

Research article

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New records of *Tarucus balkanicus* at the northern limit of its distribution along the Adriatic coast (Lepidoptera: Papilionoidea, Lycaenidae)

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Abstract

Occurrences of the Little Tiger Blue, *Tarucus balkanicus* (Freyer, 1844) in Croatia and Bosnia & Herzegovina represent the northern and western distribution limits of this species in its entire range. During our surveys the species was observed at 27 locations in Croatia and two new locations in Bosnia & Herzegovina. The most interesting records are from the three northern Adriatic islands: Cres, Rab and Pag, which represent a significant northward extension in the known range of the species in Croatia. While the records from Bosnia & Herzegovina fall into their known range, they represent the only observations of the species in more than 30 years. We redefined the distribution limits of its range in the Balkan Peninsula, including four Adriatic islands. Its habitat in the region is not under direct threat, at least in the short-term. Moreover, its hostplant *P. spina-christi* Mill., thrives in abandoned pastures and grasslands in Mediterranean and submediterranean regions in both countries and is one of the more successful colonizers of such abandoned areas. Thus, the species is not considered threatened at least in Croatia and could benefit from ongoing abandonment of the pastures and grasslands as well as climate change.

Key words: Bosnia & Herzegovina, Croatia, distribution, habitat, *Paliurus spina-christi*.

Introduction

The genus *Tarucus* Moore, 1881 comprises around 25 species distributed from northwestern Africa to South East Asia (Tennent 1996). In Europe, only two species are present, *Tarucus theophrastus* (Fabricius, 1793) restricted to coastal areas of southern Spain, and *T. balkanicus* (Freyer, 1844) which within Europe it occurs on Cyprus and on the Balkan Peninsula. More precisely, the species is known from Cyprus, Greece, Albania, Northern Macedonia, Montenegro, Croatia and Bosnia & Herzegovina (Tolman & Lewington 2008). Outside Europe, the species is present sporadically from northern Africa (Tennent 1996), Middle East (Tshikolovets & Yehuda 2020), Arabian Peninsula (Larsen 1984), and western and central parts of Asia (Tshikolovets et al. 2014; Tshikolovets & Pagès 2016).

It is one of the smallest European species of blues. As it is the only species of the genus *Tarucus* in the Balkan

Peninsula, it cannot be confused with any similar species. Most similar are the species with small tails on the hind wings, *Lampides boeticus* (Linnaeus, 1767), *Leptotes pirithous* (Linnaeus, 1767), and *Cacyreus marshalli* Butler, 1898, from which it is easily distinguished by the underside whitish color of the wings permeated with a black zebra pattern.

It has several broods per year from April to October, but it flies continuously throughout the year in warmer regions (Larsen & Larsen 1984). It occurs most commonly in hot coastal lowland areas, or inland ravines in dry rocky areas with scrubs and grasslands with abundant larval host plant, *P. spina-christi* (Tolman & Lewington 2008).

Our goal is to give a comprehensive overview of the known distribution of *T. balkanicus* in Croatia and Bosnia & Herzegovina, and to discuss its status including habitat requirements at the north western edge of its distribution in Europe.

Historical records for Croatia and Bosnia & Herzegovina

The presence of *T. balkanicus* in Croatia has been known from almost the beginning of historical surveys in the country. Mann (1869), Abafy-Aigner (1902) and Rebel (1904a) mention this species for Dalmatia, but without precise locality. Galvagni (1909) was the first to report a more precise observation from Vis Island. Müller (1921) recorded the species on Brač Island while Schwingenschuss & Wagner (1925-1927) reported it from Zadar (Zara). Also, Stauder (1923) mentions it for Zadar and adds Stobreč (a suburb of Split).

Hafner (1930) found the species on Dugi Otok and Hvar Islands. Haig-Thomas (1931) reported it from Dubrovnik (Ragusa). Habeler (1976) in his survey of Lepidoptera of Dalmatia recorded the species at Pakoštane and Tisno towns. Mladinov (1973) found only three specimens in the Lepidoptera collection of Natural history museum in Zagreb, from Šibenik, Zadar and Biograd na Moru. Lorković's (2009) review, aside from historical localities, adds Starigrad and Martinska near Šibenik. Mihoci et al. (2007) mention that the species was historically recorded from Mt. Velebit, but was not found during their surveys. Koren et al. (2011) recorded it at Zrmanja mouth, and Verovnik et al. (2015) recorded it at four localities in Northern Dalmatia.

The records of this species from Bosnia & Herzegovina are even scarcer. Rebel (1904a, b) reported it from Mostar, Radobolja, Blagaj, Hutovo blato, Stolac and Gabela. Sijarić (1966) only quotes the species for the Mediterranean region. Later, Sijarić (1981) reported the species from Studenci near waterfall Kravice and Žitomislići. Those are the last published records of this species in Bosnia & Herzegovina and its status in the country is unclear. Several specimens from Stolac and Gabela are deposited in the collections of the National Museum of Bosnia and Herzegovina, as well as specimens reported by Sijarić (1981, 1991).

Materials and methods

To provide an overview of the distribution of *T. balkanicus* in Croatia and Bosnia & Herzegovina, a systematic study of all available literature was completed. As we wished to provide a wider context to our findings, records from other countries in the western Balkan Peninsula (Montenegro, Albania and Northern Macedonia) were also extracted. While detailed and covering the whole Europe, the Atlas of butterflies of Europe (Kudrna et al. 2015) is not a primary source of information and thus for this work was omitted as only primary sources containing data about *T. balkanicus* were used. The literature records are based on the following sources:

Croatia: Mann 1869; de la Nicholl 1899; Abafy-Aigner 1902; Rebel 1904a; Galvagni 1909; Müller 1921; Stauder 1923; Schwingenschuss & Wagner 1925; Hafner 1930; Haig-Thomas 1931; Moucha 1965, 1973; Habeler 1976; Lorković 2009;

Bosnia & Herzegovina: Rebel 1904a, 1904b; Haig-Thomas 1930; Sijarić 1966, 1981, 1991;

Albania: Rebel 1913; Rebel and Zerny 1934; Beshkov & Misja 1995; Abadjiev & Beshkov 1996; Šašić et al. 2015;

Northern Macedonia: Alberti 1922; Daniel et al. 1951; Thurner 1964; Verovnik et al. 2010; Verovnik 2012; Švara et al. 2016;

Montenegro: Rebel 1913; Carnelutti & Michieli 1958; Sijarić 1984; Švara et al. 2015; Sobczyk & Gligorović 2016; Franeta 2018.

The entomological collections of the National Museum of Bosnia & Herzegovina in Sarajevo were also inspected.

All records from the literature were georeferenced and used to create a distribution map (Fig. 1) which was prepared in ESRI ArcGIS Pro software. In addition to our records and literature data, the validated records from databases ZOBODAT (<https://www.zobodat.at/>), GBIF (<https://www.gbif.org/>), and Observation (<https://observation.org/>) were used for the distribution maps. As the larvae are monophagous in the European part of its range on *Paliurus spina-christi* (Tolman & Lewington, 2008), the records for *T. balkanicus* were overlaid with the known distribution of the host plant in Croatia (Nikolić 2005-2020). As no exact information is available for the Bosnia & Herzegovina, the distribution of the host plant is shown only for Croatia.

Results

During our butterfly surveys of Croatia and Bosnia & Herzegovina, *T. balkanicus* was recorded at 27 localities in Croatia and two localities in Bosnia & Herzegovina (Fig. 1). The list of localities contains the relevant toponyms, a short description of the habitat, altitude, coordinates, dates of the visits, and observers: IB: Ivona Burić, AŠ: Ana Štih, TK: Toni Koren, DKr: Daria Kranželić, BS: Bruno Schmidt, DK: Dejan Kulijer, GG: Gordana Glavan, RV: Rudi Verovnik, DD: Dubravko Dender, BL: Boris Lauš. Localities are in general arranged in geographical order from the northwest towards the southeast (Fig. 1).

Croatia

1. Rab, Kamenjak north of Mundanije, dry calcareous grasslands, 44.7908N, 14.7597E, 80 m, 13 May 2017, IB, AŠ, 1 spec.
2. Cres, north of Punta Križa, east of Matalda, Barnestrovica bay, karstic grasslands and edge of maquis, 44.6805N, 14.4897E, 61 m, 4 May 2020, BL, 1 spec.

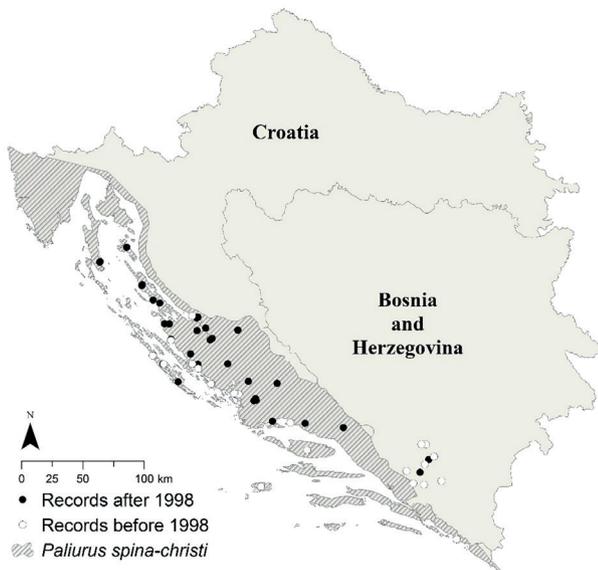


Fig. 1 – Distribution of *Tarucus balkanicus* in Croatia and Herzegovina based on new and literature records. The distribution of its host plant, *Paliurus spina-christi*, is shown only for Croatia in accordance with Nikolić (2005-2020).

3. Cres, north of Punta Križa, south of Matalda, karstic grasslands and edge of maquis, 44.6768N, 14.4857E, 96 m, 8 May 2020, DKr, 1 spec.
4. Pag, Kolansko blato, 44.5166N, 14.9280E, karstic pastures surrounded by dry walls and bushes, 15 m, 11 Sept 2015, TK, 2 spec., 21 Jul 2020, BS, DKr, 1 spec.
5. Pag, Proboj, 44.4067N, 15.0402E, calcareous rocky grasslands north of the village, 0 m, 23 Jun 2018, DKr, AŠ, 1 spec.
6. Pag, south of Gorica, karstic rocky grasslands, 44.3855N, 15.1095E, 8 m, 8 Aug 2018, Jan Vanaverbeke (<https://observation.org/observation/161133118/>), 1 spec.
7. Starigrad, first part of Mala Paklenica Valley, rocky slopes with junipers, 44.2850N, 15.5013E, 48 m, 19 Aug 2007, RV, 1 spec., 22 Aug 2010, RV, 1 spec.
8. Starigrad, near the stream south of the entrance to Mala Paklenica Valley, overgrown rocky pastures, 44.2803N, 15.4910E, 25 m, 27 Jun 2015, RV, 1 spec.
9. Zadar, Zaton, at the northern edge of the camping area, calcareous grasslands, 44.2345N, 15.1616E, 1 m, 13 Aug 2018, Wouter Van Gasse (<https://observation.org/observation/161282448/>), 1 spec.
10. Zadar, Nin, a small valley of Miljašića River, open rocky grasslands with small gullies, 44.2341N, 15.2108E, 15 m, 17 Aug 2008, RV, 1 spec., 20 Aug 2014, RV, 1 spec..
11. Obrovac, near the Zrmanja River mouth, 44.2067N, 15.5819E, 11 m, 4 Jul 2020, TK, 1 spec.
12. Obrovac, Krupa, valley and slopes above the Krupa River spring, rocky and bushy slopes, abandoned pastures, 44.1941N, 15.9093E, 194 m, 3 May 2013, 1

- spec., RV, 5 Aug 2015, 1 spec., RV, 13 Aug 2016, 1 spec., RV, 28 Jul 2020, RV, 1 spec.
13. Novigrad, along the road to Posedarje near the turn for Podgradina village, rocky overgrown gully, 44.1876N, 15.4942E, 95 m, 28 Jun 2013, RV, 1 spec.
14. Karin, Bijelina Valley, middle part, dry stream bed, rocky and bushy slopes, 44.1326N, 15.6484E, 204 m, 26 Aug 2009, 1 spec., RV, 3 May 2013, 1 spec., RV, 19 Sept 2015, 1 spec., RV.
15. Karin, Karišnica Valley, middle part, dry stream bed, rocky and bushy slopes, 44.1203N, 15.6287E, 137 m, 19 Aug 2007, 1 spec., RV, 22 Aug 2010, 1 spec., RV.
16. Zadar, Lužine, Vransko polje, along a track through pastures and forest groves, 44.0161 N, 15.4313E, 73 m, 31 Jul 2020, DKr, 1 spec.
17. Kornati National Park, Island Kornat, karstic grassland near the shoreline, 43.8281N, 15.2630E, 5 m, 12 Jul 2007, Wolfgang Schweighofer, 1 spec.
18. Benkovac, Ostrovica, maquis south-east of the village, 43.9476N, 15.81E, 157 m, 3 May 2020, DKr, 1 spec.
19. Pakoštane, north of the entrance to the Vransko jezero Nature park, 43.9415N, 15.5067E, 48 m, 9 Aug 2019, DD, 2 spec.
20. Dugi otok, Sali, along a track north-west of the village, 43.9395N, 15.151E, 46 m, 6 May 2015, TK, 1 spec.
21. Brnjica, in the Čikola River valley west of the village, scree and flowering road verges, 43.8192N, 16.0200E, 209 m, 30 Apr 2016, RV, 1 spec., 25 Jun 2017, RV, 1 spec.
22. Čavoglave, grasslands near the spring of Čikola River, 43.805N, 16.3116E, 320 m, 29 Jul 2019, TK, 1 spec.
23. Slivno, Gradina hill near village Stančići, grasslands and forest edge, 43.6926N, 16.0933E, 250 m, 3 Jun 2016, BL, 1 spec.
24. Sitno Donje, at the Staožer pond west of the settlement, dry grasslands, 43.6796N, 16.1E, 252 m, 3 Jun 2016, BL, 1 spec.
25. Slivno, Vukušića ograde, grasslands, forest edge, pastures, 43.677°N, 16.0778°E, 183 m, 3 Jun 2016, BL, 1 spec.
26. Trogir, at eastern outskirts of the town, pastures, 43.5273N, 16.2646E, 4 Sep 1981, data from GBIF (<https://www.gbif.org/>).
27. Split, Donje Sitno, in a small valley above the village, rocky gully and slopes with bushes, 43.513N, 16.595E, 270 m, 28 May 2015, RV, 1 spec., 20 May 2018, RV, 1 spec., 1 Aug 2019, RV, 1 spec., 23 May 2020, RV, GG, 1 spec., 27 Jun 2020, RV, GG, 1 spec., 25 May 2019, TK, 1 spec.

Bosnia & Herzegovina

28. Mostar, Buna, sandy area with bushes on west bank of Neretva River, 43.2386N, 17.8328E, 30 m, 15 Jul 1998, RV, 1 spec.

29. Čapljina, south of Sevaš Njive, calcareous dry and rocky grasslands with sparse low shrubs and trees, mainly *P. spina-christi*, 43.1457N, 17.7454E, 135 m, 16 May 2020, DK, 1 spec.

The observed flight period of the species in the region was from the end of April until the second half of September with no visible gap between the generations. The elevational range is from the sea level up to 320 m a.s.l..

Discussion

For most butterfly species in Croatia no comprehensive overview of their distribution and habitat preferences exists. The only exceptions are threatened species for which information is summarised in the Red book of Croatian butterflies (Šašić et al. 2015) but even for those, the distribution data are outdated insofar not comprising recent extensive surveys (e.g. Tvrtković et al. 2015; Verovnik et al. 2015; Kučinić et al. 2017; Koren et al. 2019, 2020 etc.). An updated checklist of Papilionoidea of Croatia was published only recently (Šašić & Mihoci 2011), but it does not cover the distribution of the species. The most comprehensive work in this regard is the manuscript of Lorković (2009) which was, however, written in 1954. This is the only publication in which the distribution of butterfly species in Croatia is discussed for all species known from the country at that time. It also includes some additional species recorded after the writing of the manuscript, which were added to it as notes at the end (Lorković 2009). Thus, also in the case of *T. balkanicus*, this is the only available overview of the distribution in Croatia. Lorković (2009) indicates that the species is distributed from Starigrad near Paklenica in the north across the entire Dalmatian coastline. We have thus significantly expanded the known distribution of the species northwards. The records from three northern Adriatic islands, Cres, Rab and Pag, are of particular significance and represent the most northwestern distribution points of this species in Europe.

The records of *T. balkanicus* from island Cres were most unexpected, as the butterfly fauna has been recently studied in detail (Koren et al. 2015) with 77 species recorded from the island. The area north of Punta Križa where the species occurs (localities 2 and 3) is rather remote and was not surveyed previously. Additional surveys of the southeastern parts of Cres, which has the most thermophilous vegetation, may reveal additional localities of this species. Also, it would be important to check similar habitat on nearby Lošinj Island.

The record from Rab Island was also unexpected as it is one of the better studied islands where no less than 55 species were recorded so far (Galvagni 1909; Luy 1988, 1994, 2002). The island's butterfly fauna is indeed diverse and several predominantly Mediterranean species, like

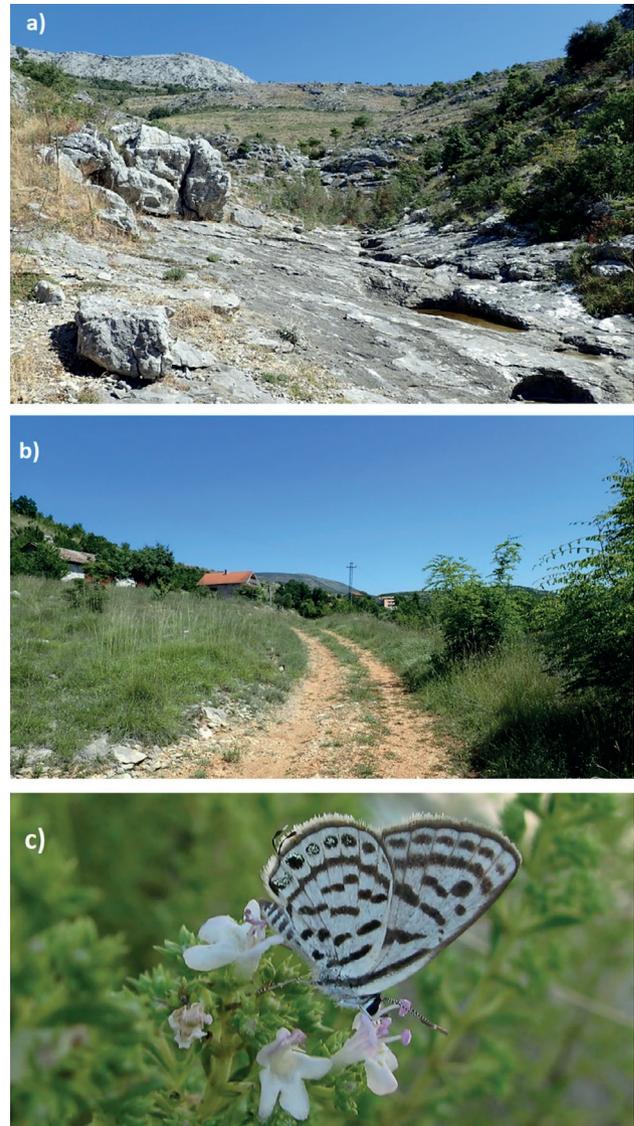


Fig. 2 – a), Rocky habitat of *Tarucus balkanicus* at the Donje Sitno locality; b), Ruderal habitat at the locality Čavoglave, near the spring of Čikola river; c), *T. balkanicus* feeding on *Satureja* sp.

Iolana iolas (Ochsenheimer, 1816) and *Pyronia cecilia* (Vallantin, 1894) occur (Withrington & Verovnik 2008). However, some parts of the island, such as the Kamenjak area where we found *T. balkanicus*, are more difficult to access and possibly remained unstudied during previous surveys. The location is accessible only by a partially abandoned footpath and is mostly overgrown with bushes, with only small remnants of open grasslands among stone walls. Additional surveys of the other remote parts of the island could yield additional finds of this species.

Pag is one of the most barren islands, where rocky calcareous pastures predominate, especially in the central and southern part. The butterfly fauna of Pag includes 55 species (Mladinov 1965; Withrington & Verovnik 2008), some of them reaching their northernmost distribution limit on the island such as the Mediterranean species *Gegenes pumilio*

(Hoffmannsegg, 1804), *Proterebia phegea* Borkhausen, 1805 and *Euchloe ausonia* (Hübner, 1804) (Mladinov 1965; Zakšek 2005). *Tarucus balkanicus* is an additional Mediterranean species which is now known from Pag from three localities, located in the central and southern part of the island. As with records from Cres and Rab, it was probably overlooked during the previous surveys, although one of the localities (Kolan) was extensively surveyed in the past (Mladinov 1965).

Aside from the three new island records discussed above, the species has been historically known only from three additional Adriatic islands, namely Vis (Galvagni 1909), Brač (Müller 1921) and Dugi otok (Hafner 1930). The source of the record from Hvar Island reported by Hafner (1930) remains a mystery as it was not mentioned in the original publications (see Koren et al. 2014). During our surveys, we confirmed the presence of the species on Dugi otok Island, almost a century after the last record (Hafner 1930). Also, it was photographed on the nearby island Kornat by Wolfgang Schweighofer on 12th July 2007 (Lepiforum 2020). The species was not observed during recent surveys of the island (Koren & Bjelić 2010).

Interestingly, most of the new and historical records are from northern and central Dalmatia, while there is only a single record for southern Dalmatia from Dubrovnik-Neretva county (Haig-Thomas, 1931). Despite extensive surveys of mentioned county and neighboring regions (Koren et al. in prep.) no recent records are known. This is even more surprising, as the species is known further south in Montenegro (Franeta 2018), however not from the proximity of the Croatian border. Targeted butterfly surveys of Dubrovnik-Neretva county were however successful in confirmation of several other interesting or rare species, e.g. *Muschampia proto* (Ochsenheimer, 1808), *Kirinia roxelana* (Cramer, 1777), and *Lycaena ottomana* (Lefebvre, 1830) (Koren et al. 2015, 2019, 2020).

The records from Bosnia & Herzegovina fit into the general distribution of the species in the country (Rebel 1904b; Lelo 2008) but are important as no recent records existed. The habitat for *T. balkanicus* in Bosnia & Herzegovina covers a much smaller area than in the coastal parts of Croatia, and thus the species may be more localized in the southernmost part of the country, particularly along the lower part of Neretva River Valley. The current status in the Red list of butterflies of Bosnia & Herzegovina (Škrijelj et al. 2013) is Near Threatened (NT). Only two recent observations (Fig. 1) might indicate its actual decline but this could only be a result of a much lower research effort than in neighbouring Croatia. Further field studies targeting all historical localities should be undertaken to reassess its status.

The distribution of the species in Croatia and Bosnia & Herzegovina is now better understood, but the almost ubiquitous habitat does not help in narrowing the search for additional locations. On many occasions, a seemingly

perfect biotope with abundance of *P. spina-christi* failed to produce any specimens. The host plant is also widespread in Istria, where the species could be present given the proximity of the records on Cres Island, but it has so far not been recorded (Koren et al. 2018). The adults were generally scarce at most localities, which also plays an important role in the low rate of the species discovery in suitable habitat. The representatives of the genus *Tarucus* are also notably sedentary and seldom stray more than a few meters from their host-plant (Tennent 1995), which also does not aid to their detectability.

The preferred habitat of the species in the Adriatic region are dry rocky places (Fig. 2a, b), usually in sheltered small valleys or gullies, in which bushes of the host plant *P. spina-christi* are abundant. These also represent the main source of nectar for the adults in the flowering period in May and June, while rosemary (*Rosmarinus officinalis*) and *Satureja* spp. (Fig. 2c) are the most important source in late summer. On rare occasions, adults were also observed imbibing water on wet soil during the hot summer months.

The observed flight period and elevational range of the species in both surveyed countries are in accordance with the literature (e.g., Tshikolovets 2011), but the species was never observed later than the end of September. It is possible that later visits to known localities could yield additional sightings in October, as is the case in some south Mediterranean countries (Makris 2003; Pamperis 2009). No clear gap in recording indicates a continuous presence of the species in overlapping broods, which is in line with observations in other countries (Tshikolovets 2011).

The general pattern of the species distribution in the western Balkan Peninsula indicates that harsh winters with longer periods of freezing temperatures represent the most likely limiting factor for the distribution of the species. Thus, it is limited to coastal areas along the Adriatic Sea and penetrates further inland only along the Neretva River in Herzegovina. The situation is a bit different in North Macedonia, where populations are distributed further inland. However, they are limited here to the most thermophilous and sheltered localities like rocky gorges with south facing slopes (Verovnik 2012; Švara et al. 2016).

One additional ecological limiting factor could be the presence of sufficient humidity to enable the survival of larvae during hot summers, as many localities (e.g., Kolansko blato, Bijelina, Karišnica, Donje Sitno) are near wetlands or temporary streams. This would require further research, as no in-depth study of ecological requirements of the species or its congeners was published so far.

While *T. balkanicus* seems to be a local species in Croatia and even rarer in Bosnia & Herzegovina, its habitat is not under any direct threat. Moreover, its hostplant, *P. spina-christi*, thrives in abandoned pastures and grasslands across Dalmatia and south Herzegovina and is one of the most successful colonizers of such open areas. However, the situation may be different on smaller unpopulated islands.

In the past, such islands were used as grazing sites for sheep, but they are nowadays mostly abandoned and completely overgrown with maquis. Although *T. balkanicus* adults prefer bushy areas and only rarely venture into open grasslands to feed on flowers, it is likely that areas completely covered by maquis are unsuitable for the species due to overshadowing of its host plants. So it is likely that some habitat loss has occurred over the past decades due to abandonment, but in general we conclude that the species should not be considered threatened, at least in Croatia, and is at present still likely benefiting from ongoing abandonment of grasslands in the region. However, for Bosnia & Herzegovina, the species status is unknown due to the lack of recent comprehensive surveys. Whether or not the current expansion of the known range is linked to climate change will be matter of long-term monitoring, which should be coupled with a better understanding of the ecological requirements and dispersal abilities of this species.

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