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A new subspecies of *Cicindela* (*Cicindela*) *campestris* Linnaeus, 1758 (Coleoptera Cicindelidae) from the Aeolian Islands (Italy)

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ABSTRACT *Cicindela* (*Cicindela*) *campestris didyme* n. ssp. from the islands of Salina and Lipari (Aeolian Archipelago, Sicily, Italy) is here described. The new subspecies differs from other Italian populations of *C. campestris*, in particular from the closest ones of Sicily (*C. campestris siculorum* Schilder, 1953) and Calabria (*C. campestris calabrica* Mandl, 1944) for some morphological characters such as the shape of the clypeus, the granules of the elytra less elevated and more sparse and the different aedeagus. It is immediately recognizable by more or less extensively green-brown color of the dorsal surface often entirely red-brown.

KEY WORDS New subspecies; taxonomy; insularity; biodiversity.

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INTRODUCTION

The Palearctic *Cicindela campestris* species complex includes 13 and about 41 currently accepted taxa, respectively, at specific and infraspecific level (Putchkov & Matalin, 2003; 2017; Wiesner, 2020; Gebert et al., 2020). In Italy, it is represented by *Cicindela* (*Cicindela*) *campestris* Linnaeus, 1758, with the nominal subspecies in the northern and central-southern regions up to Basilicata, the ssp. *calabrica* Mandl, 1944 in Calabria (locus typicus: Aspromonte), the ssp. *nigrita* Dejean, 1825 in Sardinia, the ssp. *saphyrina* Gené, 1836 in San Pietro Island (South West Sardinia), and the ssp. *siculorum* Schilder, 1953 in Sicily (Loew, 1843; Mandl, 1988; Putchkov & Matalin, 2003; 2017; Wiesner, 2020; Casale et al., 2021).

Many old records for this latter region have been referred to the ssp. *suffriani* Loew, 1843, that has a Eastern-Mediterranean distribution (Putchkov & Matalin, 2003; 2017; Wiesner, 2020). One of them was that given by Magistretti (1971) for the island of Salina, in the Aeolian Archipelago. This population has been successively confirmed withouth infraspecific information (Dent, 2017), or considered as belonging to the ssp. *siculorum* (see Lo Cascio & Magrini, 1998; Lo Cascio & Navarra, 2003; Lo Cascio & Pasta, 2004; Lo Cascio, 2017;

Lo Cascio et al., 2022), as was the one recently detected on the island of Lipari, in the same archipelago (Lo Cascio et al., 2022).

However, a more detailed study of the Aeolian populations showed the occurrence of some chromatic and morphological peculiarities that have taxonomical significance and suggest to refer them to a new subspecies, described in the present paper.

MATERIAL AND METHODS

Tiger beetles were observed directly in their habitat, photographed or sampled using a entomological net. Specimens from other entomological collections were also studied. Morphological examination was done under a stereomicroscope (Optika). Photos were taken with a Canon EOS 100D camera and body lenght was measured (in mm) with a digital calliper or using a lens equipped with a millimetric scale.

The biometric survey was performed with Past 4.14, an open-source software package for statistical data analysis (Hammer et al., 2001).

The systematic follows the contributions of Putchkov & Matalin (2003, 2017), Wiesner (2020), Casale et al. (2021) and others papers (see References). Often included in Carabidae, Cicindelidae are here considered as distinct family according to Duran & Gough (2010).

ACRONYMS AND ABBREVIATIONS: GAC, Giovanni Altadonna collection, Messina, Italy; CAF, Amedeo Falci collection, Caltanissetta, Italy; CL, Tommaso Lisa, Firenze, Italy, PLC, Pietro Lo Cascio collection, Lipari, Italy; CM, Calogero Muscarella collection, Palermo, Italy; CS, Ignazio Sparacio collection, Palermo, Italy; MSNG, Civic Museum of Natural History, Genoa, Italy; ex/x, specimen/s.

RESULTS

Ordo COLEOPTERA Linnaeus, 1758
Familia CICINDELIDAE Latreille, 1806
Subfamilia CICINDELINAE Csiki, 1906
Genus *Cicindela* Linnaeus, 1758
Subgenus *Cicindela* Linnaeus, 1758
Species *campestris* Linnaeus, 1758

Cicindela* (*Cicindela*) *campestris didyme n. ssp.
https://www.zoobank.org/5CC2BE32-9F37-4D5E-8466-1BB3A879F0E3

TYPE MATERIAL. Holotype male: Italy, Sicily, Aeolian Archipelago, Salina Island: Monte Fossa delle Felci, XI.2017, legit P. Lo Cascio (MSNG). Paratypes: idem, 4 females, III.1999 (PLC); 2 females, III.1999, legit P. Lo Cascio and F. Tassi (PLC); idem, 1 female, XI.2019 (PLC); idem, 1 female, 22.V.2009, legit P. Lo Cascio and F. Grita (PLC); idem, 2 females, 29.IX.2009 (PLC); idem, 2 males and 4 females, 14.IV.2015 (CM); idem, 5 males and 5 females, III.2023, legit P. Lo Cascio (CS); idem, 6 males and 3 females, XI.2023, legit P. Lo Cascio (PLC); Lipari Island: Poggio dei Funghi, 1 male, XI.2008, legit P. Lo Cascio (PLC); idem, 1 male 21.II.2021, legit P. Lo Cascio and L. La Fauci (PLC).

OTHER MATERIAL EXAMINED. *Cicindela campestris campestris*. Piemonte, Monte Musiné, 10.IV.1976, 2 males and 2 females, legit D. Gianasso (CS); Verbania: Monte Zeda, Pian Vadà, 16.VI.1997, 1 male (CM); Veneto, Cison di Valmarino (Treviso), 18.IV.1984, 1 males, legit B. Costella (CS); Padova, Colli Euganei, 1 male and 1 female, V.2011 (CM); Toscana, San Casciano in Val di Pesa (Firenze), 15.X.1998, 1 male and 3 females, legit G. Vassalli (CS); Marche, Ancona, II.2009, 1 female, legit M. Bellavista (CS); Basilicata, Potenza, Pollino: Piani di Ruggio 1600 m, 12.VI.1983, 1 male, legit P. Magrini (CL).

Cicindela campestris nigrita. Sardegna, Cagliari: Stagno di Molentargius, 13.X.1990, 6 males and 8 females, legit C. Meloni (CS); Gennargentu: Ortuabis, 700 m, 8.IV.1985, 2 males and 3 females, legit C. Meloni (CS); Gennargntu: Bruncu Spina, 2 females, 29.VI.1987, legit M. Romano (CS); Cagliari: Quartu, 3.III.1980, 2 males and 2 females, legit C. Meloni (CS).

Cicindela campestris calabrica. Calabria, Sila Piccola, Villaggio Mancuso, 15/23.V.1950, 11 males and 7 females, legit G. Binaghi (MSNG); Monte Gariglione: Bivio per Buturo, 26.IX.2015, 2 females, legit I. Sparacio (CS).

Catanzaro, Sila, Buturo, 30.VI.1994, 1 female (CL); Cosenza, Monte Botte Donato, 30.VII.1985, 1 female, legit F. Izzillo (CL).

Cicindela campestris siculorum. Messina: Forte Petrazza (240 m), 1 female 24.X.2010 (GAC); Monte Soro: Portella Femmina Morta, 12.IX.1988

(CS); Raccuja: Monte Giannì (1300 m), 1 ex 25.IV.2015 (GAC); Tortorici: Lago Pisciotto (1240 m), 1 ex 25.IV.2015 (GAC). Madonie: Piano Battaglia, 18.VI.1980, 2 exx (CS). Gibilmanna, 4.X.2019 (CM); Polizzi Generosa: Calanchi Xireni, 12 exx 23.IX.2019 (CAF); Torretta: Piano dell'Occhio, 1 ex 9.IV.2011 (CS); Altofonte, Rebuttone, 22.III.2012 (CM); San Vito Lo Capo: Golfo di Macari, 7 exx 13.IV.2002 (CS); Godrano, 4 exx 21.III.1992 (CS); Siculiana, Torre Salsa, Pantano, 1 ex 5.III.2022 (CM). Sperlinga, 6 exx 1.XI.2004 (CS); Piazza Armerina: Monte Rossomanno, 2 exx 15.IV.2008 (CS); Castel di Judica (CT), 17.IV.2017 (CM); Caltanissetta: Calanchi Milicia, 5 exx 21.X.2008 (CAF); RN Sughereta Niscemi, 3 exx 21.IX.2019 (CAF).

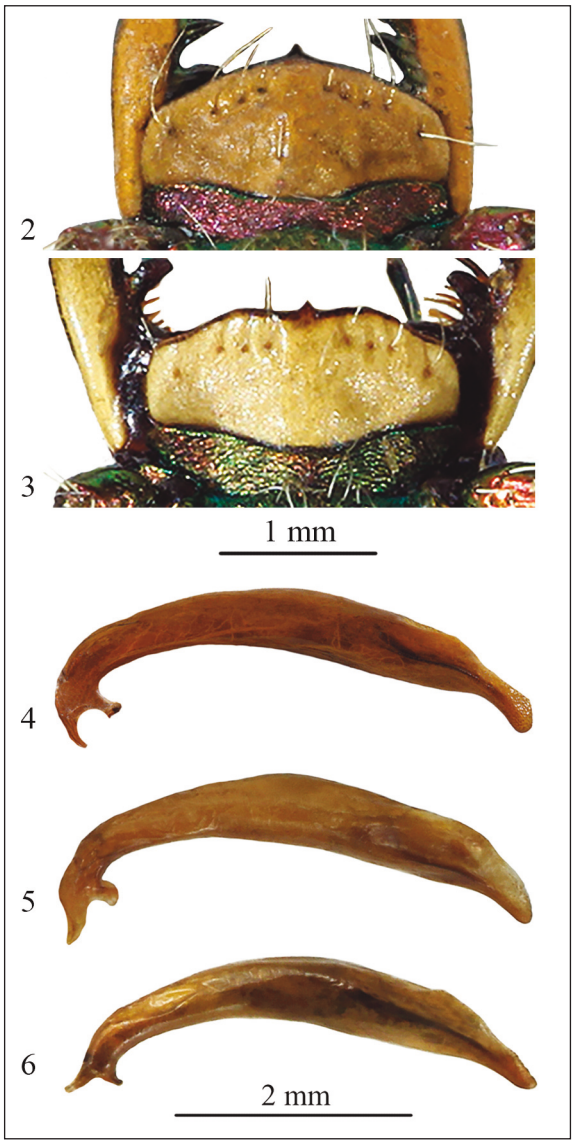
Description. Body length (except mandibles): males 12.3–12.9 mm, females 12.5–13.5 mm. Head, antennomeres 1-4, margins of pronotum and elytra, elytral suture and legs copper-red with brilliant metallic reflections. Labrum pale-yellowish. Elytra and pronotal disc greenish-brown and opaque. Yellowish-white elytral spots arranged as follows: one humeral lunula; one spot, sometimes very small or absent, at the elytral border in the anterior fourth; one spot near the elytral border towards the middle and one large post-median iuxta-sutural spot, these latter sometimes connected by a thin, irregular oblique transverse band less evident and often interrupted; one apical lunula often divided into two distinct spots (Fig. 1). In the females there are also two black spots iuxta-sutural to the anterior fourth. Yellowish-white long and erect pubescence occurring laterally on the body and the legs, much denser on forehead, femurs and ventral surface; few scattered setae on first and second antennomeres. Labrum sharp, with edges regularly converging forwards; on each side there are setae pores arranged as follows: 4 on the anterior margin, 1 on the lateral margin and 1 on the posterior margin towards the centre (Fig. 2). Forehead with longitudinal wrinkles parallel to the ocular edge and dense roughness on the posterior edge. Antennomeres 5–11 pubescent, the last one as long as the penultimate; labial and maxillary palpi with last article truncate at apex.

Pronotum broader anteriorly, sides rounded in anterior half then narrowed anteriorly, posterior angles obtuse and rounded; anterior and posterior border with dense transverse wrinkles, disc and sides of pronotum with dense rugosity and a median longitudinal groove. Elytra subparallel at sides up to the fourth distal, then rounded at apex, rugose-dotted with spaced, sparsely elevated granules. Last abdominal sternite with centrally hollowed apex in males and broadly truncate in females.

Figure 1. Three specimens of *Cicindela campestris didyme* n. ssp. from Salina Island (Aeolian Archipelago).

Aedeagus is elongated and clearly bent near the middle on the concave side and has an elongated tip (Fig. 6).

DISTRIBUTION AND BIOLOGY. The new subspecies has so far been found on Lipari and Salina, the two largest islands of the Aeolian Archipelago.



Figures 2, 3. Labrum of *Cicindela campestris didyme* n. ssp. from Salina island (Fig. 2) and of *C. campestris siculorum* from Sicily, Monte Soro (Fig. 3). Figures 4–6. Aedeagi of *C. campestris calabrica* from Calabria, Sila Piccola: Villaggio Mancuso (Fig. 4), *C. campestris siculorum* from Sicily, Monte Soro (Fig. 5) and *C. campestris didyme* n. ssp. from Salina island (Fig. 6) .

The preferred habitat seem to be open and sunny areas with bare ground or scarce vegetation, at the edge of forest and pre-forest formations; the local distribution ranges from 700 and 500 m a.s.l. to the top, respectively, on Monte Fossa delle Felci at Salina and on Poggio dei Funghi and Monte Chirica at Lipari. Adults are active during daylight hours and in the sunniest days. The phenology of the species has two peaks in February-April and August-October.

ETYMOLOGY. The new taxon is named "*Didyme*" as the ancient greek name of Salina, which was inspired by the similarity among the two reliefs that dominate orographically the island (from δίδυμος = double, twin). This specific epithet is as a noun in apposition.

REMARKS. The new subspecies is immediately recognizable from the other Italian and Sicilian populations by the reddish-green colour of head, pronotum and elytrae, by the matt surface of these latter, and by the small size of the elytral yellowish-white spots; the labrum is more triangular in shape and has more setae pores; the pubescence on the forehead, femurs and ventral surface is more dense and visible; the pronotum is narrower behind, the scutellum smaller, and the granules of the elytra are less elevated and more sparse; finally, the aedeagus differs significantly from the other populations (Figs. 1, 2, 6).

Concerning the chromatic variability, only a small percentage of the examined specimens (10%) has green head and pronotum and reddish-green elytra, while the majority has red-brown head and pronotum with more or less extensively green-brown elytra, and 25% are entirely red-brown.

Despite the high level of variability that characterizes this species, for which several chromatic varieties have been described (see Ragusa, 1883; 1921; Porta, 1923; 1949; Luigioni, 1929; Mandl, 1944), the Italian and Sicilian populations of *Cicindela campestris* show more or less constantly a bright green colour with red-metallic highlights on the margins of the body, the antennomeres 1–4, the elytral suture and the legs.

In the Sicilian specimens (*C. campestris siculorum*) the red hue on elytra is sporadically occurring and usually circumscribed around the large post-median iuxta-sutural spots; the yellowish-white elytral spots are usually more developed; the labrum

is more transverse, with sinuate anterior edges and fewer setae pores; the pubescence on the forehead, femurs and ventral surface is less dense; the scutellum is larger and with evident striae; the granules of the elytra are higher and denser. Aedeagus is elongated, unbent near the middle on the concave side, bulging in the middle on the convex side with a slightly elongated tip (Figs. 3, 5).

In *C. campestris calabrica*, on the other hand, the red hue is rarely extended on head and pronotum, the labrum has a shape more triangular but with sinuate anterior margins, the elytral granules higher and denser, and the apex of the aedeagus is granulated and has a very characteristic shape (Fig. 4).

The differences in aedeagus conformation between *C. campestris calabrica*, *C. campestris siculorum*, and *C. campestris didymae* n. ssp. show a clear differentiation of these three taxa.

Cicindela campestris didyme n. ssp. is also smaller in size than *C. campestris siculorum*, as confirmed by a morphometric analysis of female specimens through the comparison of elytra length (EL), elytra width (EW), pronotum length (PL) and elytra width (EW). Difference between the two populations are statistically significant (Hotelling T2 test: 50.338, F = 8.3897, P = 0.012) (Figs. 7, 8).

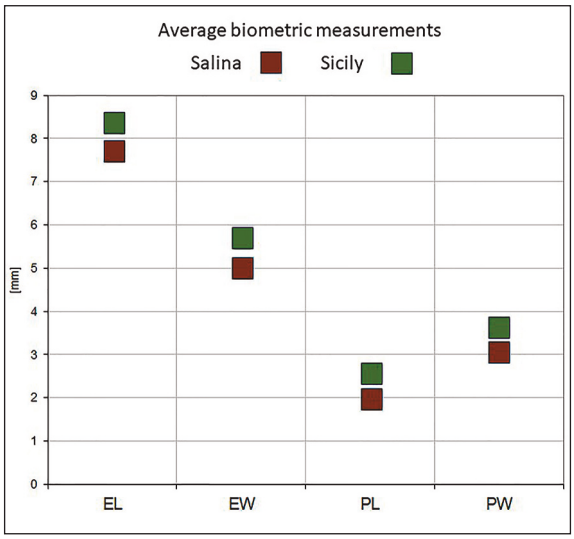
DISCUSSION AND CONCLUSIONS

As already stated, the *Cicindela campestris* complex shows a high level of variability, especially with regard to chromatic patterns. This mosaic, however, includes small island populations in which colour patterns and morphological differences are more consistent, which have been referred to several subspecies, such *C. campestris saphyrina* Gené, 1836 from the circum-Sardinian island of San Pietro, *C. campestris naxosica* Deuve, 2012 from Cyclades or *C. campestris balearica* Sydow, 1934 from Balearics (Sydow, 1934; Deuve, 2012).

Geographic isolation is certainly the determining factor in these micro-evolutionary processes, on which, however, local adaptive phenomena play also a role and may emphasize recessive traits not frequent in the populations of origin.

This seems to be the case of the populations of the Aeolian Islands, characterized by a general tendency towards darkening of the colour pattern, that is fully responding to the mimetic requirements imposed by soils of volcanic origin.

An example with interesting similarities is that of the tenebrionid beetle *Phaleria bimaculata* (Linnaeus, 1767), for which the Aeolian populations had been referred to a distinct subspecies (ssp. *marcuzzii*



Females Sicily	EL	EW	PL	PW
N.	10	10	10	10
Min.	7.7	5	2.2	3.1
Max	8.7	5.8	2.8	3.6
Mean	8.16	5.48	2.42	3.37
Std. error	0.103	0.083	0.073	0.050
Females Salina	EL	EW	PL	PW
N.	10	10	10	10
Min.	7.5	5	2	2.9
Max	8.1	5.6	2.4	3.3
Mean	7.89	5.19	2.15	3.06
Std. error	0.064	0.060	0.040	0.034

Figures 7, 8. Graph (left) and table (right) with biometric data (average ± S.E.) of the females of *Cicindela campestris siculorum* from Sicily and those of *C. campestris didyme* n. ssp. from the Aeolian Archipelago (Salina). Four morphological characters were measured for each specimen: elytra length (EL), elytra width (EW), pronotum length (PL), pronotum width (PW).

Aliquò, 1993) on the basis of their marked melanism, although its taxonomic value deserves further investigations (see Lo Cascio et al., 2022 and references therein).

The biogeographical context of the new subspecies is that of islands emerged since 300,000 years ago, and thus of a relatively recent colonization and differentiation (schizoendemism). Moreover, during the last 8 millennia the anthropic pressure has contributed significantly to transforming the original landscape and vegetation (Lo Cascio, 2017). Within this scenario, the most conservative environments - although also largely disturbed - are the innermost and higher areas of the islands, where the populations of the new subspecies seem to be strictly localized.

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