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ENDANGERED TRANSSYLVANIAN WINGLESS GROUNDHOPPER (*TETRIX TRANSSYLVANICA*) IS NOT EXTINCT IN CROATIA AND REQUIRES URGENT PROTECTION

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The Transsylvanian wingless groundhopper, *Tetrix transsylvanica* (Bazyluk et Kis, 1960) is a flightless pygmy grasshopper (Orthoptera: Tetrigidae) known only from a few fragmented localities and thus considered an endangered (EN) species in the IUCN Red List. The species consists of two subspecies, the nominal *T. t. transsylvanica* inhabiting the southern Carpathians in Romania, and *T. transsylvanica hypsocorypha* Skejo, 2014, until now known from a single locality in Slovenia (Mt Boč) and a single locality in Croatia where it was caught last time in the 1940s in Hrvatsko Zagorje (Gornja Pačetina, Trnovec). It is possible that the two subspecies represent separate species. The species has been considered extinct in Croatia. In this paper, we report the discovery of several subpopulations in Croatia, the largest one being at Siljevec on Ivanščica mountain. In addition, small subpopulations are reported on three other mountains (Strahinjčica, Medvednica and Zelinska gora), and two of them are suspected to be under threat of extinction: the subpopulation on the peak of Medvednica, Sljeme, and the subpopulation on Strahinjčica. The latter was discovered in a proximity of a quarry. The species is a (Pleistocene) relic and may be the only groundhopper endemic to Central Europe. Herewith, we appeal for its inclusion in the Ordinance on Strictly Protected Species of the Republic of Croatia, and for *T. transsylvanica* to be proposed as a candidate for the list of species protected through the Habitats Directive.

Key words: conservation, threatened species, rare species, relict, endemic, *Tetrix transsylvanica hypsocorypha,* pygmy grasshopper, Ivanščica, Siljevec, Natura 2000

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Transilvanijski monaški skakavac, *Tetrix transsylvanica* (Bazyluk et Kis, 1960) beskrilna je trnovratka (Orthoptera: Tetrigidae) koja se, budući da je poznata tek s nekoliko udaljenih lokaliteta, prema IUCN-ovoj Crvenoj listi smatra ugroženom (EN) vrstom. Vrsta ima dvije podvrste, nominalnu *T. t. transsylvanica* koja živi na južnim Karpatima u Rumunjskoj i *T. transsylvanica hypsocorypha* Skejo, 2014 za koju se do sada znalo da nastanjuje jedan lokalitet u Sloveniji (Boč), kao i da je 1940-ih bila povijesno zabilježena na jednom lokalitetu u Hrvatskom zagorju (Gornja Pačetina, Trnovec). Moguće da su dvije navedene podvrste zasebne vrste. Vrsta se do danas smatrala izumrlom u Hrvatskoj. U ovom radu izvještavamo o pronalasku nekoliko subpopulacija ove vrste u Hrvatskoj, od kojih je najveća na lokalitetu Siljevec na planini Ivanščici. Osim ovog lokaliteta, vrsta je pronađena na još trima gorama (Strahinjčici, Medvednici i Zelinskoj gori), od kojih sumnjamo da se se na dvjema populacije mogu smatrati ugroženima, a radi se o subpopulaciji na vrhu Medvednice (Sljeme) i o subpopulaciji na Strahinjčici koja se nalazi pored kamenoloma. Riječ je o pleistocenskom reliktu i možda jedinom monaškom skakavcu endemičnom za središnju Europu. Ovim radom apeliramo da vrsta bude uvrštena u Pravilnik o strogo zaštićenim vrstama Republike Hrvatske te da se predloži uvrštenje transilvanijskog monaškog skakavca na popis vrsta koje će se zaštititi posredstvom Direktive o staništima.

Ključne riječi: zaštita, vrsta kojoj prijeti izumiranje, rijetka vrsta, relikt, endem, *Tetrix transsylvanica hypsocorypha,* trnovratka, Ivanščica, Siljevec, Natura 2000

INTRODUCTION

The Transsylvanian wingless groundhopper, *Tetrix transsylvanica* (Bazyluk et Kis, 1960), is the rarest European groundhopper (Orthoptera: Tetrigidae), discovered only in 1960 on the southern slopes of the Southern Carpathians of Romania (Bazyluk & Kis, 1960; Harz, 1975; Podgornaya, 1995; Skejo *et al.*, 2018). Nadig (1991) provided the first record of *T. transsylvanica* in the western part of its range, on Mt Boč in Slovenia. He was surprised to find the species so far from its type locality in Romania, which prompted him to search for it further. He explored the mountains Medvednica Žumberak, Bohor, Mrzlica, and Pohorje, but found no evidence of its presence on any of them. Although his search had yielded no positive results, he described the microhabitats of the species and indicated candidate areas for further search, e.g., the northern slopes of Medvednica and Ivanščica.We owe much to Nadig (1991) whose work paved the way for our research and pointed us in the right direction. Matvejev (1983) gives a report of this species for the northeastern Serbia. However, the specimen that was supposedly found was not collected, and the precise locality was not recorded. It is difficult to say at the moment whether this is a case of a misidentification or a missed opportunity for the protection of this species in Serbia.

Even though Nadig (1991) was first to report this species in the west, a few specimens had been found much earlier by Imre von Igálffy, in 1943 and 1945, in Gornja Pačetina, Croatia. These specimens were discovered in the Croatian Natural History Museum in Zagreb and suggested some hope of this species' continued presence in the country (Skejo *et al.*, 2014). Skejo *et al.* (2014) described a new subspecies, *T. transsylvanica hypsocorypha*, to formalize the differences between the eastern and the western populations, and designated Imre von Igálffy's specimens as the holotype and the paratype. This kickstarted a new search for the species, which finally bore fruit. Numerous localities within the distribution range of both subspecies of *T. transsylvanica* have been visited over the years, but only occasionally have specimens of this species been found, indicating its rarity (Nadig, 1991; Szövényi & Puskás, 2012; Skejo *et al.*, 2014).

Little is known about the phylogenetic relationship between the eastern and the western subspecies, but some authors presume that they may represent separate species (Devriese pers. comm.). Besides morphological differences in pronotum and vertex shape, the two subspecies are completely isolated geographically and have different habitat preferences (Bazyluk & Kis, 1960; Skejo *et al.*, 2014). The eastern subspecies, *T. t. transsylvanica*, inhabits the southern slopes of the Southern Carpathians where it can be found in fragmented locations in high beech forest clearings at 1500 meters above sea level or above, while *T. t. hypsocorypha* lives below 900 meters above sea level on the northern exposures of SW Peripannonian mountains (Bazyluk & Kis, 1960; Skejo *et al.*, 2014). Bazyluk & Kis (1960) and Nadig (1991) suggest clearings in humid beech forests intersected by cold streams as a suitable habitat of *T. transsylvanica*. Only a few years ago, *T. t. transsylvanica* was photographed alive in its habitat in the continental beech forests on waterproof stone, for the first time.

Because of its rarity and specific habitat, the whole species is considered endangered (EN) at global, Europe, and EU28 level (Hochkirch *et al.*, 2016; Chobanov *et al.*, 2016). Despite our many efforts to find *T. t. hypsocorypha* population in Gornja Pačetina and its surroundings, this rare species was not found until 2022 and 2023, when large subpopulations were discovered on Ivanščica and Zelinska gora, and small subpopulations on Medvednica and Strahinjčica.

The study aims to consolidate all available data from our nine-year-long search for the Transsylvanian wingless groundhopper in Croatia, which resulted in the discovery of several small and one large subpopulation. We give special emphasis to the latter, Ivanščica, Siljevec-Obrovščica subpopulation, the largest known subpopulation of this endangered species in the world. We aim to present annotated distribution data, rough estimates of population size, notes on variability and habitat preferences, and appeal for the species to be urgently protected.

MATERIALS AND METHODS

Species identification

Among 12 species of Tetrigidae found in Europe (Hochkirch *et al.*, 2016), the Iberian *Tetrix nodulosa* (Fieber, 1853) and central European *Tetrix transsylvanica* (Bazyluk et Kis, 1960) are, because of the lack of visible wings (Fig. 1), easily distinguishable from all other groundhopper species (Devriese, 1996) inhabiting Europe: *Paratettix meridionalis* (Rambur, 1838), *Tetrix bipunctata* (Linnaeus, 1758), *T. bolivari* (Saulcy, 1901), *T. depressa* (Brisout de Barneville, 1848), *T. fuliginosa* (Zetterstedt, 1828), *T. subulata* (Linnaeus, 1758), *T. tenuicornis* (Sahlberg, 1891), *T. tuerki* (Krauss, 1876), *T. undulata* (Sowerby, 1806). The species is superficially similar to species with roof-like pronotum, i.e., *T. bipunctata, T. tenuicornis*, and *T. undulata,* but these have visible tegmenula (Devriese, 1996). The main cause for confusion in identification of the two flightless European tetrigid species might be their distinction from groundhopper nymphs, but unlike nymphs, adult Tetrigidae have an antegenicular notch on the hind knee (Figs. 1A, 1D) (Devriese, 1996). The eastern *T. transsylvanica transsylvanica* (Bazyluk et Kis, 1960) can be distinguished from the western *T. transsylvanica hypsocorypha* Skejo, 2014 by the shape of the median carina of the vertex, which is much more compressed and elevated in the latter subspecies (Figs. 1B, 1E) than in the former.

Type specimens and other museum material

Two specimens of *Tetrix transsylvanica hypsocorypha* Skejo, 2014 found in the Croatian Natural History Museum in Zagreb were described as the holotype and the paratype of the subspecies (Skejo *et al*., 2014). The photograph of the holotype is available online in Orthoptera Species File (Specimen ID=116264, Cigliano *et al*., 2023). These are the only specimens of *T. t. hypsocorypha* deposited in the Zagreb museum, but several newly collected specimens were recently donated to the Entomological Collections of Varaždin City Museum, and Leibniz-Institut zur Analyse des Biodiversitätswandels - Standort Hamburg, while several others are deposited in Josef Tumbrinck's collection in Wassenberg (Fig. 1) and Josip Skejo's collection in Zagreb.

Field work

Since the 2014 description of *Tetrix t. hypsocorypha* (Skejo *et al*., 2014) from Gornja Pačetina in Hrvatsko Zagorje, we have made numerous attempts with significant field efforts in spring, summer, and autumn, aiming to find this species over the last nine years. We visited more than 120 localities on almost all the mountains of northern Croatia, from Medvednica and Zelinska gora in the south, *via* Strahinjčica, Ivanščica, and Kalnik up to Macelj and Ravna gora in the north. Mount Boč in Slovenia was the only locality where the presence of the species was certain (Nadig, 1991), since it had recently been confirmed (Lehmann & Lehmann, pers. comm.). Several times we visited the type locality, Gornja Pačetina, and Trnovec Castle, near which the first Croatian specimens of this species were likely collected in April 1943 and May 1945.

At each locality we spent up to an hour visually searching for the first specimen of *T t. hypsocorypha*, and where we found a single specimen, we spent several hours meticulously visually searching for more specimens in order to roughly assess the size of the subpopulation. We consider a small subpopulation one in which up to 10 specimens were observed per hour of field effort, and a large subpopulation the one in which 60 or more specimens were observed within an hour of field research. Localities where the species was found were sorted according IUCN locations. IUCN (2012) defines a single location as an area in which a single threatening event can rapidly affect all individuals of the species.

AOO and EOO

Area of occupancy (AOO) is defined as the area occupied by the taxon and is calculated as the number of localities where the species was observed multiplied by 4 km^2, i.e., one locality is calculated as 4 km^2 even if less is actually occupied by the species. On the other hand, the Extent of occurrence (EOO) is defined as the general region including the species range, i.e., a polygon encompassing all the localities included in AOO. AOO and EOO are important when assessing species conservation status (IUCN, 2012).

RESULTS

In this study, we report that the Transsylvanian wingless groundhopper is not extinct in Croatia. For the first time, we report what this most elusive European groundhopper species looks like in its natural habitat (Fig. 2).

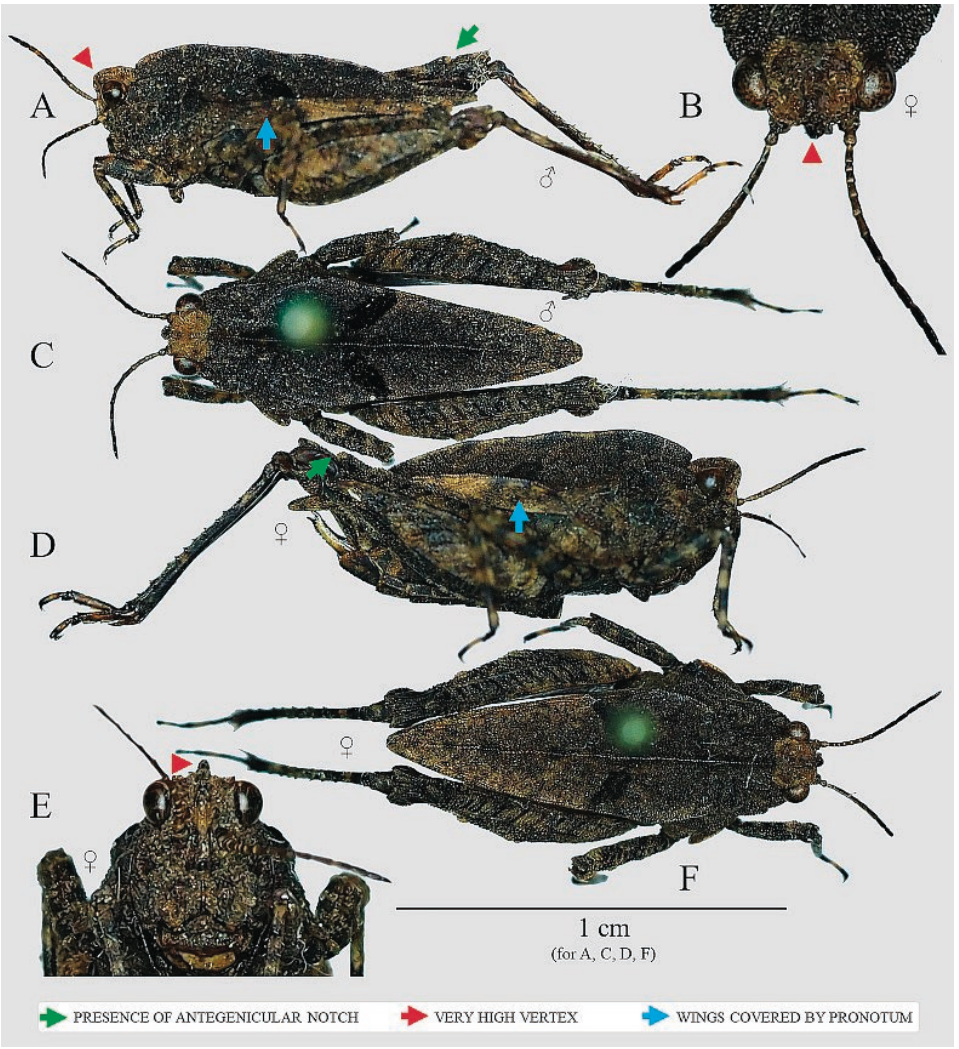

Fig. 1. Western Transsylvanian wingless groundhopper, *Tetrix transsylvanica hypsocorypha* Skejo, 2014, morphological traits useful for the identification of adult Tetrigidae, as well as for the identification of *T. transsylvanica* and its western subspecies. A) Male in lateral view, B) Female head in dorsal view, C) Male in dorsal view, D) Female in lateral view, E) Female in frontal view, F) Female in dorsal view. Collected on Mt Ivanščica (46.193N, 16.119E) 21.VII.2021. leg. & photo Josef Tumbrinck.

In September 2020, we found a small subpopulation in Prigorec, Mt Ivanščica on a parking lot at the edge of a beech (*Fagus sylvatica* L.) forest. Then, a large Ivanščica Mrzljak subpopulation and a single individual from the Strahinjčica subpopulation were discovered in July 2021. Furthermore, a large Zelinska gora subpopulation and a small Medvednica (Sljeme) subpopulation were discovered in May and June 2022. Finally, the Obroščica-Siljevec subpopulation was discovered on Ivanščica in October 2022 and confirmed in April 2023 to be the largest and most extensive known subpo-

pulation of *T. t. hypsocorypha*. We did not find the species in Gornja Pačetina, Trnovec. The species was not found on Macelj, Ravna Gora, or Kalnik, despite our numerous field excursions over the last nine years, on either northern or southern slopes, beech forests or clearings.

Thus, the Transsylvanian wingless groundhopper is in our study reported from the northern slopes of four mountains: Ivanščica, Strahinjčica, Medvednica and Zelinska gora, from 14 microlocalities altogether (AOO = 32 km^2, EOO = 980 km^2 for whole western subspecies) (Fig. 3). The mountains Ivanščica, Strahinjčica, and Medvednica are part of the Natura 2000 network.

The species is likely extinct in Gornja Pačetina as there seem to be no suitable (forest) habitats in the vicinity of the village. It is questionable whether it was ever present at this locality, or if it was collected in 1940s in another locality and later incorrectly labe-

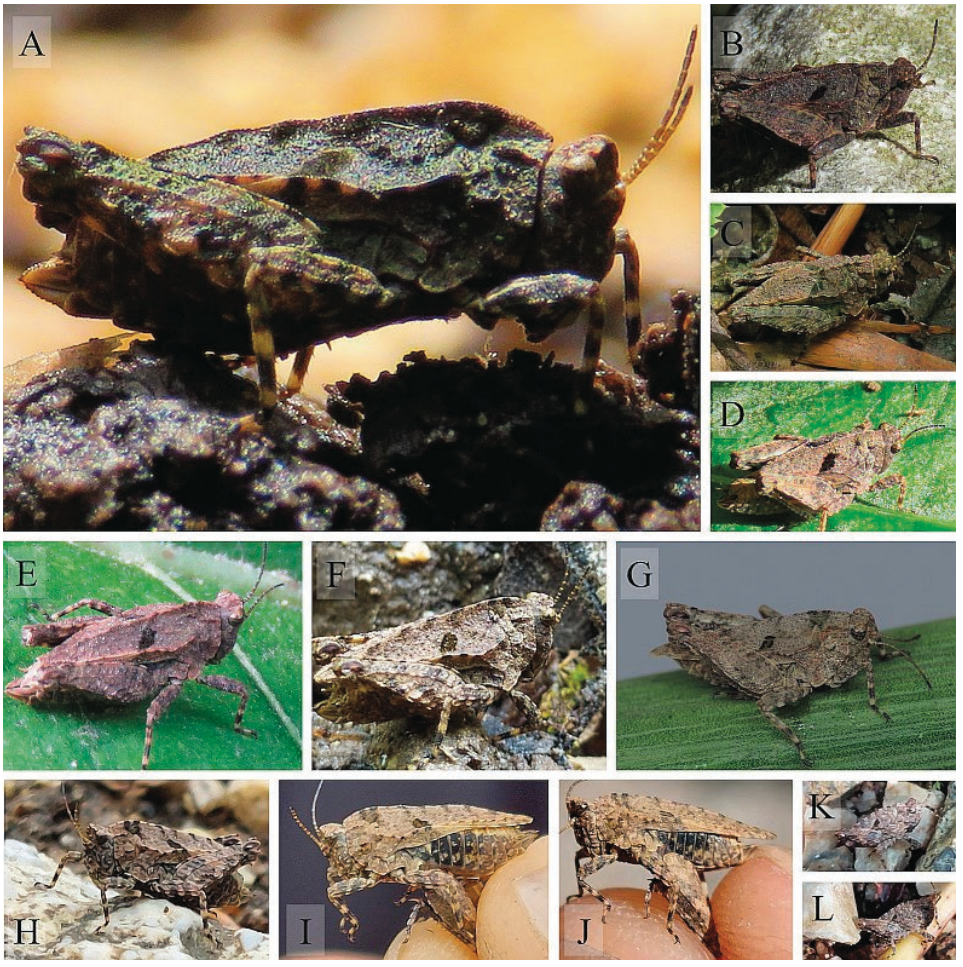

Fig. 2. Variation in coloration among live individuals of *Tetix transsylvanica hypsocorypha* from Croatia. A–F photo J. Skejo, G. photo I. Pakrac, H–L photo I. Mahalec. A–J adult specimens, K–L nymphs (nymps recorded on 9th October 2022).

led. Altogether 16 microlocalities presently known for *T. transsylvanica hypsocorypha* amount to only 7 localities and only 5 locations *sensu* IUCN (Tab. 1).

An annotated distribution of the western subspecies of *T. transsylvanica* is shown in Fig. 3. According to the present data, the species is most abundant on Mt. Ivanščica, where two relatively large subpopulations were found, the Siljevec-Obroščica subpopulation (>60 individuals of both sexes observed) and the Mrzljak subpopulation (about 30 specimens recorded in two hours). The third, Prigorec subpopulation (fewer than 10 specimens recorded in two visits, each an hour long), is potentially endangered by anthropogenic disturbance, as it is situated at the edge of a partly cut beech forest. If the deforestation continues, this subpopulation could be threatened with extinction.

In the Siljevec - Obroščica subpopulation we observed nymphs in October 2022, and found large numbers of adults already in April 2023, suggesting that the species overwinters in the nymphal stage. Since the Siljevec-Obroščica, the Mrzljak, and the Prigorec subpopulations are geographically very close to each other, these localities should be regarded as a single location *sensu* IUCN, because any negative effect in the area could harm the entire subpopulation of this species on Ivanščica. On Zelinska gora, we discovered a relatively large subpopulation below Zelingrad in May and June 2022 where >30 individuals were recorded in one hour of field research.

During our research on Strahinjčica, only a single individual of the Transsylvanian wingless groundhopper was observed. On the northern slopes of Sljeme on Medvednica, a total of only five individuals were recorded in this subpopulation in our two field visits conducted in 2022 and 2023.

The species inhabits beech (*Fagus sylvatica*) forests and their clearings on the northern slopes of the northern Croatian mountains (Fig. 3). It is important to note that the species is not common in its distribution area, but is found only in several suitable microhabitats or microlocalities. Ivanščica, especially Siljevec, seems to be the most suitable locality, taking the exceptionally high abundance recorded at the site into account. Together with Mrzljak and Zelingrad, this locality is characterized by numerous streams on dolomite (Fig. 4C), surrounded by a lush beech forest rich in bushes and low herbs, and with a lot of wet and dry leaf litter (Fig. 4B, 4D).

Only a few other orthopteran species were found together with *T. transsylvanica* (Tab. 2). At microlocalities where large (supposedly also healthy) subpopulations were recorded, *Poecilimon schmidti* (Fieber, 1853) and *Phaneroptera nana* Fieber, 1853 were observed in low abundance on the nearby bushes and trees, *Odontopodisma schmidti* (Fieber, 1853) usually in medium abundance on the nearby bushes, while *Pholidoptera griseoaptera* (De Geer, 1773) and *Pachytrachis gracilis* (Brunner von Wattenwyl, 1861) were observed in high numbers below the bushes and dwelling on the leaf litter. These two omnivorous species may include *T. transsylvanica* in their diet.

In several localities, another groundhopper species, *Tetrix subulata* (Fig. 4E) was recorded syntopically with *T. transsylvanica*. *Isophya brevicauda* Ramme, 1931 and *I. kraussi* Brunner von Wattenwyl, 1878 were recorded together in the *T. transsylvanica* habitat on Medvednica and Zelinska gora. These shy bush-cricket species may also be present in other localities, but as they are active only in early spring, they may have not been covered by our fieldworks in July, August, September and October. Interestingly, besides the aforementioned species, on Strahinjčica, *Oedipoda caerulescens* (Linnaeus, 1758) was observed next to a *T. transsylvanica* specimen. On Medvednica,

Tab. 1. List of all the localities where *Tetrix transsylvanica hypsocorypha* has been recorded in Croatia. First row shows number (N) according to the list of the locations *sensu* IUCN and corresponds to number shown in map, Fig. 3. Second row gives the name of the mountain inhabited by the species. Third row lists the localities from which the species has been reported. Fourth, fifth and sixth rows show the coordinates, the date of the fieldwork when the species was found and the altitude of the locality, respectively. First locality shown in the table is Boč, where Nadig (1991) recorded the species, while the second is the type locality of *T. t. hypsocorypha*, Gornja Pačetina (Skejo *et al*., 2014), where the species is likely extinct. Locations 3, 4, and 6 belong to Natura 2000 network.

N	Mountain	Locality name	Coordinates	Date	Altitude
1	Mt Boč	Boč N slopes	46.29N, 15.60E	21.VIII.1983	500–650 m
2	Hills of Hr. Zagorje	Gornja Pačetina, Trnovec (*type locality*)	46.106N, 15.867E	IV.1943, III.1945	220 m
3	Mt Ivanščica (also known as Ivančica, Ivanjčica , and, historically , Mt Očura.)	Obroščica; Veliki Siljevec, and Mali Siljevec N, NW, NE slopes	46.1889N, 16.1845E, 46.1893N, 16.1903E, 46.1897N, 16.1783E, 46.1897N, 16.1897E, 46.1900N, 16.1872E, 46.1903N, 16.1822E, 46.1911N, 16.1796E, 46.1917N, 16.1899E, 46.1983N, 16.1772E	9.X.2022, 25.IV.2023	270–500 m
		Mrzljak N slopes	46.1925N, 16.1189E 46.1874N, 16.1154E	5.VII.2021, 21.VII.2021	450–650 m
		Prigorec N slopes	46.1942N, 16.1431E	10.IX.2020, 4.VII.2021	440 m
4	Mt Strahinjčica	Strahinjčica NW slopes	46.1921N, 15.8933E	25.VII.2021	400 m
5	Mt Zelinska gora	Zelingrad NE slopes	45.9811N, 16.2005E	15.V.2022, 11.VI.2022	380 m
6	Mt Medvednica	Sljeme NW slopes	45.9034N, 15.9404E	24.VI.2022, 22.IV.2023	880 m

Pseudochorthippus parallelus (Zetterstedt, 1821) and *Pezotettix giornae* (Rossi, 1794) were observed in large numbers. On Ivanščica, Prigorec, *P. parallelus* was recorded in the same biotope, as well.

Interesting additions are also made to the knowledge of the species variability. Coloration may vary from pale grey or brown to almost black. Without the known exception, the humeral area bears two black spots, which are present already in young nymphal instars (Figs. 2K, 2L). Median carina of the pronotum, humero-apical, external and internal lateral carinae are yellow (or pale) in color, interspersed with black dots. The species is more robust in appearance than other European Tetrigidae and produces a louder click when jumping than *T. subulata*, with which it is found syntopically (see above). In the Ivanščica subpopulation (especially Siljevec-Obroščica) and in the Zelinska gora subpopulation, we observed many specimens in a variety of colors (Fig. 2).

DISCUSSION

A (Pleistocene) relic in the heart of Europe

Central European species that survived the last glaciation are now considered endemic due to their limited distribution ranges (Hewitt, 1996). One such species is *T. transsylvanica*, which is known only from very few localities in Croatia, Slovenia, and

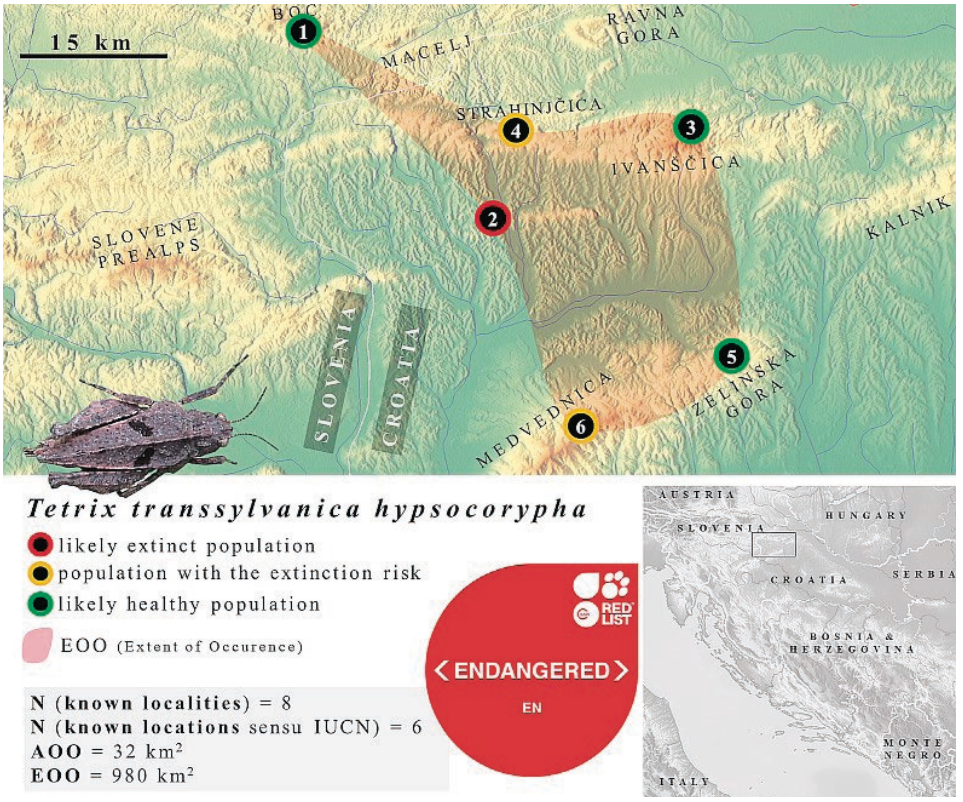

Fig. 3. Distribution and the data necessary for updating the IUCN species assessment in the Red List for *Tetrix transsylvanica hypsocorypha*. Numbers of locations correspond to the numbers listed in Tab. 1. The localities are given three colour annotations: red for a subpopulation that is likely extinct (Gornja Pačetina subpopulation known only from 1940s), yellow/orange for the subpopulations suspected to be threatened by anthropogenic disturbance (ski lift next to the small Medvednica subpopulation, and quarry in direct proximity to the Strahinjčica subpopulation), and finally green for large and likely healthy subpopulations (Boč in Slovenia and Ivanščica and Zelinska gora in Croatia).

Romania. The presence of this species only in beech forests on the northern slopes of a few Peripannonian mountains alongside clear freshwater streams implies its potential as an indicator of these unique and rare habitats (Dymytrova *et al.*, 2013). Additionally, since these habitats are of great ecological importance in Central and East Europe (Schmitt & Varga, 2012; Sommer & Nadachowski, 2006), *T. transsylvanica* could serve as an umbrella species for the protection of the biodiversity supported by these habitats. Rare habitats harbour rare species, and the potential of further interesting discoveries in these areas cannot be understated (Schröder *et al.*, 2021). For example, *T. transsylvanica* could play an important role in the dispersion of certain species of fungi, like its sister species, *T. bipunctata* (Bouwman *et al.*, 2022). Many mushrooms and other fungi were observed in all the localities where *T. transsylvanica* was found, due to their shared preference for humid microhabitats in deciduous forests (Webster & Weber, 2007). Further research should investigate whether some of these species might represent food for *T. transsylvanica*.

Tab. 2. Orthoptera species found with *Tetrix transsylvanica hypsocorypha* at six newly reported localities representing four known locations of this species in Croatia. (+++ – very high abundance, >60 specimens observed within an hour of field research; ++ – high abundance, about 10–50 specimens observed; + – low abundance, <10 specimens observed).

	Mt Ivanščica			Mt Strahinjčica	Mt Medvednica	Mt Zelinska gora
	Siljevec	Mrzljak	Prigorec	Strahinjčica	Sljeme	Zelingrad
Ensifera						
Poecilimon schmidti	+	+	+		+	+
Isophya kraussi					+	+
Isophya brevicauda					+	
Phaneroptera nana	+	+	+		+	+
Pholidoptera griseoaptera	++	++	++	++	++	++
Pachytrachis gracilis	++	++	+	+	+	++
Caelifera						
Tetrix transsylvanica	+++	++	+	+	+	++
Tetrix subulata	+	+			+	+
Odontopodisma schmidti	++	++		+	+	++
Pseudochorthippus parallelus			+++		++	
Pezotettix giornae					++	
Oedipoda caerulescens				+		

"Resurrected", but threatened again

Tetrix transsylvanica was believed to have been extinct in Croatia (Skejo *et al.*, 2014), but our recent findings have proved otherwise—not only is it not extinct, but in some localities, it is even thriving. Still, it should be noted that even the largest subpopulation discovered, the Obroščica-Siljevec, does not cover a large area and can be threatened with disappearance if its habitat is disturbed. Unfortunately, there is a real possibility that such a disturbance might occur: there are plans in place for building a quarry in the location of the Obroščica-Siljevec subpopulation. Although the preliminary assessment by the Croatian Ministry of Economy and Sustainable Development indicated that there is a likelihood of the quarry having a significant impact on the local ecology and that further assessment is necessary (MINGOR, 2022), the plans for the quarry are still in progress (Particip GmbH, 2023). Since our finding of *T. transsylvanica* in Croatia has already been reported by local news outlets (Index.hr, 2021; Dnevnik.hr, 2023) and an ecological association "Naša Ivanščica" is using this information to oppose the establishment of the quarry, this has already become an important and urgent public issue in Croatia (Dnevnik.hr, 2023).

On Mt Strahinjčica, the thermophile/xerophile *Oedipoda caerulesces* thrives in a nearby quarry and has been observed in *T. transsylvanica* habitat, possibly indicating environmental change in proximity to the quarry. On Medvednica, *Pseudochorthippus parallelus* (Zetterstedt, 1821) and *Pezotettix giornae* (Rossi, 1794) were observed in large numbers. These are generalist species that can signalize anthropogenic disturbance and their presence here could be the first sign of refugial habitat degradation (Chisté *et al.*, 2016; Lemonnier-Darcemont & Darcemont, 2021). Similarly, on the parking space in Prigorec (Ivanščica Mt.), *P. parallelus*, dispersing from nearby agricultural lands, may be observed in the same biotope as *T. transsylvanica*.

Fig. 4. ***Tetrix transsylvanica hypsocorypha*** **habitat. Beech (*Fagus sylvatica*) forests on the northern slopes of the northern Croatian mountains, examples of the habitat in Ivanščica Mt.** A) beech forest, B) clearings in the beech forests with thick leaf litter, C) fast and cold streams on dolomite, D) leaf litter inside the dark beech forest, E) *Tetrix subulata* occurs together with *T. transsylvanica* in some localities, F) habitat in Prigorec, a parking space on the edge of a beech forest, where the species may be endangered, G) habitat in Siljevec where the largest subpopulation of *T. t. hypsocorypha* has been recorded.

Accordingly, considering the highly restricted distribution of *T. transsylvanica* and its likely susceptibility to environmental change due to specific habitat requirements, in combination with potential anthropogenic threats, we appeal for the inclusion of this species in the Ordinance on Strictly Protected Species of the Republic of Croatia (Ministarstvo zaštite okoliša i prirode 2013). Furthermore, we appeal for the species to be proposed as a candidate for the list of species to be protected through the Habitats Directive. The IUCN already recognizes the species as endangered, emphasizing the need to protect its habitat (Orthopteroid Specialist Group, 1996; Hochkirch *et al.*, 2016; Chobanov *et al.*, 2016). Our proposal that it be protected at the EU level reflects

the need for swift actions needed to fulfil the goals of the IUCN, in order to protect rare and pristine European habitats in the age of widespread ecological decline (van der Sluijs, 2020).

CONCLUSIONS

The wingless Transsylvanian groundhopper has been found after almost 80 years in Croatia, inhabiting the northern slopes of the mountains Ivanščica, Strahinjčica, Medvednica, and Zelinska gora. Therefore, this curious species should not be regarded as extinct in Croatia anymore. Besides the largest subpopulation in Siljevec-Obroščica, and a large subpopulation discovered in Mrzljak (both on Ivanščica) and Zelingrad (Zelinska gora), two subpopulations, those of Medvednica and Strahinjčica, are suspected to be threatened by anthropogenic activity. *Tetrix transsylvanica* may be the only groundhopper species endemic to the EU and to central Europe; likely important as an indicator of continental refugia, its remaining populations should be strictly protected and monitored. Systematic mapping of the species distribution and habitat in Croatia is urgently needed.

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AUTHORS ' CONTRIBUTIONS

The study was JS's idea. JS and NK wrote the manuscript, prepared figures, and are the authors of equal contribution. I.P., J.S., J.Š., M.P., Jos.T., Joh.T., M.R., N.S. studied Ivanščica Mt., Strahinjčica Mt. was studied by J.S., J.Š., Jos.T, Joh.T., Medvednica Mt. by J.S., J.Š., M.D., K.A., N.K., and Zelinska gora by J.S., J.Š, and S.Ć.

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SAŽETAK

Ugroženi transilvanijski monaški skakavac (*Tetrix transsylvanica*) nije izumro u Hrvatskoj, ali treba hitnu zaštitu

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Transilvanijski monaški skakavac, *Tetrix transsylvanica* (Bazyluk et Kis, 1960) beskrilna je trnovratka (Orthoptera: Tetrigidae) koja se na IUCN-ovoj Crvenoj listi smatra ugroženom (EN) vrstom, a u Hrvatskoj čak i izumrlom. Ovo je jedina vrsta trnovratke endemična za Europsku Uniju. Vrsta ima dvije podvrste, istočnu *T. t. transsylvanica* koja živi na južnim Karpatima Rumunjske i zapadnu *T. t. hypsocorypha* Skejo, 2014 za koju se do sada znalo samo da nastanjuje jedan planinu u Sloveniji (Boč) i da je 1940ih povijesno zabilježena u Hrvatskom zagorju na lokalitetu Trnovec. Dvije navedene podvrste prema nekim bi znanstvenicima čak mogle biti i zasebne vrste.

Nakon višegodišnjih potraga za ovom vrstom, napokon predstavljamo prve subpopulacije ove rijetke vrste u Hrvatskoj. Naš rad donosi podatke o pronalasku nekoliko subpopulacija ove vjerojatno mikofagne vrste na sjevernim padinama planina Ivanščice, Strahinjčice, Medvednice i Zelinske gore u hladnim i vlažnim bukovim šumama na vodonepropusnoj podlozi. Vrstu smo zabilježili na ukupno 14 mikrolokaliteta (6 lokaliteta, 4 lokacije prema IUCN-u) koji pokrivaju površinu nastanjenja (AOO) od 32 km^2 i obim pojavljivanja (EOO) 980 km^2. Najveća zabilježena subpopulacija je ona na lokalitetu Siljevec na Ivanščici gdje je u sat vremena zabilježeno preko 60 jedinki ove vrste, a po brojnosti jedinki slijede je subpopulacija na lokalitetu Mrzljak također na Ivanščici i subpopulacija podno Zelingrada na Zelinskoj gori. Iako smo tek pronašli subpopulacije ove vrste u Hrvatskoj nakon gotovo 80 godina, već sumnjamo da je na dvjema lokacijama vrsta ugrožena, i to na vrhu Medvednice (Sljeme) gdje bi mogla biti ugrožena od obližnjeg skijališta te na Strahinjčici gdje bi mogla biti ugrožena obližnjim kamenolomom.

Ova je vrsta vjerojatno pleistocenski relikt i vjerojatno jedini monaški skakavac endemičan za središnju Europu. Ovim radom apeliramo da vrsta bude uvrštena u Pravilnik o strogo zaštićenim vrstama Republike Hrvatske te da se predloži uvrštenje transilvanijskog monaškog skakavca na popis vrsta koje će se zaštititi posredstvom Direktive o staništima. Republika Hrvatska trebala bi organizirati kartiranje staništa i monitoring ove rijetke i zanimljive vrste.