

Taxonomic and biogeographical observations on a new population of *Calomera* Motschulsky, 1862 (Coleoptera Carabidae Cicindelinae) from Crete Island (Greece)

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ABSTRACT

During a wildlife expedition to Crete Island (Greece), we found a population of *Calomera* Motschulsky, 1862 (Coleoptera Carabidae Cicindelinae), which was new to this island and that we describe as a new subspecies (*C. panormitana cretensis* n. ssp.). In this paper, some taxonomic and biogeographical observations on the *C. aphrodisia* (Baudi di Selve, 1864) group are provided, the validity of the taxon *C. panormitana* is confirmed, and, for nomenclatural stability, a neotypus of *C. lugens* Dejean, 1831, and a lectotypus of *C. panormitana* are designated.

KEY WORDS

Calomera aphrodisia; *panormitana*; speciation; Mediterranean.

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INTRODUCTION

Calomera aphrodisia (Baudi di Selve, 1864) (Coleoptera Carabidae Cicindelinae) was described as a “variety” of *C. littoralis* (Fabricius, 1787) on the basis of specimens collected by Eugenio Truqui in “*insula Cypro et Asia Minor*” (Baudi di Selve, 1864).

Ragusa (1882) discovered in Sicily, in the same day and in the same locality, “*Cicindela littoralis* var. *lugens* Dahl.” and “*Cicindela littoralis* var. *aphrodisia* Truqui”. Subsequently, Ragusa (1884, 1904) better distinguished the two mentioned taxa by describing the Sicilian populations of *C. aphrodisia* as a distinct variety that he named “*panormitana*” (Ragusa, 1906).

Piochard de la Brulerie (1885) and Horn & Roeschke (1891), among the two original localities mentioned by Baudi di Selve (1864) for *C. aphrodisia*, reported Cyprus as the locus typicus of this species. Horn (1931) observed that the populations coming from these two localities are different from

each other and that the description of Baudi di Selve (1864) corresponded to those coming from the Syrian coasts. Mandl (1981) confirmed these observations and described the populations of Cyprus and Rhodes as a distinct subspecies (*cypricola*).

Cassola (1983, sub *Lophyridia aphrodisia panormitana*) made a detailed review of the literature on the presence and biology of *C. panormitana* in Sicily.

Wiesner (1992) considered *C. panormitana* as a synonym of *C. lugens* Dejean, 1831 and proposed the following classification: *Calomera lugens lugens* (Sicily), *C. lugens cypricola* (Cyprus and Rhodes), and *C. aphrodisia* (Turkish and Syrian coasts). Korrell (1994) followed this approach. Cassola (1999) repeated what was previously stated on the Sicilian populations (Cassola, 1983), i.e., that “*lugens* Dejean, 1831” should refer to a chromatic variety of a species of the *C. littoralis* and not of the *C. aphrodisia* and he confirms the validity of *C. panormitana*.

At the moment, some Authors, such as Franzen (2001) and Aydın (2011), follow Cassola (1983, 1999), while others follow Wiesner (1992).

During a wildlife expedition to Crete, we found a population of *Calomera* Motschulsky, 1862, which was new to this island and which showed some peculiar morphological characteristics. We describe below this taxon as a new subspecies, adding also some taxonomic and biogeographical observations on the whole *C. aphrodisia* group (Figs. 1–8).

MATERIAL AND METHODS

All specimens were collected on sight in their

natural environment during daylight hours. In these localities, they have been photographed with a camera Canon Eos 100D - macro 100 mm (I. Sparacio). Collected samples were then prepared in laboratory and male genitalia were extracted. Laboratory photos have been taken using a Canon Eos 450D digital camera equipped with Canon MPE-65 lens and mounted on a Manfrotto micro-slider movement system. The images were then processed with Zerene Stacker 1.0.32 software by M. Romano. All the specimens were studied using an Optika light microscope and a Carl Zeiss light microscope. The taxonomic order and nomenclatural arrangement follow the cited papers.

ACRONYMS AND ABBREVIATIONS. M. Romano collection, Capaci, Palermo, Italy (CMR);

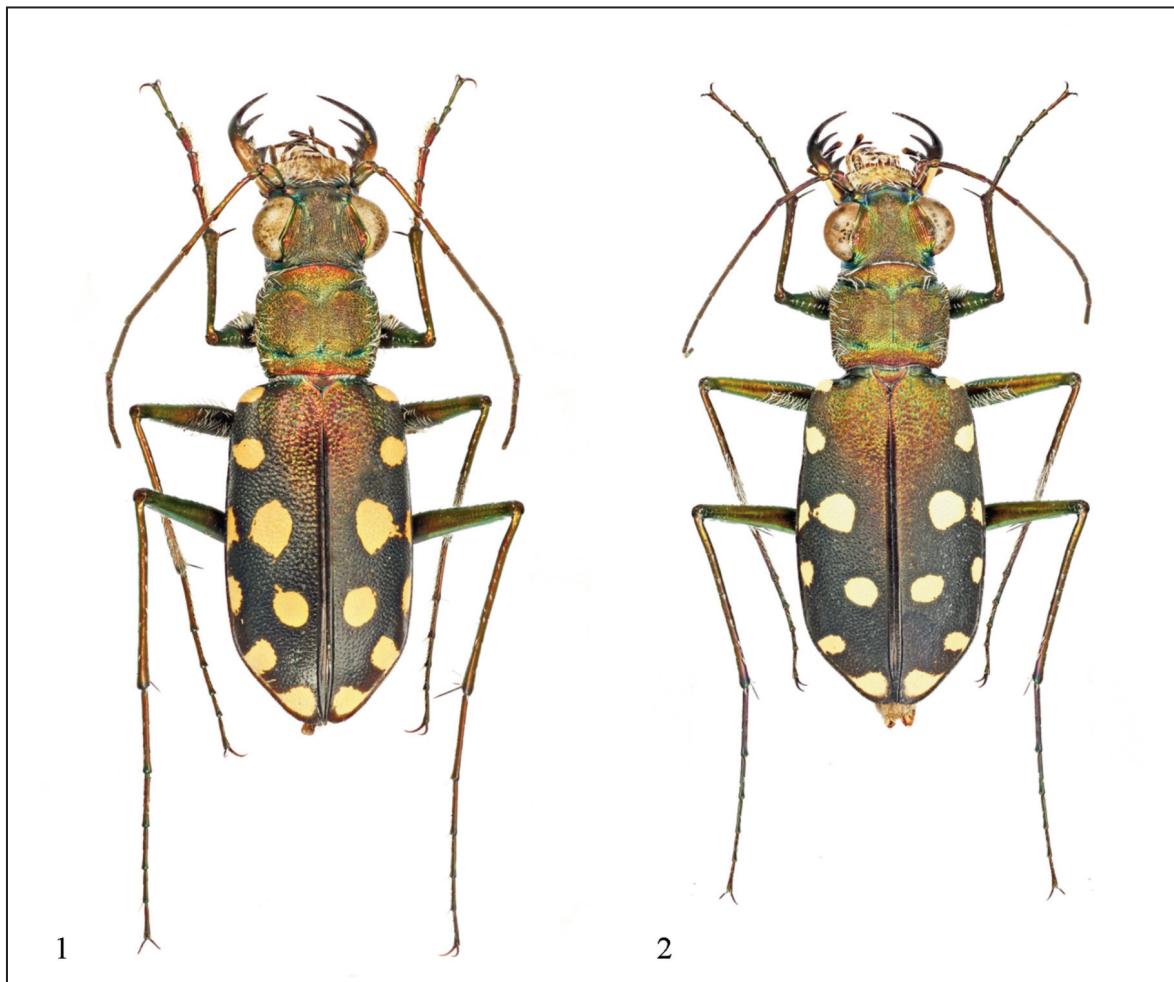


Figure 1. *Calomera aphrodisia* from Lebanon, Beyrouth.

Figure 2. *Calomera panormitana cypricola* from Cyprus, Alsancak Girne.

I. Sparacio collection, Palermo, Italy (CIS); Collection of Dipartimento di Biologia Animale University of Catania, Italy (CMC); Collection of Museo Civico di Storia Naturale “Giacomo Doria”, Genova, Italy (MCSNG); Collection of Museum National d’Histoire Naturelle, Paris, France (MNHN); ex/x = specimen/s. Unless otherwise stated, the collector of the beetles in the field is also the owner of the collection where the specimens are preserved.

RESULTS

Systematics

Ordo COLEOPTERA Linnaeus, 1758

Familia CARABIDAE Latreille, 1802
Subfamilia CICINDELINAE Latreille, 1802
Genus *Calomera* Motschulsky, 1862
Species *panormitana* (Ragusa, 1906)

Calomera panormitana cretensis n. ssp.

TYPE MATERIAL. Holotype male, Creta, Chania, Daratsos, 31.V.2014, 35.51509N, 23.98947E (CIS). Paratypes: 5 exx, same locality of the holotype, 2.VI.2014, 35.51621, 23.98173E (CIS), 2 exx, idem (CMR), 1 ex, idem, legit I. Sparacio (MCSNG).

OTHER EXAMINED MATERIAL. *Calomera panormitana panormitana*. E. Ragusa collection (CMC): “*Cicind. aulica* a. *panormitana* Rag.”: 1 ex labelled

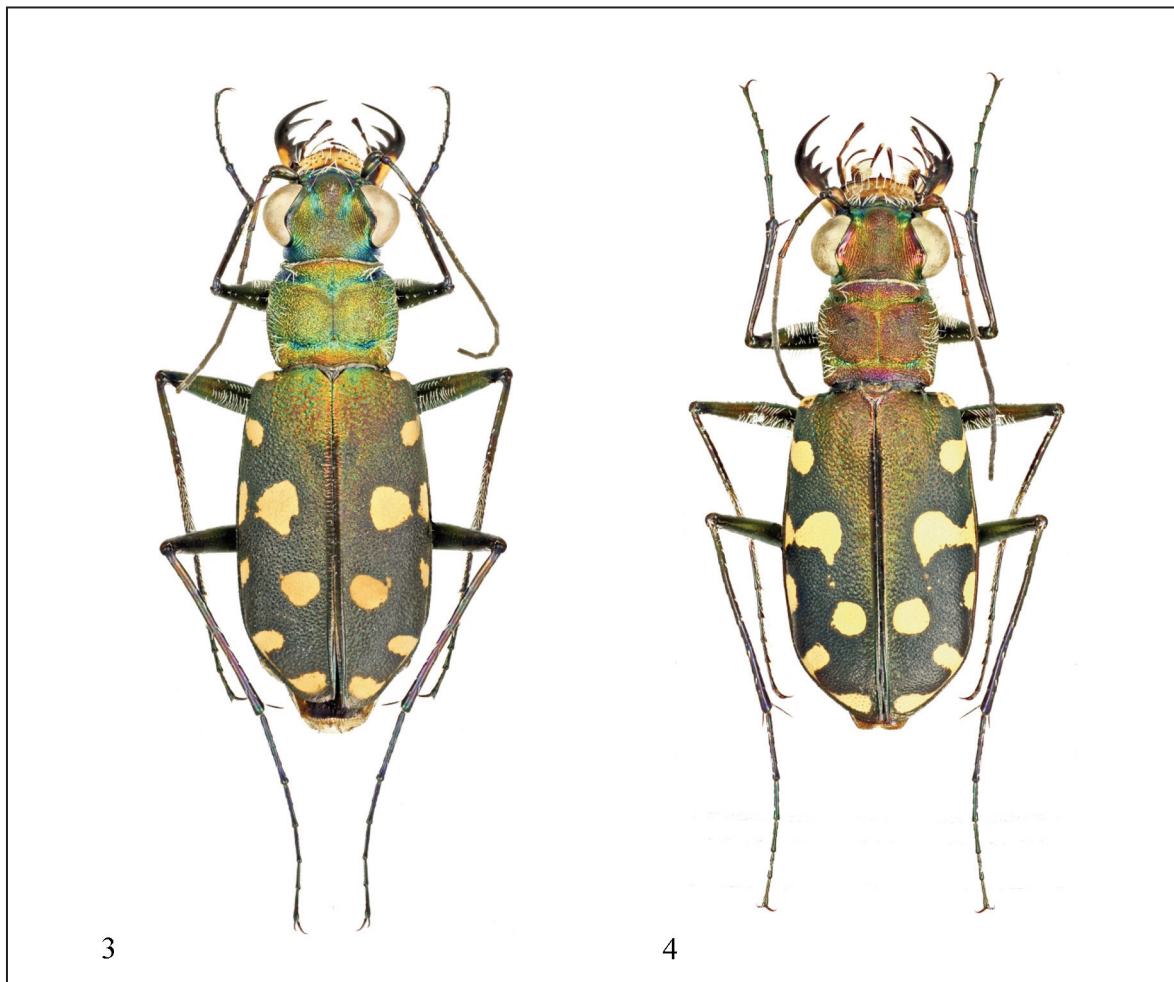


Figure 3. *Calomera panormitana cretensis* n. ssp., Crete (Greece), Chania, Daratsos.
Figure 4. *Calomera panormitana panormitana* from Italy, Sicily, San Vito Lo Capo.

“Sicilia, Mondello, E. Ragusa, 8” - red label: *Calomera panormitana* Ragusa, 1906 - Lectotypus, M. Romano & I. Sparacio des. 2018; 3 exx labelled “Sicilia, Balestr.[ate], E. Ragusa, 6”. 8 exx without labels; “*Cicind. aulica* a. *lugens* Rag.”: 1 ex labelled “Sicilia, Mondello, 21.7.07; 1 ex labelled “Sicilia, Mondello, E. Ragusa, 8; 7 exx without labels; “*Cicind. aulica* a. *luctuosa* Rag.”: 1 ex labelled “Sicilia, 2.8.921, Isola scogliera, A. Modica”; 6 exx without labels. All these specimens, except the Lectotype, have a red label: *Calomera panormitana* Ragusa, 1906 - Paralectotypus - M. Romano & I. Sparacio des. 2018.

San Vito Lo Capo (Trapani), 22.VII.1982, 10 exx (CMR); 23.VIII.1994, 1 ex (CMR); 23.VII.1995, 1 ex (CMR); 2.VIII.1996, 4 exx (CMR); 20.VI.1997, 18 exx (CMR).

San Vito Lo Capo (Trapani), 13.VI.1982, 3 exx (CIS); 28.VI.1997, 4 exx (CIS); Cinisi (Palermo), 6.VIII.1983, 2 exx (CIS); idem, 18.VIII.1983, 5 exx (CIS); idem, 7.VII.1986, 4 exx (CIS); idem, 19.VIII.1989, 2 exx (CIS); idem, 2.VIII.1993, 2 exx (CIS); Carini (Palermo), Torre Pozzillo, 6.VII.1985, 2 exx (CIS); Sferracavallo (Palermo), Punta Matese, 2.VIII.1986, 4 exx (CIS); idem, 6.VIII.1986, 1 ex (CIS); idem, 25.VIII.1988, 3 exx (CIS); idem, 8.VIII.1997, 1 ex (CIS); idem, 10.VII.2000, 1 ex (CIS); idem, 13.VIII.2001, 2 exx (CIS); Isola delle Femmine (Palermo), Punta della Catena, 2.VIII.1993, 2 exx (CIS); idem, 14.VIII.1993, 3 exx (CIS); Castelluzzo (Trapani): Golfo di Cofano, 5/8.VIII.2008, 8 exx (CIS); Sferracavallo (Palermo): Barcarello, 13.VIII.2011, 2 exx (CIS).

Calomera panormitana cypricola. Cipro. Cipro coll. Truqui D. Baudi 1872 - Syntypus *Cicindela littoralis* var. *aphrodisia* Baudi, 1864 (red label) - cfr. scheda 7911 - *Cicindela aphrodisia* det R. Gestro - Museo Civico di Genova, 3 exx (MCSNG); Cipro, sud di Larabay, VIII.2005 - *Lophyr. aphrodisia cypricola*, 1 ex (MCSNG); Alsancak Girne Cyprus, VIII.1979 P. Cabella legit - *Lophyridia aphrodisia* Baudi - *Lophyridia aphrodisia* Baudi - Museo Genova coll. P. Cabella (dono 2011) 1 ex (MCSNG); Alsancak Girne Cipro VIII.1979 P. Cabella legit - *Lophyridia aphrodisia* Baudi - *Lophyridia aphrodisia Baudi* - Museo Genova coll. P. Cabella (dono 2011) 4 exx (MCSNG).

Calomera aphrodisia. Libano. Beyrouth Acq. E. Deyrolle 1870 - *Cicindela aphrodisia* Baudi det. R.

Gestro - Museo Civico di Genova, 1 ex; Beyrouth Acq. E. Deyrolle 1870 / *Cicindela* sp. - *Cicindela aphrodisia* Baudi det R. Gestro - Museo Civico di Genova, 1 ex (MCSNG);

Calomera littoralis nemoralis (Olivier, 1790). Italy, Sicily, Balestrate (Palermo), Foci Torrente Calatubo, 13.V.1979, legit I. Sparacio, red label: *Calomera littoralis nemoralis* ab. *lugens* Dejean, 1831- Neotypus - M. Romano & I. Sparacio des. 2018 (MNHN). Ragusa collection (CMC): “*Cicindela* ab. *lugens* Dej.”: 1 ex labelled “Sicilia, Oreto, E. Ragusa, 4”; 1 ex labelled “Sicilia, Trapani, E. Ragusa, 8; 1 ex labelled “*Cic. ab. Lugens* Dej.”; 1 ex labelled “Sicilia, Balestr.[ate], 19/6; 2 exx senza cartellino.

DESCRIPTION OF THE HOLOTYPE. Male. Length 14 mm (without labrum). Reddish-bronze green in colour on head, pronotum, front of the elytra, legs and ventral surface; elytra opaque, blackish in the 2/3 posterior of the elytral length, with six white-yellowish spots, well separated, of which four spots at or close to the elytral margin (one humeral, two marginal, and one apical), and two at the discal level. White pubescence is present on the head, sides of the pronotum, legs, and under side.

Head large, with 2 iuxta-orbital setigerous punctures near both eyes and 1 central: each puncture bearing a very fine, long, erect, sensorial seta. Eyes large and prominent. Frons and vertex covered with longitudinal striae, which are deeply developed near orbital edges and somewhat irregular and wrinkly in the middle; clypeus hollow in the middle; labrum testaceous, transverse, nearly three times wider than long, distinctly tridentate forwards (longer median tooth), and 15 long hairs. Mandibles long and pointed, testaceous on the sides of the base. Labial and maxillary palpi black, yellow at the apex; last segment with wider and rounded apex; penultimate segment of maxillary palpi a little shorter. Antennae long, reaching approximately the middle of the elytral length; scape and 2–4 antennomeres glabrous, metallic, with only 2–3 short hairs; antennomeres 5–11 finely and evenly pubescent with some longer sparse hairs.

Pronotum wider than long (with of pronotum/length of pronotum: 1.18), subparallel sided, slightly wider forward, with dense white decumbent hairs covering the sides; central disk glabrous; front edge slightly protruding forward; anterior and posterior grooves deep; surface wrin-

kled with numerous, dense, and irregular longitudinal striae converging on the median longitudinal groove.

Scutellum triangular with micro-wrinkled surface. Elytra elongated, partially subparallel sided, slightly wider towards the middle, gradually rounded to apical angle, micro-denticulate in their back curve; sculpture formed by small granules well spaced from each other on a finely and regularly microrugous surface.

Abdominal sternites with some punctures on the front and back edges. Legs long, anterior and middle femora with dense, short, and white pubescence; posterior tarsi slightly longer than the corresponding tibiae.

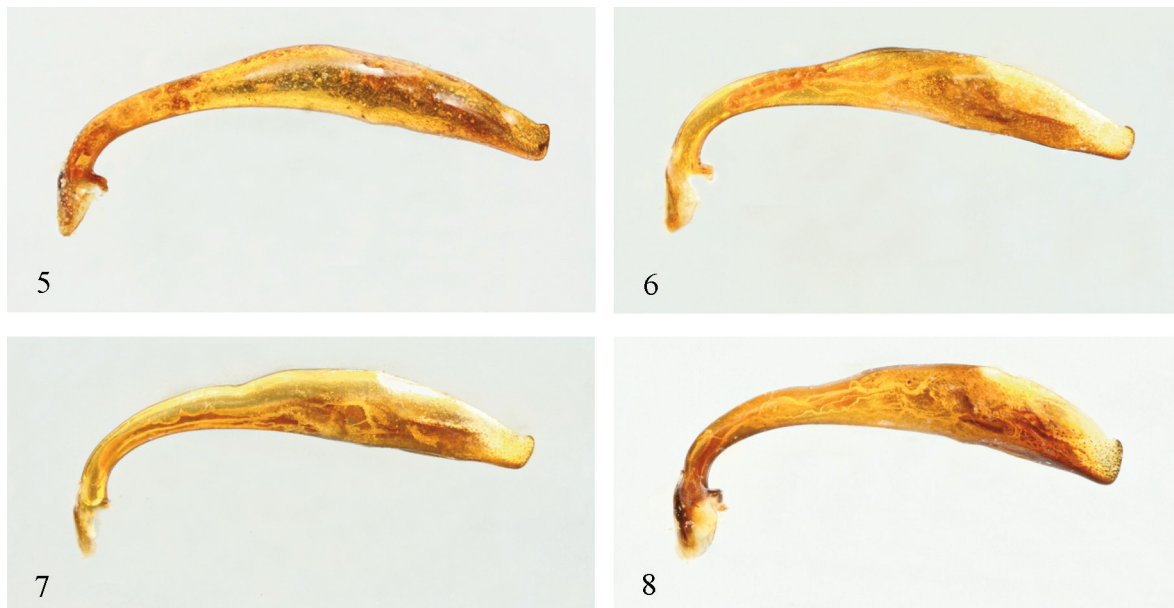
Shape of median lobes of the aedeagus (Fig. 7) wider and shorter forward, longer and arched in the posterior part, apex rounded with the tip slightly curved upwards and with little punctures, latero-apical crest long and detected.

VARIABILITY. The paratypes do not show appreciable morphological differences compared to the holotype. The body length is 13–16 mm; the greenish reflections in some specimens are less evident; labrum with 14–20 long hairs; the females have greater body length and wider elytra.

ETYMOLOGY. The subspecific epithet refers to the type locality, Crete, the largest of the Greek islands.

BIOLOGY AND DISTRIBUTION. *Calomera panormitana cretensis* n. ssp. is found in rocky habitats in the littoral zone, as all the taxa of the aphrodisia group (Ragusa, 1906; Horn 1931, Cassola, 1983, 1999; Sparacio, 1994; Franzen 2001; Lisa, 2002; Austin et al., 2008; Aydin, 2011). *Calomera* species feed on *Ligia* spp. (Isopoda) and other small invertebrates such as *Littorina* spp. and *Gibbula* spp. (Mollusca). Adults are active during late Spring and Summer months (May to August). Larval development occurs in the same habitat of adults (see Cassola, 1983).

Calomera panormitana cretensis n. ssp. is, at present, only known from the type locality (Figs. 9, 10), but it is likely that this subspecies occurs also elsewhere in Crete, in suitable habitat, which have not yet been explored. *Calomera panormitana panormitana* is endemic to Sicily. *Calomera panormitana cypricola* lives in Cyprus, Rhodes, and SW-Turkey. *Calomera aphrodisia* is reported from few localities in southern Turkey, Syria, Lebanon, and Israel (Tschitscherine, 1903; Horn, 1931; Korell, 1994; Franzen, 2001; Avgin & Wiesner, 2009; Jaskuła & Rewicz, 2014; Assmann, 2018).



Figures 5–8. Aedeagi of *Calomera aphrodisia* from Lebanon, Beyrouth (Fig. 5), *C. panormitana cypricola* from Cyprus, Alsancak Girne (Fig. 6), *C. panormitana cretensis* n. ssp., Crete, Chania, Daratsos (Fig. 7), *C. panormitana panormitana* from Italy, Sicily, San Vito Lo Capo (Fig. 8).

CONSERVATION. Tiger beetles are good indicators for habitat changes (Pearson & Cassola, 1992; Rodrigues et al., 1998; Cassola & Pearson, 2000, Pearson & Vogler, 2001; Aydın, 2006, 2011; Choate, 2010).

The species of the *C. aphrodisia* group, in particular, are relic species in the Eastern Mediterranean with very small or restricted populations and in constant reduction. They are herein classified as Vulnerable taxa (VU, according to the IUCN Red List of Threatened Species Categories, 2017), with a high risk of extinction (see Aydın, 2011 and cited references). The decline of these species is due to habitat degradation by human activity and to disturbance due to Summer tourism.

Calomera panormitana cretensis n. ssp. is classified, at the moment, as Vulnerable (VU).

COMPARATIVE NOTES. Morphologically we can distinguish two groups as follows:

1. Narrower, elongate, bright, forebody and elytra darker. Elytra subparallel sides, narrower in the apical third with sculpture formed by big granules, often converging on the sides, on a large micro-wrinkled surface. Posterior tarsus much longer than the corresponding tibiae (1.32–1.35). Shape of median lobes of the aedeagus slender, little widened at the middle, short and slightly arched in the posterior part, apex rounded with the tip protruding and slightly curved upwards, latero-apical crest long and detected*Calomera aphrodisia*

-. Larger, especially in the posterior part of the elytra and in the females, opaque, reddish-bronze or greenish-bronze in colour on head, pronotum, front of the elytra, blackish in the 2/3 posterior of the elytra; elytra with arched sides, dilated and rounded in the apical third with sculpture formed by little and spaced granules on a finely micro-wrinkled surface. Posterior tarsus a little longer than the corresponding tibiae (1.04–1.16). Shape of median lobes of the aedeagus enlarged after the middle, longer and arched in the posterior part, latero-apical crest shorter and less detected.....2

2. Body on average larger, length 13–16 mm; coloration dorsal surface less dark; discal spot of the elytra small, not extensive, usually well separated from the marginal spot or just united. Pronotum transverse, wider than long. Granules of the elytra smaller and more spaced. Shape of median lobes of the aedeagus less dilated forward.....3

-. Body on average smaller, length 12–14.5 mm; coloration dorsal surface darker, often blackish; discal spot of the elytra bigger, often united with the marginal spot and with that lower discal. Pronotum short and narrow, slightly wider than long. Granules of the elytra larger and irregular arranged. Shape of median lobes of the aedeagus wider and shorter forward, apex with little punctures, latero-apical crest longer and detected.....

.....*Calomera panormitana panormitana*

3. Larger body; anterior part of the dorsal surface greenish-bronze in colour. Pronotum clearly wider than long. Shape of median lobes of the aedeagus longer, latero-apical crest little short, apical punctures fairly extensive.....

.....*Calomera panormitana cretensis* n. ssp.

4. Body less wide; anterior part of the dorsal surface reddish-bronze in colour. Pronotum less transverse. Shape of median lobes of the aedeagus longer, latero-apical crest shorter, apical punctures very extensive.....*Calomera panormitana cypricola*

REMARKS. The *C. aphrodisia* species group has several nomenclatural problems mainly due to designation of the locus typicus of *C. aphrodisia* and, more recently, with the use of the name *panormitana*.

Ragusa (1882), along the beach of Mondello, on the same day, collected for the first time in Sicily two different forms of taxa then classified as belonging to the genus *Cicindela* Linnaeus, 1758: the specimens with the seven-shaped elytral stain were attributed to “*Cicindela littoralis* var. *lugens* Dahl.”, while two specimens were reported as “*Cicindela littoralis* var. *aphrodisia* Truqui”. The figure that Ragusa provided of the “var. *lugens* Dahl” (Ragusa, 1882: table 1 Fig. 1), as also confirmed by Cassola (1983), actually depicts a specimen of *C. aphrodisia*.

Two years later, aware of his mistake, Ragusa (1884) distinguished the “*lugens* Dejean”, attributable to *C. littoralis*, from the “*lugens*” as interpreted by him (Ragusa, 1882), attributable to *C. aphrodisia*, and described the latter as a new variety (“var. *lugens* m.”) (Fig. 11). Subsequently, Ragusa (1887) divided morphologically and biologically the two groups, *C. littoralis* and *C. aphrodisia*, and placed its variety *lugens* in the *C. aphrodisia* species group. Ragusa (1904) then described another Sicilian variety of *C. aphrodisia* (“*Cicindela aphrodisia* Baudi var. *luctuosa* Ragusa var. nov.”).



Figure 9. Crete (Greece), Chania, Daratsos: locus typicus of *C. panormitana cretensis* n. ssp.



Figure 10. *Calomera panormitana cretensis* n. ssp. from Crete (Greece), Chania, Daratsos.

Finally, Ragusa (1906), following a suggestion by Horn, the then leading specialist of Cicindelidae, described the *C. aphrodisia* of Sicily as a distinct taxon (*panormitana*, locus typicus Mondello near Palermo), and renamed its two aberrations of color (*lugens* and *luctuosa*) because those names were synonyms of names already used by Dejean for the genus *Cicindela*. Moreover, he clearly reiterated that his 1882 identification of *lugens* Dejean (Ragusa, 1882), probably for misinterpretation of some information received from other colleagues, did not concern a taxon of the *C. aphrodisia* group.

The examination of the Ragusa collection confirms all the above. There are both “*lugens* Ragusa” (in the group of *C. aphrodisia*, with the typical seven-shaped elytral spot) and the “*lugens* Dejean” in the group of the *C. littoralis* (a. *lugens* Dej.). In the same entomological drawer, the systematic order follows the state of the art in force at least until 1891 with *C. aphrodisia*, and therefore also these Sicilian populations, included in the *C. aulica* group (Dejean, 1831), subsequently separated as a species distinct from Horn & Roeschke (1891; see also Ragusa, 1906).

In short, therefore, the taxon “*lugens*” as identified by Ragusa in 1882 is now *C. panormitana*. Conversely, according to Grandi (1906) and Horn (1926), the “var. *lugens* Dejean” corresponds to a variety of *C. littoralis* and this is confirmed by Porta (1923), who recorded the “var. *lugens* Dahl (Dejean)” only for Basilicata, among the Italian regions.

Cassola (1983) in a monographic work on *C. panormitana* confirms the above views. Wiesner (1992), without mentioning the sources, placed “*panormitana*” as a synonymous with “*lugens* Dejean, 1831”, probably sensu Ragusa, 1882. Cassola (1999) reaffirms and extends its previous observations (Cassola, 1983), reconfirming that there is no reason to consider “*panormitana*” as a synonym of “*lugens* Dejean, 1831”.

In fact, in the description of this variety (Dejean, 1831): there is no reference to the chromatic variety (seven-shaped elytral spot), characteristic of the Ragusa variety (1882); the locus typicus is Sicily and Morocco (where no species of the *C. aphrodisia* group occur); the only morphological datum indicates short elytra, while in the *C. aphrodisia* group all species and subspecies have elongated elytra.

The description of Dejean’s variety is as follows (Dejean, 1831): “*Cicindela littoralis* Var. *C. Lugens*. Dahl M.. Dahl m’a envoyé sous le nome del *Lugens*, des individus pris par lui en Sicilie, qui sont un peu moins allongés, et dont la couleur est presque noire en-dessus, mais qui ne me paraissent ce pendant qu’une simple variété de cette espèce. M. Goudot en a rapporté de semblables des environs de Tanger”.

The type of this variety has never been mentioned in all of this cited bibliography and is not present in the Dejean collection, kept at the Museum of Natural History in Paris, where we have researched it (“... unfortunately I couldn’t find the var. *lugens*” A. Taghavian-Azari, MNHN, in litteris).

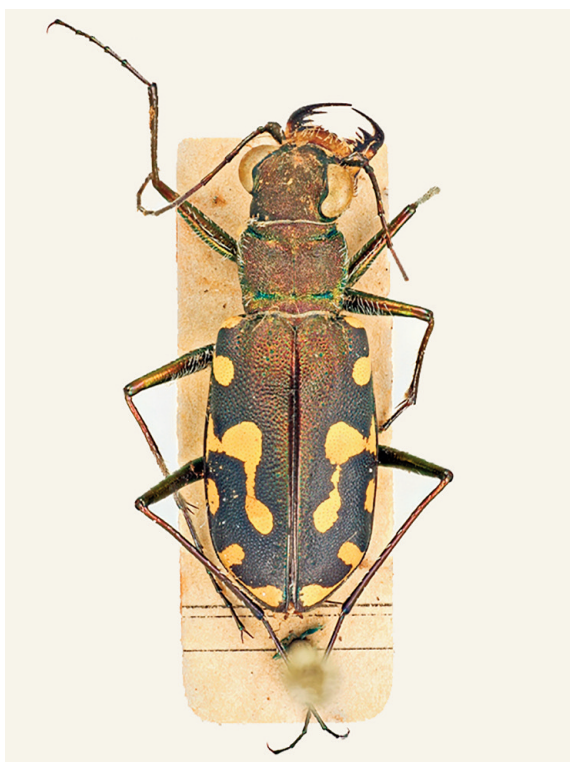


Figure 11. *Calomera panormitana panormitana* with seven-shaped elytral stains from E. Ragusa collection.

Even Ragusa (1902) had searched for this type without any result and it is not even in part of the Dejean collection kept in the Spinola collection (Giachino, 1982; R. Poggi *in litteris*).

For all these reasons, we establish here a neotypus attributable to *C. littoralis nemoralis*, because there is an exceptional need (art. 75 ICZN) for a nomenclatural stability with the following particulars: this neotype is designated with the express purpose of clarifying the taxonomic status of “*C. lugens* Dejean, 1831” and the type locality (75.3.1), to differentiate it from it from *C. aphrodisia panormitana* (75.3.2), to establish new data and a description sufficient to ensure recognition of the specimen designated (75.3.3.), considering that the type is lost or destroyed and that we have researched without finding it (75.3.4).

This neotype is consistent with what is known of the former name-bearing type from the original description (art. 75.3.5) and from the original type locality (75.3.6), following the interpretations of almost all the authors mentioned. It is deposited in the collection of the Museum of Natural

History in Paris (75.3.7) (see Other examined material).

Calomera aphrodisia was described without its typical locality in a work that included material from Cyprus and Asia Minor (see Baudi di Selve, 1864, which however specified the location of the described species from Cyprus), but in these two locations there are two different populations. The typical locality, based on the original description, was established by Mandl (1981) only for Asia Minor, as accepted by all subsequent Authors. Mandl (1981) did not designate a lectotype, but reported having seen typical material present in the Kraatz collection. In the Baudi di Selve collection kept in the Museo Civico di Storia Naturale of Torino, in the typical series, there is a specimen (that seems to be attributable to *C. aphrodisia* from Asia Minor) without a label but with a small red label placed next to it.

In the original series of the entomological collection of E. Ragusa, preserved in the Institute of Environmental Biology of the University of Catania, we have selected a lectotype of *C. panormitana*, coherent with the indications of this author, while all other specimens have been labelled as paralectotypes (see Other examined material).

CONCLUSIONS

It is evident, even with this contribution, that *C. aphrodisia* is a morphologically well identifiable species, little variable, distributed along the continental coasts of Asia Minor from southern Turkey to Israel, clearly distinct from *C. panormitana* s.l.

On the contrary, in *C. panormitana* there are several widespread taxa, almost always insular, ranging from southern Turkey to Sicily, showing a greater morphological variability, probably due to allopatric speciations in progress.

They are, however, all relic populations, in constant rarefaction, with narrow ecological requirements, living only in rocky coasts, of great biogeographical importance.

Aliquò & Romano (1976) and Cassola (1983) hypothesized that the greatest expansion of these populations occurred in the upper Miocene, when the salinity crisis of the Mediterranean Sea created new and greater territorial connections, facilitating their movements. Probably, these populations have

reached Sicily, at the western limit of their distribution, through the new territories emerged during the salinity crisis, directly and without the aid of the more northern “Balkan-Apennine” bridges. This is demonstrated also by the presence in southern Italy and Sicily of animal and plant species with an Eastern Mediterranean origin showing little or no intermediate locality.

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