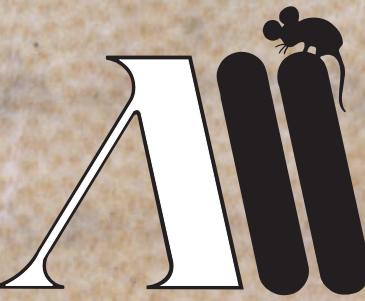


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ON THE PRESENCE OF TWO-TAILED PASHA (*CHARAXES JASIUS* (LINNAEUS, 1767), PAPILIONOIDEA: NYMPHALIDAE) IN THE NORTHEASTERN ADRIATIC REGION

Rudi VEROVNIK

University of Ljubljana, Biotechnical Faculty, Department of Biology, Jamnikarjeva 101, Ljubljana, Slovenia
e-mail: rudi.verovnik@bf.uni-lj.si

Nejc RABUZA

Dobje pri planini 22a, 3224 Dobje, Slovenia
e-mail: nejc.rabuza@gmail.com

Miroslav REPAR

Dolinska 1H, 6000 Koper, Slovenia
e-mail: miro.repar@yahoo.com

Matjaž ZADRGAL

Pod Lazami 53 Vrtojba 5290 Šempeter pri Gorici, Slovenia
e-mail: zadrgalm@gmail.com

Paul TOUT

Malchina 5/A, 34011 Duino-Aurisina (TS), Italy
e-mail: tout@xnet.it

ABSTRACT

The paper presents and discusses the first observations of two-tailed pasha (*Charaxes jasius*) in northeastern Adriatic, including first records for Slovenia. It was first noted north of its known range in Umag, Istria, in 2018, followed by an observation in Piran in 2019, Savudrija in 2020, and three observations in 2021 from well-separated localities of Strunjan, Osp, and Sela na Krasu. A search for early stages on local strawberry trees (*Arbutus unedo*) proved fruitless, indicating that the current spate of records is very likely due to the vagrant nature of the species in the region. Factors potentially limiting its range expansion, such as limited availability of the main host plant and low winter temperatures, are also discussed.

Key words: distribution, climate change, Istria, host plants, *Arbutus unedo*

PRESENZA DELLA NINFA DEL CORBEZZOLO (*CHARAXES JASIUS* (LINNAEUS, 1767), PAPILIONOIDEA: NYMPHALIDAE) NELLA REGIONE ADRIATICA NORD-ORIENTALE

SINTESI

L'articolo presenta e discute le prime osservazioni della ninfa del corbezzolo (*Charaxes jasius*) nell'Adriatico nord-orientale, compresi i primi dati per la Slovenia. Questa farfalla è stata notata per la prima volta a nord del suo areale conosciuto, a Umago, in Istria, nel 2018, e successivamente a Pirano nel 2019, Salvore nel 2020, e tre osservazioni nel 2021 in località ben separate: Strugnano, Ospo, e Sella delle Trincee. Una ricerca di esemplari allo stadio iniziale sui corbezzoli locali (*Arbutus unedo*) si è rivelata infruttuosa, indicando che l'attuale ondata di registrazioni è molto probabilmente dovuta alla natura vagabonda della specie nella regione. Vengono anche discussi i fattori che potenzialmente limitano la sua espansione, come la disponibilità limitata della principale pianta ospite e le basse temperature invernali.

Parole chiave: distribuzione, cambiamento climatico, Istria, piante ospiti, *Arbutus unedo*

INTRODUCTION

The two-tailed pasha is one of the largest butterflies in Europe and the only species of the mainly Afro tropical genus *Charaxes* that reaches as far as the Mediterranean. It is distributed from the western part of North Africa (Tennent, 1996) across the Iberian Peninsula to southern France and Italy and down to the coastal areas of Greece and southern Turkey in the eastern Mediterranean (Tolman & Lewington, 2008), with isolated colonies in the Middle East (Benyamin & John 2020, Tshikolovets & Yehuda 2020). It is widespread along the east Adriatic coast, reaching as far north as the southern parts of Istria (Koren, 2012; Koren et al., 2019). Along the western Adriatic coast, its occurrence, like that of its host plant, is much more sporadic reaching Mt. Conero near Ancona in the north (Teobaldelli, 1976).

The species' distribution roughly coincides with various types of Mediterranean evergreen scrubland including maqui and garrigue, where the main larval host plants, the strawberry tree *Arbutus unedo* L. and the Greek strawberry tree *A. andrachne* L., abound. On rare occasions, the larvae have also been found on other plants including bay laurel *Laurus nobilis* L. (Nel, 1979; Stefanescu, 1995), wild tea plant *Osyris quadripartita* Salzm. ex Decne. (Fernandez-Martinez, 2000), tree tobacco *Nicotiana glauca* Graham (Markis, 2003), and a range of cultivated trees including apricots (*Prunus persica* L.) and citrus trees (*Citrus* spp.) (Danner, 2001; Longo et al., 2000). The species is bivoltine in most of Europe with a pronounced second generation on the wing from the second half of August to the beginning of October (Abós & Stefanescu, 1999). Despite being strong fliers, adults are generally observed near their larval habitats, although they can fly considerable distances to feed on ripe fruit, such as figs (Tolman & Lewington, 2008; Verovnik, pers. obs.). Males are notably territorial and both sexes are commonly observed congregating on prominent peaks, a behaviour known as "hill-topping" (Sturm, 1998; Tolman & Lewington, 2008).

Females lay conspicuous yellow eggs on the upper surface of the leaves of the host plants, and the larvae hatch within 8 to 15 days. They are not very mobile and spin a silky mat on the leaf on which they rest, which is used throughout their development to the fifth instar. They usually leave the host plant to pupate in nearby vegetation (Abós & Stefanescu, 1999). The emergence of adult butterflies follows in two to four weeks, depending on temperature. Under laboratory conditions, larvae or pupae exposed to temperatures below 5 °C for extended periods of time do not develop or they produce crippled individuals (Sanetra & Peuker, 1993).

The current poleward range shifts linked to climate change are becoming ever more evident in butterflies, although so far these have been more evident in regions of northern Europe and North America, which are without major topographical barriers and are more common

in ecological generalist species (Parmesan et al., 1999, Estrada et al., 2016, Fourcade et al., 2017). In our study, we present the first observations of *Charaxes jasius* in Slovenia and its close proximity, and evaluate its potential range shift northwards.

MATERIAL AND METHODS

The first observations of the two-tailed pasha were purely incidental as the authors observed the species completely unexpectedly. Deliberate surveys of potential feeding and hill-topping sites along the Slovenian coast followed. In all instances, the behaviour of adults was checked. We also surveyed the known sites where *Arbutus unedo* grows in natural habitats (Wraber, 1972; Žnidaršič, 2014) or is planted in urban areas along the Slovenian coast. Information was sought via social media regarding the distribution of strawberry tree along the Italian coast, with the search yielding several new records to add to those already known, as well as providing the location of an area of *A. unedo* (the species is not native to NE Italy) naturalised in a suitable habitat north of the village of Santa Croce-Križ in the Province of Trieste, an area that should be kept under observation in years to come.

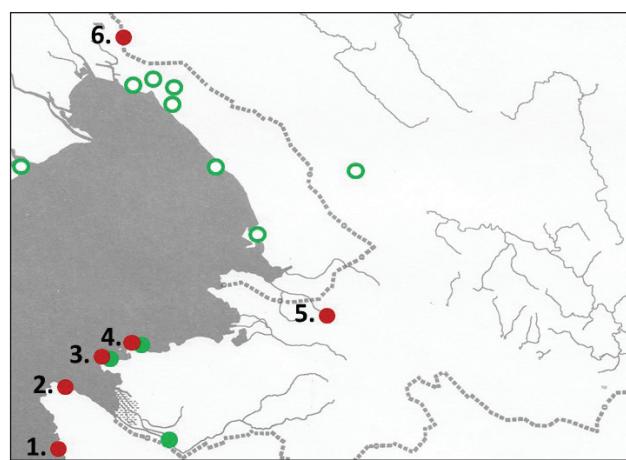


Fig. 1: The distribution of two-tailed pasha (*Charaxes jasius*) in the northeastern part of the Adriatic. The numbering of the localities follows the list in the results section. The green dots represent approximate positions of the surveyed strawberry tree (*Arbutus unedo*) stands, the empty circles denoting those that have not been checked for larvae.

Sl. 1: Razširjenost dvorepega paše (*Charaxes jasius*) v severovzhodnem delu Jadranu. Oštevilčenje sledi seznamu lokacij v Rezultatih. Zelene točke predstavljajo približen položaj pregledanih rastišč jagodičnice (*Arbutus unedo*), točke z zeleno obrobo pa lokacije, kjer prisotnost larvalnih stadijev ni bila preverjena.

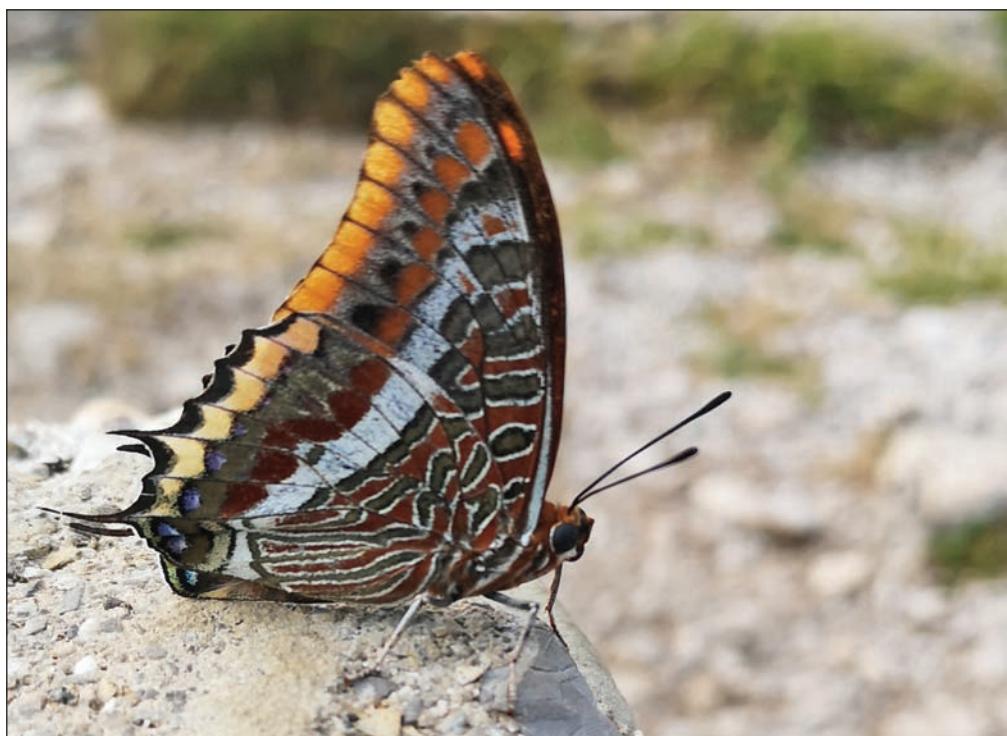


Fig. 2: A male two-tailed pasha (*Charaxes jasius*) hill-topping at the peak of Mt. Kremenjak on 25 September 2021. (Photo: Kaja Milašinovič).

Sl. 2: Samec dvorepega paše (*Charaxes jasius*) na vrhu hriba Kremenjaka 25.9.2021. (Foto: Kaja Milašinovič).

RESULTS

Adults were observed at six sites in the period from 2018 to 2021. The localities are listed in geographical order from south to north (see Fig. 1):

1. Umag, within the urban area of the town, Croatia (45°26'31"N, 13°30'54"E), leg. Nejc Rabuza. A single specimen feeding on ripe figs was observed on 13 October 2018. No strawberry trees were seen in the vicinity, but they likely occur in the wider area.

2. Savudrija, the ruins of Velika stancija, Croatia (45°30'01"N, 13°30'46"E), leg. Paul Tout. A female flying around a bay laurel near the ruins was observed around noon on 16 September 2020. It was probing the leaves regularly, but no oviposition was confirmed. After a short period, it flew away. No strawberry trees were observed in the vicinity, but they likely exist in nearby urban areas.

3. Piran, above the cliff at the Church of St. George, Slovenia (45°31'47"N, 13°34'05"E) leg. Nejc Rabuza. A single specimen was briefly observed flying eastwards on 30 October 2019. As the sighting was completely unexpected, the identification is not entirely certain, although extremely likely. There are two stands of planted strawberry trees in the close proximity of the site.

4. Strunjan, at the large cross at the edge of a cliff above Moon Bay (Mesečev zaliv), Slovenia (45°32'14"N,

13°36'23"E), leg. Rudi and Jan Verovnik. A male specimen was briefly observed flying westwards along the edge of the cliff before noon on 1 October 2021. Soon afterwards, another specimen appeared flying from the inland towards the cliff, so it could have been the same individual potentially exhibiting hill-topping behaviour. No specimens were observed there an hour later. A natural population of about 20 strawberry trees (Žnidaršič, 2014) occurs on the same cliff about 300 m to the east.

5. Osp, at the upper edge of the precipitous walls above the village, Slovenia (45°34'16"N, 13°51'53"E), leg. Miro Repar. The butterfly (probably a male) was settling on bushes and low trees in the morning, on 28 September 2021. It is likely that it had spent the night at the site and was just warming up when discovered. There are no known strawberry trees in the vicinity, as the site is further inland than the others.

6. Sela na Krasu, on the peak of Mt. Kremenjak on the border with Italy, Slovenia (45°49'24"N, 13°35'33.17"E), leg. Matjaž Zadrgal. A male was seen circling an old fig and occasionally settling on nearby rocks (Fig. 2) close to the peak on 25 September 2021 in the afternoon. Given the prominence of the peak and considerable time the observed specimen spent there, it is likely that it was exhibiting hill-topping behaviour. There are no strawberry trees in the vicinity, but the coast of Duino, where planted

specimens are known (Zadrgal, M. and Tout, P., *pers. obs.*), is only about 4 km away.

The following localities were also inspected based on the abundance of fig trees and/or their prominence, but without success: Seča (45°29'53"N, 13°36'25"E), Cape Seča (45°30'07"N, 13°35'22"E), Cape Ronek (45°32'17"N, 13°36'49"E), Tinjan (45°33'40"N, 13°50'07"E), and Sočerb castle (45°35'21"N, 13°51'40"E).

In addition, the natural stand of strawberry trees in Cape Ronek above the cliffs (45°32'22"N, 13°36'49"E) was inspected for early stages. Only three trees were accessible at the site, all already overshadowed by nearby oaks and partially overgrown with *Smilax aspera* L. Despite that, the trees looked vital with both flowers and fruits present. No larvae or eggs were found on visible parts of the trees, however leaf damage on the terminal parts of the branches similar to what *Charaxes jasius* (Abós & Stefanescu, 1999) is known for was evident, but it might have been caused by other herbivorous insects. Larvae were also searched for, unsuccessfully, at two sites within urban area of Piran (45°31'43"N, 13°34'18"E and 45°31'33"N, 13°34'21"E) and in the Dragonja Valley at Stena (45°27'08"N, 13°39'38"E), a very well-known refugium for Mediterranean plants (Wraber, 2002).

DISCUSSION

Despite permanent populations of *Charaxes jasius* on the west coast of Istria, Croatia, as far north as Palud, south of Poreč (Koren 2012), no historical records are known for the Slovenian and Italian parts of the Istria coast (see overview in Stauder, 1922). This is rather surprising given the odd record of the species as far north as Styria (Austria) near Graz, which might however have resulted from a released reared specimen (Habeler, 1983). Given the concise effort to map the distribution of butterflies in Slovenia over the last two decades (Verovnik et al., 2012), it is hardly likely that the species had been overlooked, which means that the present sightings are indeed the first in the studied region. Although the almost perfect sequence of occurrences further north each year might be entirely coincidental, it still shows a trend for the species to expand northwards. The autumn of 2021 proved exceptional, with the three independent occurrences spread across a wide area potentially indicating a more numerous invasion. Breeding, which would indicate an attempt of colonization, remains to be confirmed.

Whether our observations indicate a leading edge of the species' expansion is yet to be seen. A similar local northward expansion, linked with planted ornamental strawberry trees, has been noted in Madrid province in central Spain, which has a more continental climate (Cancela & Vasconcelos, 2019). However, the population of strawberry trees at sites where breeding of *Charaxes jasius* was confirmed is much larger than anywhere else in the studied

region. The sparseness of the main host plant along Slovenian and Italian coasts of the Northern Adriatic may be one of the major factors inhibiting permanent colonization by this species. However, no in-depth survey of the distribution of the strawberry tree, especially in urban areas, has so far been conducted in Slovenia or in neighbouring parts of Italy. Such survey might somewhat change the picture, as would the potential utilization of *Laurus nobilis* (seen Stefanescu, 1995), which is much more widespread in the region. The female observed assessing the bay laurels in Savudrija certainly points in this direction.

The other major factor is the climatic conditions, especially for larvae overwintering on the host plants. These are quite thermophilous and require temperatures above 11.5 °C for successful foraging (Abós & Stefanescu, 1999). In addition, extended periods below 5 °C can prove detrimental to the early instars, especially pupae (Sanetra & Peuker, 1993). The only climatic data available for the coastal part of Slovenia are from the Portorož Airport and suggest that half of the past 10 winters might have been too cold for the development and survival of *Charaxes jasius*, with average January temperatures below 5 °C, and average minimum temperatures below zero on three occasions (ARSO Meteo, 2021). However, this particular weather station is positioned on the valley floor and thus likely to be exposed to colder conditions than the steep slopes on which the strawberry trees grow.

Whether *Charaxes jasius* will become a common sight along the northern coast of Istria or not remains to be seen, but several steps could be taken to successfully trace its potential expansion. Using baited traps in early autumn (see Abós & Stefanescu, 1999) at sites with strawberry trees might be an efficient way to discover whether females are able to find the host plants and facilitate the finding of the early stages. Long-term temperature measurements at these sites would also be useful to see if the microclimatic conditions allow larval survival over winter. Additionally, a more comprehensive survey of the distribution of strawberry trees would be needed, as well as promotion of their ornamental and culinary value for their wider use in the region. To conclude, we believe that the species is currently only a vagrant to the area under study, but that might change in a not so distant future.

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O POJAVLJANJU DVOREPEGA PAŠE (*CHARAXES JASIUS* (LINNAEUS, 1767), PAPILIONOIDEA: NYMPHALIDAE) NA OBMOČJU SEVEROVZHODNEGA JADRANA

Rudi VEROVNIK

University of Ljubljana, Biotechnical Faculty, Department of Biology, Jamnikarjeva 101, Ljubljana, Slovenia
e-mail: rudi.verovnik@bf.uni-lj.si

Nejc RABUZA

Dobje pri planini 22a, 3224 Dobje, Slovenia
e-mail: nejc.rabuza@gmail.com

Miroslav REPAR

Dolinska 1H, 6000 Koper, Slovenia
e-mail: miro.repar@yahoo.com

Matjaž ZADRGAL

Pod Lazami 53 Vrtojba 5290 Šempeter pri Gorici, Slovenia
e-mail: zadrgalm@gmail.com

Paul TOUT

Malchina 5/A, 34011 Duino-Aurisina (TS), Italy
e-mail: tout@xnet.it

POVZETEK

V raziskavi predstavljamo in obravnavamo prva opazovanja dvorepega paše (*Charaxes jasius*) na območju severovzhodnega Jadrana, vključno s prvimi najdbami v Sloveniji. Vrsta je bila prvič opažena severno od znane-
ga območja razširjenosti v Istri v Umagu leta 2018, sledilo je opazovanje v Piranu leta 2019, Savudriji leta 2020
in tri opazovanja leta 2021 iz precej oddaljenih najdišč pri Strunjanu, Ospu in Selah na Krasu. Iskanje larvalnih
stadijev na lokalnih jagodičnicah (*Arbutus unedo*) se je izkazala za neuspešno, kar kaže na trenutno zelo verje-
tno nestalno naselitev vrste v regiji. Razpravljamo še o potencialnih dejavnikih, ki bi lahko predstavljali omejitev
za širitev vrste, na primer omejena razpoložljivost glavnih gostiteljskih rastline in nizke zimske temperature.

Ključne besede: razširjenost, podnebne spremembe, Istra, gostiteljske rastline, *Arbutus unedo*

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