species. BL: 25-36 mm. In woodlands (Fig. 15), forests, and batha (Fig. 16), not in arable land (~500 to 2000 m above sea level, Fig. 19). In the north (Mount Hermon, Golan Heights, Upper and Lower Galilee). Fig. 7c and 10 .....  
..... *C. (Chaetomelas) piochardi* Géhin, 1884  
in Israel: ssp. *labruleriei* Géhin, 1884  
ssp. *pinguis* Lapouge, 1914
- 7 (6) Elytron without punctures or striae, smooth. Wider species ..... 8
- 8 (9) Elytron less rounded in lateral view (Fig. 3). Pronotum wider (Fig. 1b) .... 11
- 9 (10) Elytron more rounded in lateral view (Fig. 3). Pronotum slender (Fig. 1c) ....  
..... 13
- 11 (12) Tooth of mentum broad, tip truncate (Fig. 4a). Median lobe of aedeagus rounded at apex (Fig. 7d). BL: 32-39 mm. Mainly in open and semi-open habitats (especially batha, Fig. 16), rarely in woodlands or forests (from 200 m below sea level to 1400 m above sea level, Fig. 15). From Mount Hermon and Golan Heights to Upper Galilee (Mt. Meron, first finding in 2005). Fig. 1b, 2, 3 and 11 ..... *C. (Lamprostus) syrus* Roeschke, 1898  
in Israel only ssp. *cheikensis* Deuve, 1992



**Fig. 2.** Labrum divided into three lobes (above: *C. impressus*) and two lobes (below: *C. syrus*).



**Fig. 3.** Elytron in lateral view, less rounded (above: *C. syrus*) and more rounded (below: *C. sidonius*).

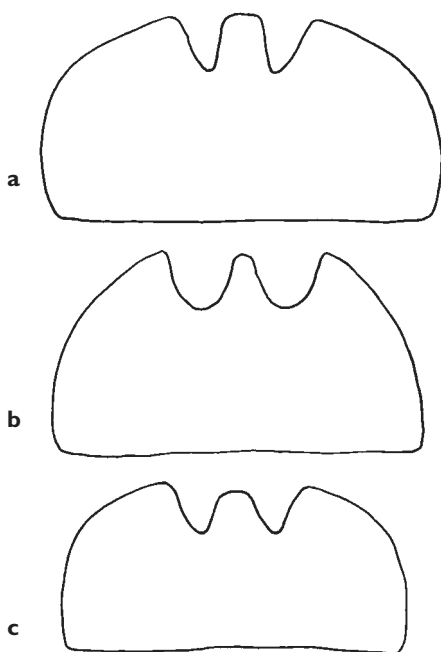
- 12 (11) Tooth of mentum sharpened (Fig. 4b). Median lobe of aedeagus sharpened at apex (Fig. 7e). BL: 32-37 mm. Distribution area still poorly known, described from Lebanon. Listed by Schweiger & Rapuzzi (2004) from north-eastern Israel ..... *C. (Lamprostus) lecordieri* Deuve, 1992

**Note:** *C. lecordieri* was degraded as a subspecies of *C. syrus* by Kleinfeld & Rapuzzi (2004), but the species status was re-established by Deuve (2005). Deuve (2004b) treated the taxon as a subspecies of *C. syrus*. Some specimens from Israel cannot be classified as one of the species due to variability of the mentum tooth and small differences of the aedeagus.

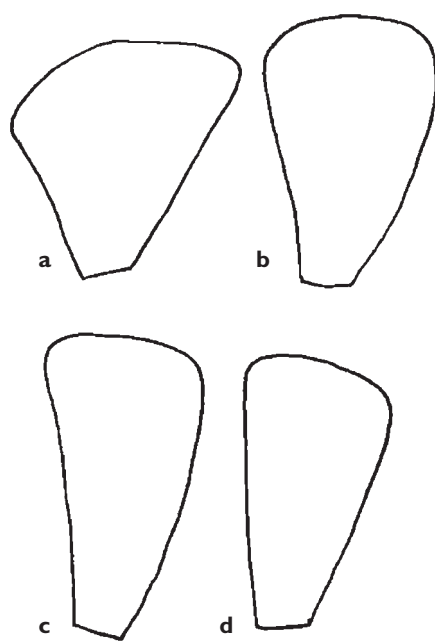
- 13 (14) Hind angles of pronotum rounded, a little bit more pronounced, very similar to its sister species (*C. hemprichi*). Apical part of aedeagus deflexed, narrow and more distinctly set off (Fig. 7f). BL: 31-35 mm. In woodlands (Fig. 15), forests, and batha (up to 1200 m above sea level, Fig. 16). Northern and central Israel, southwards up to Jerusalem. Fig. 1c, 3, 4c and 12 .....

..... *C. (Lamprostus) sidonius* Lapouge, 1907  
in Israel: ssp. *elonensis* Schweiger, 1970  
ssp. *cheikhermonensis* Deuve, 1992

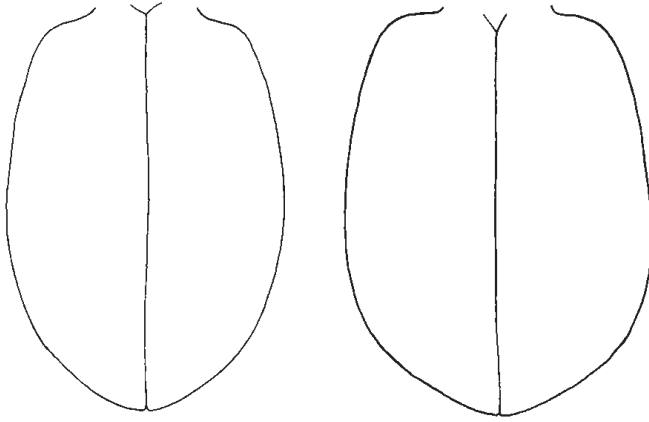
- 14 (13) Hind angles of pronotum rounded, only slightly prolongate. Apical part of aedeagus not distinctly deflexed, wider and not distinctly set off (Fig. 7g). BL: 31-37 mm. In woodlands, batha and arable fields. In north-eastern Israel (Mount Hermon and Golan Heights) ..... *C. (Lamprostus) hemprichi* Dejean, 1826  
in Israel only *damascenus* Lapouge, 1924



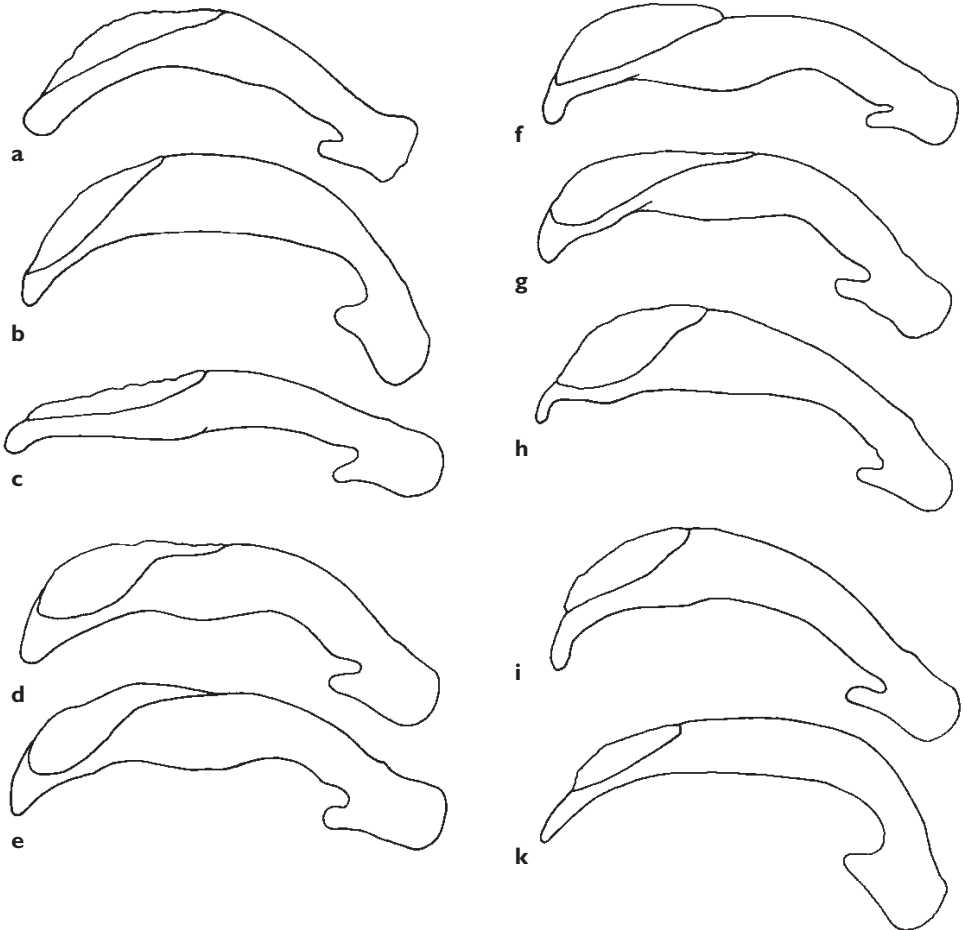
**Fig. 4.** Mentum of *Lamprostus* species (a: *C. syrus*; b: *C. lecordieri*; c: *C. sidonius*).



**Fig. 5.** Last segment of maxillary palpi (a, b: *C. rumelicus*; c, d: *C. maurus*; a, c: male; b, d: female).



**Fig. 6.** Shoulder of elytron rounded (left: *C. phoenix*) and angulate (right: *C. maurus*).



**Fig. 7.** Aedeagus of *C. impressus* (a), *C. syriacus* (b), *C. piochardi* (c), *C. syrus* (d), *C. lecordieri* (e), *C. sidonius* (f), *C. hemprichi* (g), *C. rumelicus* (h), *C. phoenix* (i), and *C. maurus* (k).

- Note:** A zone of sympatry between *C. hemprichi* and *C. sidonius* in Lebanon led Deuve (2004) to consider both taxa as valid species. In previous publications these taxa were ranked as subspecies of *C. hemprichi*. The distinction of both species is extremely difficult. Moreover, in the last years two additional sibling species of the subgenus *Lamprostus* were described from Lebanon.
- 15 (1) Pronotum with marginal setiferous pores (if seta broken, the pupillate insertion is visible) (Fig. 1d, e, f) ..... 16
- 16 (17) Last segment of maxillary palpus in males triangular or axe-shaped (Fig. 5a). BL: 17-20 mm. In montane and subalpine altitudes of Mount Hermon (semi-open woodlands with *Quercus libani* and tragacanth vegetation, pastures, Fig. 19). Fig. 1d, 5b, 7h and 13 ..... *C. (Tomocarabus) rumelicus* Chaudoir, 1867  
in Israel only ssp. *syriensis* Breuning, 1943
- 17 (16) Last segment of maxillary palpus in males more elongate, slightly dilated (Fig. 5c) ..... 18
- 18 (19) Submentum thickened. Hind angles of pronotum prolongate (Fig. 1e). Shoulder of elytra rounded (Fig. 6a). BL: 17-25 mm. In Israel exclusively known from Upper Galilee (Mt. Meron), in woodlands (Fig. 15). Fig. 13 ....  
..... *C. (Archicarabus) phoenix* Lapouge, 1924
- 19 (20) Submentum not thickened. Hind angles of pronotum more rounded (Fig. 1f). Shoulder of elytra angulate (Fig. 6b). BL: 15-20 mm. In montane and subalpine altitudes of Mount Hermon (semi-open woodlands with *Quercus libani* and tragacanth vegetation). Fig. 5c, 5 d and 7k .....  
..... *C. (Mimocarabus) maurus* Adams, 1817  
in Israel only ssp. *hermonensis* Schweiger, 1970



**Fig. 8.** *Carabus impressus* (Negev).



**Fig. 9.** *Carabus syriacus* (Mount Meron).



**Fig. 10.** *Carabus piochardi* (Mount Meron).



**Fig. 11.** *Carabus syrus* (Mount Meron).





**Fig. 12.** *Carabus sidonius* (Mount Meron).



**Fig. 13.** *Carabus rumelicus* (Mount Hermon).



**Fig. 14.** *Carabus phoenix* (Mount Meron).



**Fig. 15.** *Quercus calliprinos* dominated woodland (Ya'ar Bar'am). Habitat of *C. impressus*, *C. piochardi*, *C. syrus*, *C. sidonius*, and *C. phoenix*.



**Fig. 16.** Batha (Mount Meron). Habitat of *C. impressus*, *C. piochardi*, *C. syrus*, and *C. sidonius*.



**Fig. 17.** Dune habitat (south of Ashdod). Habitat of *C. impressus*.





**Fig. 18.** Steppe habitat (west of Be'er Sheva). Habitat of *C. impressus*.



**Fig. 19.** Montane to subalpine pasture (Mount Hermon). Habitat of *C. piochardi* and *C. rumelicus*.

## Discussion

Ten species of the genus *Carabus* are known from Israel. The presence of *C. phoenix* in Israel – first records known from the surrounding of Sasa in Upper Galilee (Kleinfeld & Rapuzzi, 2004) – can be confirmed by several records from the Meron area (Upper Galilee, cf. Timm et al., 2008)<sup>2</sup>. At several locations in Galilee (including a site close to the Sea of Galilee, about 200 m below sea level) we detected *Carabus syrus* populations. The previously known distribution area in Israel covers the Golan Heights, parts of the Mount Hermon and the Upper Jordan Valley close to Qiryat Shemona (Schweiger & Rapuzzi, 1970). We believe that larger parts of Galilee (including Lower Galilee), Golan Heights and Judean Foothills are still under-represented in faunistical studies. Therefore it seems most likely that additional populations and perhaps species can be detected. From Jordan and Lebanon new species of the subgenus *Lamprostus* were already described in the last years (*C. pseudopinguis* Heinz, 2000; *C. lecordieri* Deuve, 1992; *C. rostandianus* Deuve, 2005; cf. Deuve, 2005; Heinz & Staven, 2000).

Despite the still incomplete faunistic inventory of Israel, the records of *C. syriacus* seem to decline, especially in the last decades. Coleopterists, also those collecting mainly in the northern parts of Israel, have not found this largest *Carabus* species in the Middle East for many years (e.g. Rittner, personal communication). Urbanization, habitat fragmentation and large-scale changes of land use (especially the transformation of natural and semi-natural habitats, e.g. sclerophyllous woodlands and batha, to pine stands and arable fields) might be a reason for this decline. Species of the subgenus *Procerus* show a remarkable decline not only at the southern limit of their distribution area but also in Europe: *C. gigas* Creutzer, 1799 was once distributed in Styria and Carinthia. At present the species is extinct in Austria (Paill, personal communication), in Slovenia the species is still occurring, but clearly declining (Drovenik, personal communication; Turin et al., 2003). A similar decline seems to occur in some places in Italy (Brandmayr and Casale, personal communication). – If one or several populations are rediscovered, an action plan to conserve the relict populations at the most southern limit of this species (and subgenus) will have to be developed.

A clear problem for identification are the sibling taxa of two *Lamprostus* groups: The characters given in the literature to separate *C. hemprichi* from *C. sidonius* and *C. syrus* from *C. lacordieri* show a remarkable variability within and between populations; this is true for both the mentum tooth and the apex of the median lobe of aedeagus. Sometimes it is impossible to classify some specimens exclusively from the exoskeleton. While a zone of sympatry is known for *C. hemprichi* und *C. sidonius* in Lebanon, any evidence of sympatry is still lacking for the members of the *C. syrus* group (including *C. lacordieri*, *C. pseudopinguis* and *C. rostandianus*).

The results of Pavliček & Nevo (1996) on *C. sidonius* demonstrated a small-scaled genetic differentiation, similar to some other *Carabus* species (Assmann, 2003; Assmann

<sup>2</sup> Records from Sasa are not considered in the distribution map of *C. phoenix* given by Kleinfeld & Rapuzzi (2004).

& Weber, 1997). The morphological differentiation (from eye inspection) reflects this strong geographic differentiation on another level and should encourage us to study the species complexes morphometrically in order to solve the taxonomic problems (but for this approach still more material is necessary than is available at the moment).

In general one has to keep in mind that differences in the aedeagus, especially those of the apex (and not of the internal sac) of this organ, do not seem to be useful to classify taxa at the species level (see for a detailed discussion: Assmann et al., 2008). The taxa *C. violaceus violaceus* Linné, 1758 and *C. v. purpurascens* Fabricius, 1787 of the subgenus *Megodontus* can be easily distinguished by different forms of the aedeagus tip (and by lack or presence of striae on the elytra). But both taxa form several broad hybrid zones in north-western Central Europe (Assmann & Schnauder, 1998). An excessive gene flow is documented also by molecular techniques (allozymes and mtDNA haplotypes; Eisenacher et al., in prep.). In the light of these results the species rank of some taxa of the *C. syrus* group should be critically reconsidered.

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