

CONTRIBUTION TO KNOWLEDGE OF THE DISTRIBUTION OF THE GERANIUM BRONZE *Cacyreus marshalli* (Butler, 1898) (Lepidoptera, Lycaenidae) IN CROATIA WITH NOTE ON ECOLOGY AND ETHOLOGY

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The species *Cacyreus marshalli* was introduced into Europe from South Africa in 1978. In Croatia its presence was noted for the first time in 2009 in Mali Lošinj. Previous research has recorded this species at around 20 localities. The present paper gives new records of the species Geranium Bronze from 28 localities in the Mediterranean part of Croatia with some data regarding its ecology and ethology. The known margin of the distribution area of *C. marshalli* in Croatia has expanded by around 50 kilometres to the south-east to the islands Korčula and Lastovo and in inland to the Pelješac peninsula. The Geranium Bronze has not been recorded in the continental and central mountain part of Croatia, but was for the first time recorded on Mt. Učka, on 934 meters a.s.l.

Cacyreus marshalli, distribution, ecology, ethology, Croatia

M. KUĆINIĆ, M. RANDIĆ, I. MIHOCI, T. KOREN, A. MRNJAVČIĆ VOJVODA, B. LAUŠ, I. BURIĆ: Prilog poznavanju rasprostranjenja pelargonijeva plavca *Cacyreus marshalli* (Butler, 1898) (Lepidoptera: Lycaenidae) u Hrvatskoj s noticom na ekologiju i etologiju. Entomol. Croat. Vol. 18. Num. 1–2: 49–57

Cacyreus marshalli je vrsta introducirana na područje Europe 1978. godine s područja južne Afrike. Na području Hrvatske prvi put je zabilježena 2009. godine u Malom Lošinj. Dosadašnjim istraživanjima bila je zabilježena na području Hrvatske na 20-ak lokaliteta. Ovim radom daju se novi nalazi pelargonijinog plavca na 28 lokaliteta u mediteranskom dijelu Hrvatske te neki podaci o njegovoj ekologiji i etologiji na području Hrvatske. Granica areala *C. marshalli* proširena je na području Hrvatske za 50-ak km prema jugoistoku i sada su to otoci Korčula i Lastovo i na kopnu poluotok Pelješac. Pelargonijev plavac nije utvrđen u kontinentalnom ni središnje planinskom području Hrvatske, ali je po prvi put zabilježen na Učki na 934 metra nadmorske visine.

Cacyreus marshalli, rasprostranjenost, ekologija, etologija, Hrvatska

Introduction

The butterfly *Cacyreus marshalli* (Fig. 1) is naturally widespread in Mozambique, South Africa, Zambia and Zimbabwe (Heaths et al. 2002). This species from the family Lycaenidae was introduced to Europe from South Africa in the second half of the twentieth century. The first record was of a caterpillar found in England in 1978 (Heaths et al. 2002). Geranium Bronze was recorded in Mallorca in 1990, in Italy in 1996, in Morocco, Portugal and the French Mediterranean in 1998, in Sicily in 2001, in southern Switzerland in 2002, in Slovenia in 2008 and in Croatia in 2009 (Kosmač & Verovnik, 2009; Tolman & Lewington, 2009; Verovnik et al., 2011; Kučinić et al., 2013). This species was also established in Belgium, Germany, the Netherlands and the United Kingdom but was unable to survive the winter (Gross, 2010). Larval host plants are species from the genera *Pelargonium* and *Geranium* (Tolman & Lewington, 2009). Since its accidental introduction to Europe, due to its biological and ecological features, the Geranium Bronze has spread to the south and southeastern parts of Europe (Tarrier, 1998; Aistleitner, 2002; Aistleitner & Pollini, 2004). In Croatia this species was first recorded in Mali Lošinj (Kosmač & Verovnik, 2009). Data about the spread of the species is given by Kučinić et al. (2013). Recently *C. marshalli* was recorded on the Island of Hvar (Koren et al., 2014), which is now the southernmost point of its distribution area.



Figure 1. *Cacyreus marshalli*, adult on inflorescence of *Pelargonium* sp. (photo S. Janeković).



Figure 2. Specific damage to plants on the bottom side of the leaf of *Pelargonium peltatum* caused by caterpillars of *Cacyreus marshalli* (foto M. Randić).

In this paper we present: 1. New findings and distribution of species *C. marshalli* in Croatia, 2. Data about host plants, damage to host plants and flight periods of adults (ethology data).

Material and Methods

Gathering of the data was done as a part of field work across Croatia. We observed potential larval host plants of the species *Cacyreus marshalli* for adult forms, caterpillars and damage to plants (Fig. 2). Damage to plants that belong to the genus *Pelargonium* are specific to the species *C. marshalli* and were taken as indirect evidence of the presence of this species at a certain locality. A record of damage to plants is considered a valid proof of the species' presence and equivalent to a record of the Geranium Bronze at that locality. M. Randić recorded the largest number of faunistic and ethological observations in Istria and Primorje while T. Koren recorded faunistic data in the area of Dalmatia.

Identification of the adult forms and systematic review was given according to Tolman & Lewington (2009) and Lafranchis (2004). Damage to plants and certain developmental stages were photographed using an Olympus OZ4 for photo documentation.

Results and Discussion

Distribution of *Cacyreus marshalli* in Croatia

The introduced butterfly species *Cacyreus marshalli* was recorded at 28 new localities during this survey in Sub-Mediterranean and Eu-Mediterranean parts of

Croatia (Table 1, Fig. 3). If we take into account published literature data about this species (Kosmač & Verovnik, 2009; Kučinić et al., 2013; Koren et al., 2014), it has been recorded so far in about 50 localities in Croatia. Most of the newly recorded locations are in Primorje (16), in Istria there were only 2 newly recorded locations and in Dalmatia *Cacyreus marshalli* was recorded in 10 new localities. During this research most of the records were for islands (17), while others were for the inland (11) (Table 1, Fig. 3). This research recorded the butterfly *C. marshalli* for 10 islands, for the first time for the following islands: Dugi Otok, Korčula, Košljun, Krk, Lastovo, Sv. Klement and Šolta (Table 1). This butterfly species has been recorded for 13 Adriatic islands (Kosmač & Verovnik, 2009; Koren & Lauš, 2012; Kučinić et al., 2013; Koren et al., 2014). All of the new records and literature data (e.g. Kučinić et al., 2013; Koren et al., 2014) show that the butterfly species *C. marshalli* in Croatia has been recorded only for the Sub-Mediterranean and Eu-Mediterranean areas (Table 1, Fig. 3), which is conditioned by the biological features of this South Afri-

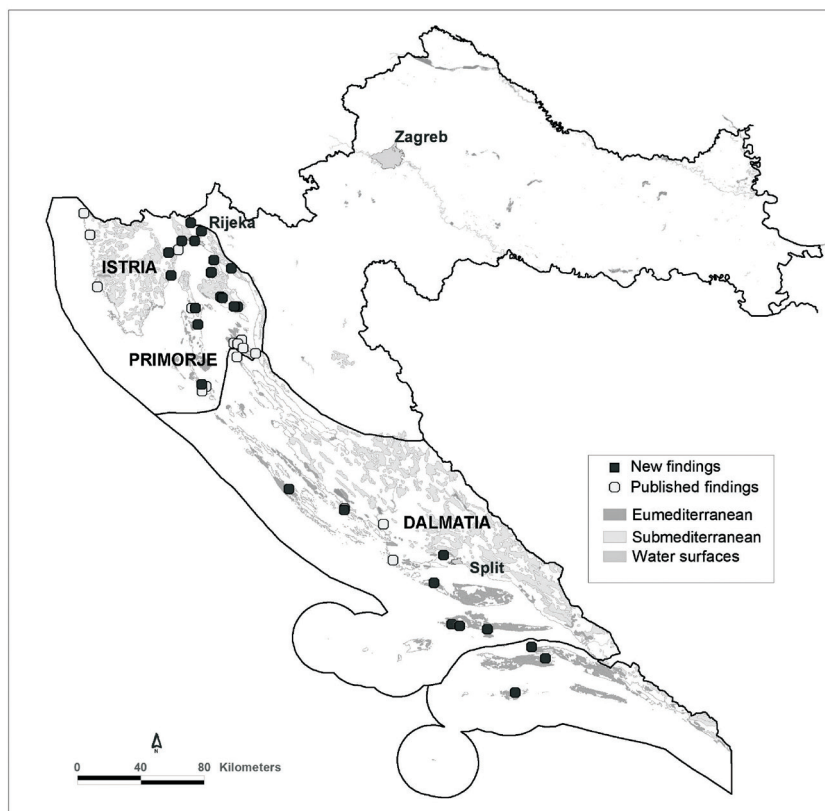


Figure 3. Distribution of species *Cacyreus marshalli* in Croatia: literature data (Kučinić et al., 2013; Koren et al., 2014), new findings.

Table 1. New records of species *Cacyreus marshalli* in Croatia with data of recording methods on certain locality: damage to plants, eggs, larvae, pupae and adults (*P. peltatum* = *Pelargonium peltatum*; *P. zonale* = *Pelargonium zonale*), geographical coordinates and altitudes.

Location	Dates	Observation	Plants	Geographical coordinates and altitudes
ferry harbour Brestova (Istria) near town Brseč	2.VIII.2013.	adults	–	45° 8.690' N 14° 13.411' E 11 meters a.s.l.
Učka Mt, locality Poklon	IX.2014.	adults, damage on plants	<i>P. zonale</i>	45° 18.480' N 14° 12.934' E 934 meters a.s.l.
island Cres, small town Beli	30.IX.2014.	damage on plants	<i>P. peltatum</i>	45° 6.656' N 14° 21.314' E 107 meters a.s.l.
island Cres, town Cres	17.IX.2014.	damage on plants	<i>P. zonale</i>	44° 57.655' N 14° 24.590' E 4 meters a.s.l.
town Crikvenica	25.IX.2014.	damage on plants	<i>P. peltatum</i> , <i>P. zonale</i>	45° 10.537' N 14° 41.178' E 6 meters a.s.l.
small town Dražice – Grobničko polje (near town Rijeka)	summer 2014.	adults, damage on plants	<i>P. peltatum</i> , <i>P. zonale</i>	45° 23.334' N 14° 27.972' E 293 meters a.s.l.
Kamenjak (location near town Rijeka)	VIII.2014.	adults, damage on plants	<i>P. zonale</i>	45° 23.237' N 14° 33.039' E 579 meters a.s.l.
small town Klana (near town Rijeka)	VIII.2014.	damage on plants	<i>P. zonale</i>	45° 26.734' N 14° 22.501' E 574 meters a.s.l.
island Košljun	IX.2014.	damage on plants	<i>P. peltatum</i> , <i>P. zonale</i>	45° 1.608' N 14° 37.089' E 1 metre a.s.l.
island Krk, Batomalj (village near town Baška)	19.IX.2014.	damage on plants	<i>P. zonale</i>	44° 58.367' N 14° 49.664' E 59 meters a.s.l.
island Krk, Kijac (suburbs of town Njivice)	28.IX.2014.	adults	sucking nectar – plants from family <i>Aizoaceae</i>	45° 9.043' N 14° 32.327' E 50 metres a.s.l.
island Krk, small town Njivice	IX. - X. 2014.	damage on plants	<i>P. zonale</i>	45° 9.894' N 14° 32.562' E 2 metres a.s.l.
island Krk, small town Omišalj	20.XI.2014.	larvae, damage on plants	<i>P. zonale</i>	45° 12.649' N 14° 33.334' E 83 metres a.s.l.
island Krk, small town Punat	XI.2014.	adults, damage on plants	<i>P. peltatum</i> , <i>P. zonale</i>	45° 1.288' N 14° 37.694' E 1 metre a.s.l.

island Lošinj, Vresikovo part of town Mali Lošinj	20.X.2010.	adults	–	44° 31.833' N 14° 27.960' E 21 metres a.s.l.
town Opatija	summer 2014.	adults, damage on plants	<i>P. peltatum</i> , <i>P. zonale</i>	45° 22.246' N 14° 18.535' E 23 metres a.s.l.
village Podkilavac – Grobničko polje (near town Rijeka)	summer 2014.	damage on plants	<i>P. peltatum</i>	45° 24.124' N 14° 28.186' E 316 metres a.s.l.
town Rijeka	12.VIII.2013. 15.VIII.2013. summer 2014. X.2014. 26.XII.2014.	eggs, larvae, pupae, adults, damage on plants	<i>P. zonale</i> <i>Geranium sp.</i>	45° 19.610' N 14° 26.545' E 12 metres a.s.l. 45° 19.267' N 14° 28.305' E 3–80 metres a.s.l.
island Dugi otok, small town Sali	20.VII.2014.	adults	–	43° 56.338' N 15° 09.840' E 21 metres a.s.l.
small town Kaštel Lukšić (near town Split)	28.IV.2013.	adults	–	43° 33.442' N 16° 21.622' E 24 metres a.s.l.
island Korčula, town Korčula	17.XI.2013.	adults	–	42° 56.973' N 17° 08.222' E 11 metres a.s.l.
island Korčula, Poljica valley	13.VI.2014.	adults	–	42° 58.800' N 16° 43.480' E 99 metres a.s.l.
island Lastovo, small town Ubli	4.V.2014.	adults	–	42° 44.710' N 16° 49.490' E 10 metres a.s.l.
island Murter, small town Jezera	23.VI.2013.	adults	–	43° 47.467' N 15° 37.748' E 17 metres a.s.l.
Palmižana, island Sv. Klement (part of Pakleni otoci island group)	17.-19. IX.2014.	adults	<i>Pelargonium sp.</i>	43° 159540 N 16° 391239 E 10-40 metres a.s.l.
Pelješac Peninsula, village Lovište	15.VI.2014.	adults	–	43° 01.040' N 17° 01.970' E 49 metres a.s.l.
island Šolta, village Gornje Selo	30.IV.2014.	adults	–	43° 21.580' N 16° 20.462' E 141 metres a.s.l.
island Šolta, small town Stomorska	19.VIII. 2014.	adults	–	43° 22.252' N 16° 21.178' E 7 metres a.s.l.

can butterfly species and its full life cycle development at temperatures higher than 24 °C (Fig. 3).

This survey contributed to the knowledge about the distribution of this species in Croatia, and expanded the known area of occurrence to the southeast of Croatia by about 50 kilometres, with the southernmost records on the islands of Korčula and Lastovo (Fig. 3). Until this investigation the southernmost point of distribution of the Geranium Bronze in inland of Croatia was Šibenik (Kučinić et al., 2013). In this investigation *C. marshalli* was recorded on Pelješac Peninsula about 100 kilometres south of Šibenik (Table 1).

In the continental part of Croatia no significant penetration was recorded. Farthest locations of record are the area of Grobničko polje near Rijeka and Poklon on Mt Učka. All localities on which the Geranium Bronze was recorded are situated in the Sub-Mediterranean and Eu-Mediterranean parts of Croatia (Table 1). Our new investigation, including literature data (e.g. Španić, 2012; Tvrtković et al., 2012) indicates that the Geranium Bronze cannot overwinter in continental and in the central mountainous areas of Croatia. The record on Poklon is also the highest record of this species in Croatia, at 934 meters a.s.l. This indicates that this species may indeed colonize higher altitudes, especially Mediterranean mountains.

Ethology of *Cacyreus marshalli* in Croatia

In the area of the city of Rijeka the most detailed research was performed about ethology of the Geranium Bronze. According to this research the female of the butterfly lays small eggs that are at first greenish and later whitish on plants of the genus *Pelargonium*. During this research damage to leaves was recorded, most likely from *C. marshalli*, on plants from the genus *Geranium* (Table 1) that are also larval host plants of the Geranium Bronze (Tolman & Lewington, 2009; Kučinić et al. 2013). On *Pelargonium* caterpillars feed on young leaves, flowers buds and drill to the soft stems, but also damage to flowers was determined. Pupation takes place at the base of the flower petioles of *Pelargonium* inflorescences. In this part of the plant caterpillars are well protected and stay there until metamorphosis.

Out of the 28 records (Table 1), most are of adult butterflies while others are of damage to plants caused by caterpillars. Only at two localities was the species *C. marshalli* recorded in the larval stage (Omišalj on the island Krk, Rijeka), and at only one locality (Rijeka) as a pupa. Only in Rijeka were all four life stages recorded (from the egg till the adult butterfly). Plant species *Pelargonium pelatum*, *P. zonale* and species from genus *Geranium* are identified as larval host plants. Species from the genus *Pelargonium* are already recognized as the most important larvae host plants and potentially very important for distribution of this species. The Geranium Bronze was introduced into Europe in the form of *C. marshalli* larvae on pelargonium seedlings.

Records of adult butterflies vary in the different parts of Croatia from spring (April and May) till fall (October and November) but they are most frequent in summer. Eggs were recorded in summer months. Activity of caterpillars and dam-

age to plants were recorded in summer, autumn and winter months. Records of caterpillars in winter months from (26.XII.2014.) indicate that there is a possibility that Geranium Bronze overwinters as caterpillar or pupa. In Palmižana, adults were recorded in September but the absence of visible damage to the larval host plant from the genus *Pelargonium* shows either that an autumn generation emerged without laying eggs or had perhaps migrated from some other island, most probably from Hvar.

The highest number of recorded adult butterflies was in Palmižana on the island of Sv. Klement from 17 till 19 September 2014. During observation and adult counting in a transect 80 metres long, on 18 September 2014, 30 specimens of species Geranium Bronze were recorded. In Croatia, the flight period of the Geranium Bronze is from April to November (Table 1), most likely in two maybe in three generations.

Based on this research we can conclude that species *C. marshalli* is still spreading toward the south of Croatia, but not toward the continental part. Records of caterpillars in November on the island of Krk and in December in Rijeka indicate that this species can overwinter in Croatia in that life stage or perhaps in the pupal. Future research should continue the monitoring of this species and should be aimed at determining potential new locations in the Mediterranean and continental parts and also at improving knowledge of the life cycle of the species Geranium Bronze in Croatia and its potential adaptation to different ecological conditions from those found in South Africa where *C. marshalli* is indigenous.

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Literature

- AISTLEITNER, U. 2002. Erste Nachweise des Geranien-Bläulings *Cacyreus marshalli* Butler, 1898, in der Schweiz (Lepidoptera: Lycaenidae). Entomologische Berichte Luzern 49: 151–154.
- AISTLEITNER, U. & POLLINI, M. 2004. Weitere Meldungen von *Cacyreus marshalli* Butler, 1898, aus der Südschweiz und Oberitalien (Lepidoptera: Lycaenidae). Entomologische Berichte Luzern 52: 153–154.
- GROS, P. 2010. Achtung: Neozoen im Anmarsch! Der Pelargonien-Bläuling (*Cacyreus marshalli* Butler 1898) in Europa. Ein Beispiel für die ausnahmsweise gut dokumentierte Expansion eines Neozoons und erste Meldung dieser Tagfalterart aus Istrien (Kroatien). Salzburger Entomologische Arbeitsgemeinschaft Haus der Natur Newsletter 2: 8–11.
- HEATHS, A., NEWPORT, M. A. & HANCOCK, D. 2002. The Butterflies of Zambia. American Butterfly Research Institute & The Lepidopterists' Society of Africa, pp. 137, Pretoria.
- KOREN, T., BIJELIĆ, M., ŠKULJEVIĆ, P. & GOMBOC, S. 2014. Contribution to the knowledge of the butterfly fauna (Insecta: Lepidoptera) of the Adriatic island Hvar, Croatia. Acta Entomologica Slovenica 22 (1): 29–44.
- KOREN, T. & LAUŠ, B., 2012. The First Faunistic Records of Butterflies and Moths from Two Small Adriatic Islands, Olib and Šćedro, Croatia. Entomologia Croatica 16 (1–4): 115–124

- KOSMAČ, M. & VEROVNIK, R. 2009: First record of *Cacyreus marshalli* (Lycaenidae) from the Balkan Peninsula. *Nota lepidopterologica* 32 (1): 81–82
- KUČINIĆ, M., KOREN, T., MIHOCI, I., VUKOVIĆ, M., BUKOVEC, D., JAKOVLJEVIĆ, T. & JENČIĆ, S. 2013. Can spreading of the Geranium Bronze *Cacyreus marshalli* (Butler, 1898) (Insecta, Lepidoptera, Lycaenidae) in Croatia be assigned to climate change? *Preiodicum Biologorum* 115 (3): 429–433.
- LAFRANCHIS, T. 2004. Butterflies of Europe. *Diatheo*, pp. 351, Paris.
- ŠPANIĆ, R. 2012. Butterfly fauna (Papilionoidea & Hesperioidea) in the surrounding area of Karlovac, Croatia. *Natura Croatica* 21 (2): 455–470.
- TARRIER, M. 1998. *Cacyreus marshalli* Butler, 1898, a new species for France, Portugal and Morocco (Lepidoptera Lycaenidae). *Alexandria* 20 (2–3): 143–144.
- TOLMAN, T. & LEWINGTON, R. 2009. *Butterflies of Britain and Europe*. Harper Collins Publishers, pp. 384, London.
- TVRTKOVIĆ, N., ŠAŠIĆ, M., VUKOVIĆ, M. & BJELIĆ, M. 2012. Review of the butterfly fauna (Hesperioidea & Papilionoidea) of the Dinara mountain range. *Natura Croatica* 21 (2): 471–481.
- VEROVNIK, R., POLAK, S. & SELJAK, G. 2011. Pojav in širenje tujerodne vrste dnevnega metulja – pelargonijevega bakrenčka (*Cacyreus marshalli*) (Butler, 1898) v Sloveniji. *Acta Entomologica Slovenica* 19 (1): 5–16.