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An annotated checklist of crickets, grasshoppers and their allies (Orthoptera) in Slovakia

ANTON KRIŠTÍN, BENJAMÍN JARČUŠKA & PETER KAŇUCH
Institute of Forest Ecology SAS, Ľ. Štúra 2, Zvolen, Slovakia.
kristin@ife.sk; https://orcid.org/0000-0001-7422-6393
benjamin.jarcuska@gmail.com; https://orcid.org/0000-0002-0654-9171
kanuch@netopiere.sk; https://orcid.org/0000-0003-2001-4541

Abstract

The first annotated checklist of ensiferan and caeliferan Orthoptera of Slovakia is presented. Altogether, we found 129 species (59 Ensifera, 70 Caelifera) in the fauna of Slovakia, based on a critical revision of museum collections, all records published since 1826 and our own unpublished data from mapping in 1994–2019 (~2000 sites located in 97.5% of the mapping grid cells). Forty-four species reach the limit of their distributional range within the country, and 31 have their northern limit there. Four species are endemic to Slovakia. In total, 11 species were erroneously reported from the country and are not included in this checklist. The relatively rich species spectrum reflects the diversity of habitats in an area of about 50 thousand km^2 and elevations from 94 to 2,655 masl. We found 30 species exclusive for the Pannonian and 18 for the Alpine biogeographical region in the study area. We emphasize changes compared to previous species lists published in 1977 and 1999, when nine species were first recorded after 1999, and eight other species have been missing for more than 50 years. Distributional patterns, accompanied by site maps, are commented for 42 species. Taxonomic, nomenclatural and zoogeographical problems are discussed for a further 23 species. Based on the actual IUCN Red List criteria, we assessed all 129 species. The species were red-listed as follows: regional extinct (*Celes variabilis*), critically endangered (*Isophya beybienkoi*, *I. costata*, *Poecilimon fussii*, *Pachytrachis gracilis*, *Saga pedo*, *Paracaloptenus caloptenoides*, *Acrotylus insubricus*, *Stenobothrus fischeri*), endangered (*Poecilimon intermedius*, *Gampsocleis glabra*, *Pholidoptera frivaldszkyi*, *Myrmeleotettix antennatus*), vulnerable (nine species), near threatened (18) and data deficient (12). A brief account of the Orthoptera research history in Slovakia is outlined.

Key words: Orthoptera, distribution, zoogeography, ecology, conservation status, Slovakia

Introduction

Updated information on species diversity and distribution is essential for conservation measures in a changing world. Grasshoppers, crickets, bush-crickets and their allies (Orthoptera) are appropriate bioindicators of habitat quality (e.g. Fartmann *et al.* 2012, Hochkirch *et al.* 2016). However, an updated checklist and distribution status of species in the country is the basis of this evaluation. Orthoptera is a cosmopolitan order that includes more than 28,780 known species (Cigliano *et al.* 2020). From the approximately 1,100 species in Europe (Hochkirch *et al.* 2016), 119 were reported as occurring in Slovakia in the last published checklist 20 years ago (Kočárek *et al.* 1999). Several checklists have been published in neighbouring or nearby European countries, e.g. in Hungary (Rácz 1998; Nagy 2003a: 124 species), Poland (Bazyluk & Liana 2000: 82 species, Żurawlew *et al.* 2020: 86 species), Romania (Iorgu *et al.* 2008: 198 species), Czechia (Holuša *et al.* 2013: 96 species), Austria (Lechner & Zuna-Kratky 2017: 139 species) and Croatia (Skejo *et al.* 2018: 184 species). Intensification of data sampling and taxonomic splitting of some species has led to an increase of the Orthoptera species spectrum in different European countries despite the worsened environmental situation (e.g. Zuna-Kratky *et al.* 2017, Skejo *et al.* 2018).

Similarly, more than 20 years after the last published checklist in Slovakia, the distributional and faunistic data has increased considerably thanks to extensive mapping (Krištín & Kaňuch 2020); therefore, we decided to update

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the checklist and to summarize and analyse the most recent knowledge. Until now, more than 580 works ranging from short faunistic reports to comprehensive elaborations of some areas or taxonomical groups have been published (e.g. Okáli *et al.* 1998; Holuša *et al.* 1999; Kočárek *et al.* 2005; Krištín & Vidlička 2020).

The first works concerning orthopteran insects in the area of what is today Slovakia were published in the 19th century (Ocskay de Ocskö 1826, 1832; Bartsch 1846; Frivaldszky 1868; Bíró 1885; Pungur 1891; Petricskö 1892; Chyzer 1897), and several other works were published at the beginning of 20th century (Csiki 1905; Zacher 1910; Ebner 1914). The turning point in Slovak orthopterological research was the first monograph on Orthoptera in the former Kingdom of Hungary (Frivaldszky 1868, with 69 species known in the territory of Slovakia) and a monograph on the former Czechoslovakia (Obenberger 1926, mentioning 61 species in Slovakia). Dobšík (1959) published the first identification key. Relatively few Orthoptera papers were published before the 1990s (less than 50% of the whole 580), when the most active authors were Adolf Čejchan, František Chládek, Ján Gulička and Josef Mařan between 1950 and 1990.

The first complete checklist of Orthoptera species in Slovakia (within the former Czechoslovakia) was compiled by Mařan & Čejchan (1977). Neither this publication nor the subsequent checklist (Kočárek *et al.* 1999) contained distributional data and annotations. Over the last 25 years, intensive faunistic surveys have concentrated on lesser known areas, endangered species and expanding species (e.g. Holuša 1996; Gavlas 2004; Vlk *et al.* 2012; Krištín & Kaňuch 2013; Jarčuška *et al.* 2015; Krištín & Jarčuška 2016; Nuhlíčková *et al.* 2017; Krištín *et al.* 2019a, b). Since the publication of the first comprehensive monograph with an identification key on Czech and Slovak Orthoptera (Kočárek *et al.* 2005), knowledge about these insects in Slovakia has increased even more considerably.

In 1977, a total of 109 species were reported from Slovakia (Mařan & Čejchan 1977; but four species—*Pholidoptera littoralis* (Fieber, 1853), *Tetrix undulata* (Sowerby, 1806), *Locusta migratoria* Linnaeus, 1758 and *Stenobothrus rubicundulus* Kruseman & Jeekel, 1967—with question marks as uncertain), and 119 species in 1999 (Kočárek *et al.* 1999). In this last checklist, two already known species (*Isophya pienensis* Mařan, 1954 and *Locusta migratoria*) were overlooked and another (*Isophya brevipennis* Brunner von Wattenwyl, 1878, today a synonym of *Isophya camptoxypha* (Fieber, 1853); see Cigliano *et al.* 2020) was listed as redundant (Appendix 1). Since that time, nine species have been recorded in Slovakia for the first time: *Isophya modesta* (Chládek & Gavlas 2003), *Paracaloptenus caloptenoides* (Gavlas 2004), *Isophya fatrensis* (Chládek 2007), *Chorthippus oschei* (Lehmann & Lehmann 2007), *Meconema meridionale* (Vlk *et al.* 2012), *Chorthippus smardai* (Chládek 2014), *Isophya costata* (Nuhlíčková *et al.* 2017), *Isophya modestior* Brunner von Wattenwyl, 1882 and *Leptophyes punctatissima* (Bosc, 1792) (both species own records, described in this paper).

In regard to the history of Orthoptera conservation status, seven endangered and rare species were included in the first Red Book of fauna in Czechoslovakia in 1992 (Gulička 1992). The first Red List of Orthoptera in Slovakia was published in 2001, listing 33 species in four threat categories (Krištín 2001). This laid the basis for the inclusion of Orthoptera species in legal protection by national law. A comprehensive Red List of 142 Carpathian Orthoptera species, including 104 species from Slovakia, was published in 2014 (Krištín & Iorgu 2014).

This contribution presents the first commented checklist of Orthoptera species in Slovakia with an emphasis on distribution and ecology of endemics, species recorded for the first time during the last 20 years, zoogeographically important species and species missing from the area for more than 50 years.

Study area

The territory of Slovakia historically was a part of the Hungarian Kingdom (from the 11th century to 1918), which was reflected in the faunistical research and literature there. The formation of an independent Czechoslovakia in 1918 enabled its boundaries to be defined for the first time in history in June 1920 (Kováč 2002). Today, Slovakia covers 49,035 km^2 in two biogeographical regions—the Alpine and the Pannonian regions (European Environmental Agency 2016, Fig. 1). The Alpine region is the largest (71%) and is located in the northern and central parts of the country; it represents a natural barrier to the spreading of thermophilous taxa, being the northern distribution border of many species restricted to the Pannonian region located southward (Mařan 1952a, c). The boundary zone of these two regions is the northern range margin for several invertebrate species (e.g. Mařan 1952c, 1956; Buchar 1983; Krištín *et al.* 2007a, b; Krištín & Jarčuška 2016). The location of Slovakia at a zoogeographical boundary substantially enriches the local fauna, including numerous Carpathian and Ponto-Mediterranean species. From a

zoogeographical point of view, northern and central Slovakia belong to the Central European Deciduous Forest province, mostly to its Western-Carpathian subprovince; only the north-easternmost part of Slovakia belongs to its Eastern-Carpathian subprovince. The warmest, southern parts of Slovakia belong to North-Pannonian subprovince of the Pannonian province of steppes (Buchar 1983). The Carpathian Mts in Slovakia (most of the Alpine region), with the highest peak Gerlachovský štít (High Tatras) reaching 2,655 masl., are structurally less compact than the Alps, being divided into a number of mountain blocks separated by basins. These mountains are also very heterogeneous from a geological point of view, which also shapes the biogeographical regionalization based on Orthoptera species (Jarčuška *et al.* 2019). The Slovak part of Carpathian Mts contains valuable areas of traditionally managed semi-natural grasslands and scrub formations, in particular hay meadows, heaths, peat bogs, alpine grasslands and scrubland facies. The Pannonian part of Slovakia is characterized mostly by large blocks of cropland and severely fragmented semi-natural habitats (such as sandy dunes, xeric steppes, wetlands, salt steppes and marshes), enhancing the diversity of Orthoptera fauna.

The average annual temperature is 10 °C. The coldest monthly average temperature is -3 °C (January). The maximum average of 26 °C occurs in July and August. Precipitation totals around 650 mm. The wettest month is July, with an average of 73 mm on 11 rainy days. The northern, mountainous part of Slovakia is cooler and more humid, while the southern part is warmer and drier (Miklós *et al.* 2002; Bochníček *et al.* 2015). The main season for Orthoptera mapping and sampling is from May to September.

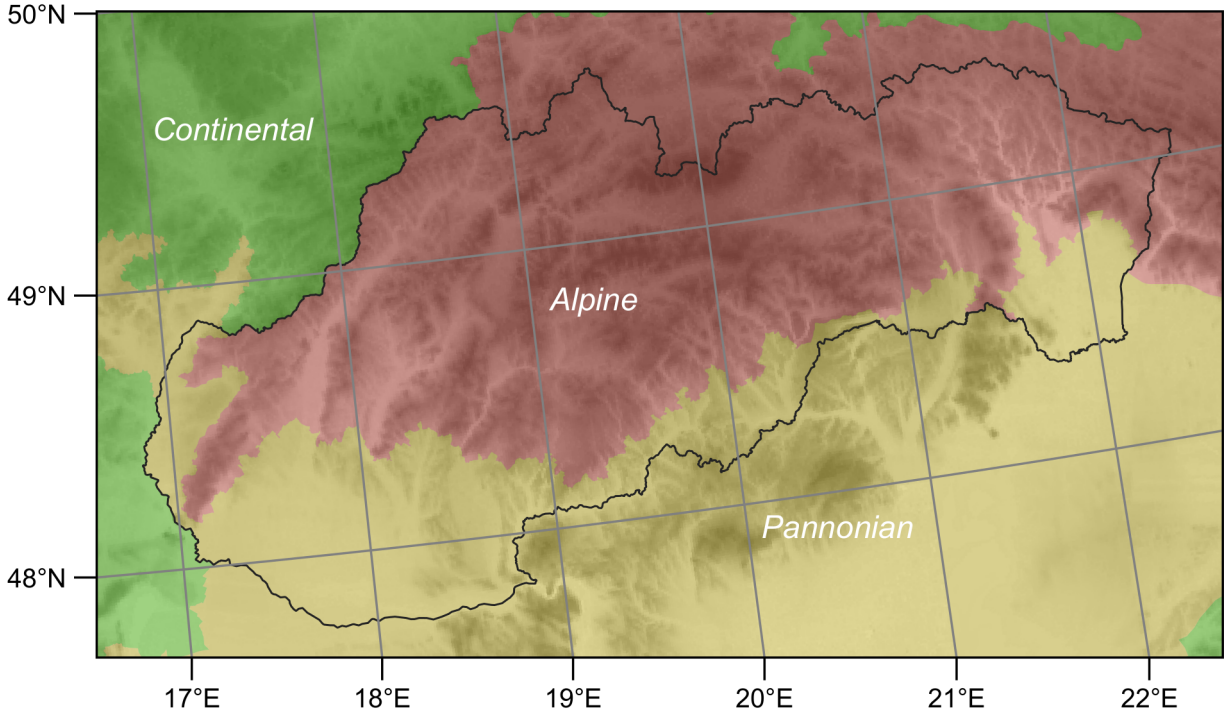

FIGURE 1. Biogeographical regions delineation according to the Habitats Directive of the EU and the borders of Slovakia (solid line).

Material and methods

Data sampling and Orthoptera mapping

We (1) examined all literature data on Slovak Orthoptera, (2) visited and revised several museum collections containing Orthoptera material from Slovakia (mainly J. Mařan and A. Čejchan collections in National Museum in Prague, J. Gulička, M. Kozánek, J. Laco, J. Roland and V. Janský collections National museum in Bratislava, and the T. Kizek and R. Martincová collections in regional museum in Banská Bystrica), (3) performed field work (1994–2019) at 1998 sites in 97.5% of the 430 Slovak grid cells of the Central European mapping grid system (Ehrendorfer & Hamann 1965), and (4) implemented relevant faunistic records from 87 mappers (listed in the Acknowledgements). We considered only geo-referenced data, and all inaccurate records were omitted.

The established Ehrendorfer & Hamann's (1965) mapping system, where the area of Central Europe was delimited by latitudinal parallels (6×6 minutes) and meridians (10×10 minutes) with an approximate grid cell size of 11.2×12.0 km, was used for the former Czechoslovakia and has been generally accepted for zoogeographic research there (e.g. Buchar 1983; Danko *et al.* 2002). It was also used in data sampling and for the checklist of Orthoptera in Czechia (Holuša *et al.* 2013). Recently, 97.5% of the 430 grid cells covering Slovak territory have been surveyed at least at one site, and 80% of the grid cells were studied at least at two or more sites. Thus, in total, 1998 sites (mean 4.8 sites per grid cell, range 1–38) and ca. 32 thousand of single-species points with GPS coordinates have been included in the database (Fig. 2). Mapping was also aimed at previously understudied areas throughout the country. In the field, we sampled species by sweeping the herb layer and beating shrubs and the lower parts of trees with hand-nets (usually ~2,000 sweeps and 50 beatings per site), supplemented by acoustical identification and individual collection of specimens.

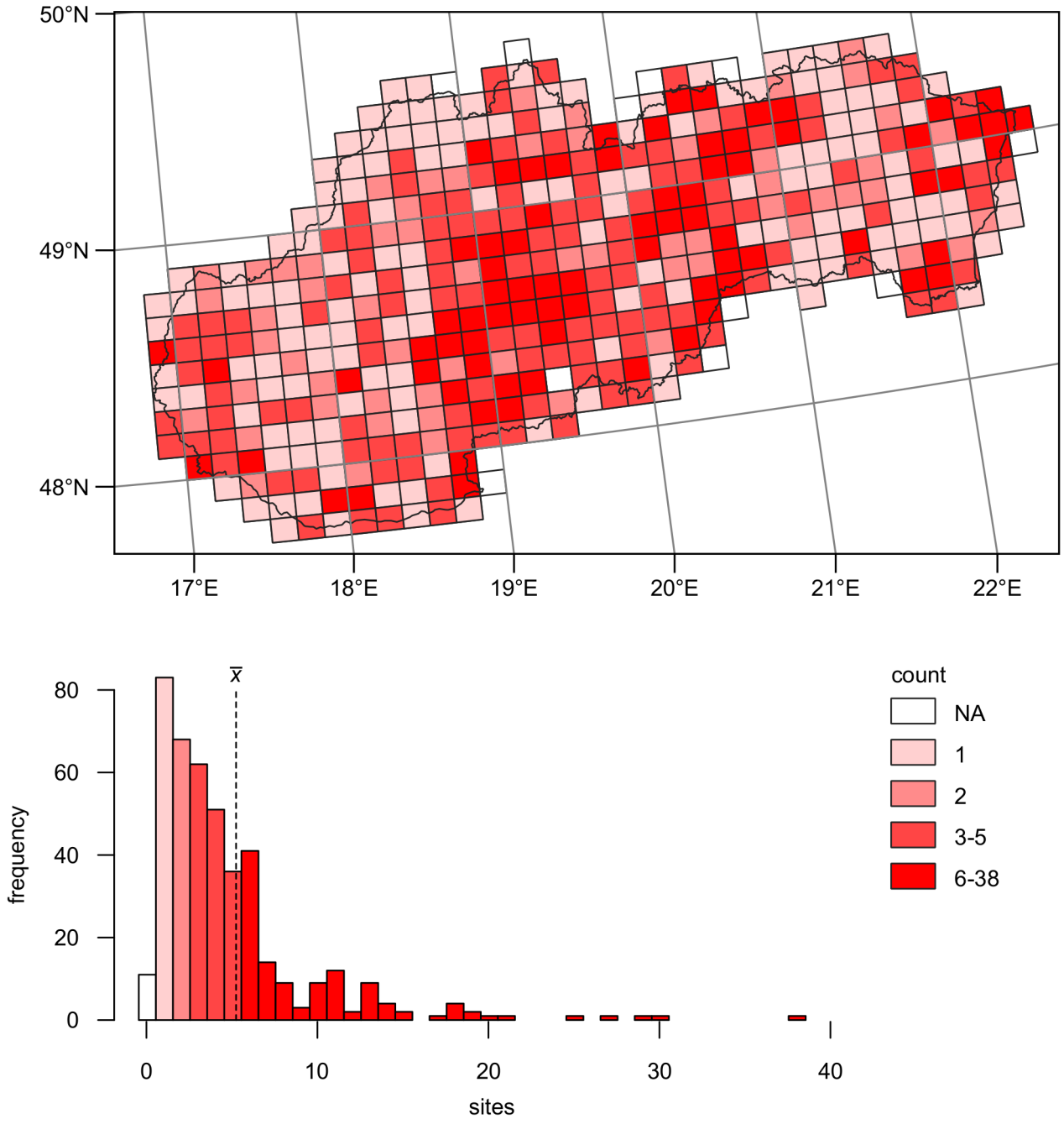

FIGURE 2. Number of sampled sites in grid cells of the Central European mapping grid system (Ehrendorfer & Hamann 1965) in Slovakia; the histogram shows the frequency of counts categorized in quartile ranking and the mean value (n = 430 grid cells; NA—not applicable).

Species list and nomenclature

For Orthoptera identification we used keys by Harz (1969, 1975), Kočárek *et al.* (2005) and Heller *et al.* (2004). We followed Orthoptera Species File Online (Cigliano *et al.* 2020) for valid nomenclature and current taxonomic placement of the species. The presented list contains all orthopteran species known from Slovakia, divided into higher taxonomic units; suborders are indicated by bold font and uppercase letters, families by uppercase letters and species by italics (Appendix 1). The presence of species in the Alpine and/or Pannonian biogeographical regions is indicated with the letters "A" and "P", respectively, in Appendix 1. The relative frequency of species occurrence within sites and grid cells is also given. The presence of all species listed in the previous two checklists (Mařan & Čejchan 1977 and Kočárek *et al.* 1999) is indicated by the symbol "+" and conservation status and threats categories using the IUCN Red List criteria (IUCN 2003) are assigned to all species (Appendix 1).

Changes to the previous checklist (Kočárek *et al.* 1999) are discussed in detail below. Comments focused mainly on species recorded for the first time since the previous checklist (8), endemic species (4), zoogeographically important species (30) and species not recorded or missing in Slovakia for more than 50 years (8). Papers listing some questionable species, such as *Gomphocerus sibiricus*, *Melanoplus frigidus, Isophya tatrica* (Majzlan 1994), *Gampsocleis abbreviata* (Majzlan & Fedor 1997), *Oedipoda germanica* (Majzlan *et al.* 2000) and *Tessellana tessellata* (Gulička 1967), which contained only general or doubtful data, were critically reviewed. Species escaping from the captivity (e.g. *Schistocerca gregaria*, *Gryllus bimaculatus*) are not included in this checklist.

Results and discussion

Species diversity and conservation status

Altogether 129 species (59 Ensifera, 70 Caelifera) were found in Slovakia. These species belong to eight families (5 Ensifera, 3 Caelifera), and 69 genera (34 Ensifera, 35 Caelifera) (Appendix 1). The relatively rich species spectrum reflects the diversity of habitats in areas of different altitudes. We found 31 species exclusive for the Pannonian and 18 for the Alpine biogeographical region. Altogether 1–70 (mean 25.6) species were found per grid cell (Fig. 3).

Four endemic species are currently known in Slovakia. Altogether, eight species were recorded for the first time since the previous checklist (Kočárek *et al.* 1999), and eight species have been missing in Slovakia for more than 50 years (see below). Forty-four species reach the limit of their distributional range in Slovakia, with 31 of them having their northern limit there. We found 11 species whose occurrence in Slovakia was published without clear documentation or were misidentified. We comment them below and they are not included in this checklist. Furthermore, we identified six species that were recorded in the close vicinity of the country, and they could be detected as new species for Slovak Orthoptera fauna in the future.

Based on the actual IUCN Red List criteria, we assessed all 129 species. The species were red-listed as follows; one "Regional Extinct" RE (*Celes variabilis*), eight "Critically Endangered" CR (*Isophya beybienkoi*, *I. costata*, *Poecilimon fussii*, *Pachytrachis gracilis*, *Saga pedo*, *Paracaloptenus caloptenoides*, *Acrotylus insubricus*, *Stenobothrus fischeri*), four "Endangered" EN (*Poecilimon intermedius*, *Gampsocleis glabra*, *Pholidoptera frivaldszkyi*, *Myrmeleotettix antennatus*) and nine "Vulnerable" VU. Altogether 18 species were assessed as "Near Threatened" NT, 73 as "Least Concern" LC, and there are still 12 species listed as "Data Deficient" DD. We could not assign a category for three non-native species (Appendix 1).

Comments on the distribution and ecology of selected species

1. Endemic species

Isophya beybienkoi Mařan, 1958

This species is known only from the Slovak Karst National Park in SE Slovakia, near the Hungarian border (Fig. 4). It was recorded as the first Slovak endemic species in July 1955 north of the villages Hrhov and Zádiel and later on north of the village Plešivec (SE Slovakia) in August 1956 by Mařan (1958a). We found it severely frag-

mented in six small populations (< 5 M[1]/ 1000 m[2]) in 1% of grid cells during the last 20 years (sites from the east to the west: Háj, Zádiel, Hrhov, Hrušov in the Rožňava district, Kováčová near Drnava and Plešivec plateau areas, elevations 400–800 masl.). Its song was described there by Orci *et al* (2001). It is an early occurring species (most of adults appeared in mid-June) living in herbal and shrub layers as a forest edge-dwelling species on steep ridges of xeric karstic rocky forest steppes. The area of occupancy is only 24 km², and the species is listed as critically endangered in Europe (Hochkirch *et al.* 2016).

Isophya fatrensis Chládek, 2007

This species belongs to the species group *Isophya pyrenaea* (Cigliano *et al.* 2020). It was first recorded in August 2003 in the Veľká Fatra Mts and described later by Chládek (2007) and confirmed by song analyses by Iorgu *et al.* (2018). In the last five years, we confirmed this endemic in the Veľká Fatra Mts, the Nízke Tatry Mts, the Kremnické vrchy Mts and the Poľana Mts (altogether 35 sites in 2.6% of grid cells, Fig. 4). The species inhabits forest edges, clearings and mountain grasslands at 600–1350 masl. As the species is difficult to identify, we need more data to evaluate its distribution in Slovakia, and for now the species is listed as NT (Hochkirch *et al.* 2016).

Pseudochorthippus tatrae (Harz, 1971)[2]

This mountainous species resembles *Chorhippus apricarius* and was described as *Ch. apricarius*, subsp. *tatrae* by Harz (1971). Later it was distinguished by morphology and song as a valid species *Chorthippus tatrae* (Chládek & Harz 1983) and recently it is posted as *Pseudochorthippus tatrae* (Cigliano *et al.* 2020). During the last 20 years, we confirmed viable populations (> 10 M/ 1000 m[2]) in the mountains in N Slovakia (Tatra Mts, Slovenský raj, Nízke Tatry and Veľká Fatra Mts). We have also found it in mountain grasslands (> 750 masl.) in the Levočské vrchy Mts (E Slovakia), the N part of the Kremnické vrchy Mts and the Poľana Mts (C Slovakia), in total at 30 sites in 3.6% of the grid cells (Fig. 4). Due to difficult identification and some doubts about its taxonomic position (Hollier & Bruckner 2015), it is listed as DD (Hochkirch *et al.* 2016).

Chorthippus smardai Chládek, 2014[3]

This cryptic species was described from high elevations (1,700–2,000 masl.) in the eastern part of the Tatra Mts (Belianske Tatry Mts) in August 1967–1971 by Chládek (2014). It resembles *Pseudochorthippus parallelus* and *P. montanus* and was distinguished by morphology, less so by song. During the last 10 years we found three specimens (2 M and 1 F) in *terra typica* (Bujačí vrch Mt., 1850 masl.) which should belong to this species (Fig. 4). Due its difficult identification, absent song analysis and unclear taxonomic position, this species is listed as DD (Hochkirch *et al.* 2016).

2. Species recorded for the first time in Slovakia in the last 20 years

Isophya modesta (Frivaldsky, 1867)

The first record was located in central Slovakia in the grasslands near Banská Belá (C Slovakia) on 22 June 2003 (4 M and 4 F; Gavlas & Chládek 2003). Later it was documented from 10 grassland sites in the vicinity of the town Banská Štiavnica (Gavlas 2005), where we confirmed viable and abundant populations (3–10 M/ 1000 m[2]) in June–July 2010–2019, and we also found it in two sites near Dobrá Niva (1 M, 2 F, June 2016) and Ďubákovo (2 M, 2 F, June 2016) in C Slovakia and near Ladmovce (2 M, 1 F, July 2004 and 1 M, July 2010) in SE Slovakia (200–800 masl., Krištín *et al.* 2004b, 2011). Altogether it was found at 13 sites in 1.2% of the grid cells and in three main areas; Fig. 4). Its range is very fragmented, and isolated populations are also known from Hungary, Romania, Ukraine and W Russia (Hochkirch *et al.* 2016).

Isophya modestior Brunner von Wattenwyl, 1882

[1] Abbreviations used in the text: M—male, F—female, ind.—individuals, ad.—adults, NP—National park, N—northern, S—southern, E—eastern, W—western, C—central.

[2] Based on the fact that the species belongs to subgenus *Glyptobothrus* (Harz 1975, Chládek & Harz 1983, Hollier & Bruckner 2015), we suppose that *Chorthippus* is correct genus name.

[3] Considering the morphological similarity with two related species *Pseudochorthippus parallelus* and *P. montanus* (Chládek 2014, Braun 2015 in Cigliano *et al.* 2020), it is likely that this species belongs to genus *Pseudochorthippus* but phylogenetic reconstruction is needed.

This species has a relatively small distribution in NE Italy, W Hungary and the Balkans south to Macedonia and Albania, with the northern range margin in NE Austria and SW Slovakia (Hochkirch *et al.* 2016; Zuna-Kratky *et al.* 2017). In Slovakia, the species (2 F) was mentioned with a question mark already by Mařan (1954a) from the Kováčovské kopce hills (SW Slovakia), but he later revised this data as not appropriately documented (Mařan 1958a). We first recorded this species at two sites near Bratislava in the xeric forest steppes of Devínska Kobyla (2 M, 1 F in June 2013, and 2 M in June 2016) and along oak-hornbeam forest edges near Bratislava, Železná studnička (2 M in July 2016, Fig. 4). The songs of these specimens were proven by I. Ş. Iorgu in August 2016, following Heller *et al.* (2004) and Orci *et al.* (2005).

Isophya costata Brunner von Wattenwyl, 1878

This species is one of the 10 orthopterans of European Community interest (Annex II and IV of Habitats Directive) endemic to the Pannonian Basin and central Transylvania (Romania). It was recorded for the first time in Slovakia in June 2017, at Devínske jazero (134 masl., Fig. 4), on a flooded meadow at the Morava River (Nuhlíčková *et al.* 2017). The presence of the species in this area is at the northern edge of its range. All older data from area of the former Czechoslovakia were considered as incorrect (Holuša *et al.* 2013).

Leptophyes punctatissima (Bosc, 1792)[4]

This species has a wide range in W and S Europe from Norway in the north and Greece in the south, with the E range margin in Czechia, Austria and Hungary (Hochkirch *et al.* 2016) and recently also in W Slovakia. In Slovakia, it was first recorded only in 2015 (July 13, one nymph M, in Bratislava—Patrónka, A. Revický, in litt.[4]) where it inhabits human settlements, parks and gardens, as in Austria (Zuna Kratky *et al.* 2017), Czechia (Brno parks; Chládek 2002; Holuša *et al.* 2013) and Hungary (Budapest parks and green belts; Nagy 1997).

Meconema meridionale Costa, 1860

This Mediterranean species is native to Italy, S France, S Switzerland, W Slovenia and NW Croatia. It has recently expanded its range in large parts of Europe as a consequence of human-mediated dispersal with transportation and horticulture (Hochkirch *et al.* 2016). The first records are from August 2011 (Bratislava, Zlaté piesky) and September 2011 (Zvolen; Vlk *et al.* 2012). We later found it in six other urban and suburban habitats of western (Bratislava and Zeleneč), central (Banská Bystrica and Zvolen) and S Slovakia (Šahy) in 2013–2019, mostly from August till November (Fig. 4). All these sites (1.4% of grid cells) are associated with car traffic and support the idea of its passive dispersal (Vlk *et al.* 2012).

Paracaloptenus caloptenoides (Brunner von Wattenwyl, 1861)

This Balkan grasshopper is a species of community interest (Annex II and IV of Habitats Directive) and has continual distribution in SE Europe, but its range is very fragmented at the northern margin (Hochkirch *et al.* 2016). Its occurrence from the former Czechoslovakia was mentioned by Harz (1975), but without a sampling site and date. The first record in Slovakia was documented at Sitno Mt near the village Ilja (C Slovakia) in andesite rocky xeric steppe in August 2004 (5 M, 1 F; Gavlas 2004). We confirmed an isolated population (up to 10–15 M and 11–18 F/1000 m^2) in June–July 2012–2019. Later, we also found it at 10 sites in the Slovak Karst National Park around the villages Silica and Silická Jablonica in SE Slovakia in 2007–2019 (Krištín *et al.* 2009), where the species inhabits xeric and karstic limestone rocky forest-steppes, surrounded by open oak forests (*Corneto-Quercetum*). This area is in contact with viable populations in Aggtelek National Park in Hungary (Nagy *et al.* 1999). The species was found in 1% of grid cells and in two main areas (Fig. 4).

Chorthippus oschei Helversen, 1986

This species belongs to the *Ch. albomarginatus*-group, whereas *Ch. albomarginatus* is replaced in SE Europe by the sister species *Ch. oschei*. The first records in Slovakia were published from SE Slovakia, the Slovak Karst area, when Lehmann & Lehmann (2007) found one male on August 2006 in the village Ardovo. A hybridization

[4] During manuscript revision, the species was confirmed in two other sites (Bratislava—Horský Park (6 male and 6 female nymphs on 23 July 2020, later reared to adults in the laboratory) and Záhorská Bystrica (3 males and 2 females in 25 July 2020, F. Oravcová, in litt.). All these sites are located in the westernmost part of the country near Austrian border (3–6 km E).

zone between *C. albomarginatus* and *C. oschei* in Slovakia was documented on the base of deviations in song and leg movements in some specimens (Vedenina *et al.* 2009). During 2010–2019 we found abundant populations in the Pannonian area of Slovakia up to 540 masl., altogether at 183 sites and in 19.8% of grid cells (Fig. 4). Due to difficult identification, this species can be easily overlooked, and more data on syntopic distribution with *Ch. albomarginatus* are needed.

3. Zoogeographic important species having a range margin in Slovakia

Phaneroptera nana Fieber, 1853

This is a Circum-Mediterranean species distributed in Europe, Africa and Asia Minor (Kočárek *et al.* 2005, Hochkirch *et al.* 2016). In Slovakia, it was found for the first time in the southwest of the country in September 1962 (1 M) by I. Okáli in Kamenín, near Štúrovo (S Slovakia) and later, not before 1994, in xerothermophilous oak forest steppes and gardens in Devínska Kobyla near Bratislava as the most numerous bushcricket species in Malaise traps (Holuša & Vidlička 1997). Up to that time it was probably an overlooked species, resembling the related species *Phaneroptera falcata.* It lives in shrub and tree canopies, preferring mostly riparian vegetation along rivers and human-made habitats (parks, gardens, vineyards). More recently, in the last 20 years, we found it at more than 160 sites (22% of grid cells), especially in the Pannonian region of Slovakia between 100 and 530 masl., reaching the northernmost occurrence within the country in riparian vegetation of Váh River near the town Nová Dubnica in W Slovakia (48.974 °N) and in xeric forest steppe of Brekov Castle near the town of Humenné in the east (48.903 °N) (Fig. 4). The species occurrence in the Bukovské vrchy Mts was mentioned by a mistake (Jarčuška *et al.* 2015).

Leptophyes discoidalis (Frivaldsky, 1867)

This vulnerable species has a relatively small range and is distributed in Bulgaria, Serbia, Montenegro, Croatia, Romania and Hungary and reaches its northern range margin in E Slovakia (Hochkirch *et al.* 2016). In Slovakia, it was documented for the first time in July 1976 in the Slovak Karst near Plešivec (1M, Chládek 1987). Until the 1990s the occurrence data were missing, and in the last 20 years we found the species at 19 sites (3.3% of grid cells) in the Pannonian region of E Slovakia between 95 and 440 masl. (Fig. 4.) The northernmost occurrence was found in the xeric steppes of Brekov Castle near Humenné. The species inhabits mostly xeric habitats, less wet grasslands along rivers in low abundance (10 individuals/ ha, Ladmovce, July 2007; Bodrog River, July 2010).

Barbitistes serricauda (Fabricius, 1798)

The species has mostly a western European range and in Slovakia reaches its northeastern range margin. The first records from Slovakia are known from the Vihorlat Mts (Biró 1885, Chyzer 1897) and Kováčovské kopce hills (Mařan 1954a), where it was not confirmed later and possibly the specimens were misidentified, with a green form of *Barbitistes constrictus* (cf. Chládek 1979). The actual distribution in Slovakia is known only in the southwestern-most part of the Malé Karpaty Mts along forest edges, shrubs and old abandoned gardens and vineyards (2001–2019) (Fig. 4). The species lives there in small populations (< 3 M found per site).

Poecilimon fussii Fieber, 1878

This Balkan species has a small and scattered range from Bulgaria and Serbia in the south to Hungary and SE Slovakia in the north (Hochkirch *et al.* 2016). It was documented for the first time in Slovakia in July 1951, under the name *Poecilimon matisi*, by Mařan (1952b) from Piliš hill near the village Bara (SE Slovakia). In the last 20 years we found the species in only five new xeric sites (two in SE Slovakia, near the villages Ladmovce and Viničky, ca. 4 and 6 km far from the first records published by Mařan; Krištín *et al.* 2004a, 2011) and three sites near the villages Silica and Silická Jablonica in the Slovak Karst (350–590 masl., August 2019) (Fig. 4., in 0.5% of grid cells). This species lives mostly in shrubs and tall herbal vegetation in oak forest steppes and at their edges in isolated but viable populations (e.g. > 100 ind. / 300 m long transect, Ladmovce, July 2005; 5–10 ind. / 300 m in August 2019 in Slovak Karst). The species status should be clarified with regard to *Poecilimon ukrainicus*, distributed eastwards of *P. fussii* (Harz 1969; Hochkirch *et al.* 2016).

Poecilimon intermedius (Fieber, 1853)

This Euro-Siberian species is widespread and common in S Russia, but it has scattered and relict distribution in Central Europe and Romania. The westernmost limit of its large distributional range is in Austria, W Slovakia and SE Moravia. The first record of this species in Slovakia was documented in July 1982 in two grassland sites near the village Vrbovce in W Slovakia (Čejchan 1983a), close to relict species distribution in S Moravia (Chládek 1980, 2003c). However, the species occurrence was mentioned as early as by Chyzer (1897) and Pungur (1899) in E Slovakia (near Slovenské Nové Mesto) or NE Hungary, but Mařan (1952) presumed that it was probably *Poecilimon fussii*. We confirmed the species occurrence at only two sites in the last 20 years, the first unexpectedly close to High Tatra Mts in grassland near the village Švábovce (650 masl.; July 2013, 1 F; Krištín *et al.* 2019b) and the second near Silická Jablonica in the Slovak Karst (SE Slovakia, 340 masl., August 2019, 2 F, Fig. 4). Only parthenogenetic females are known from Central Europe (Zuna-Kratky *et al.* 2017).

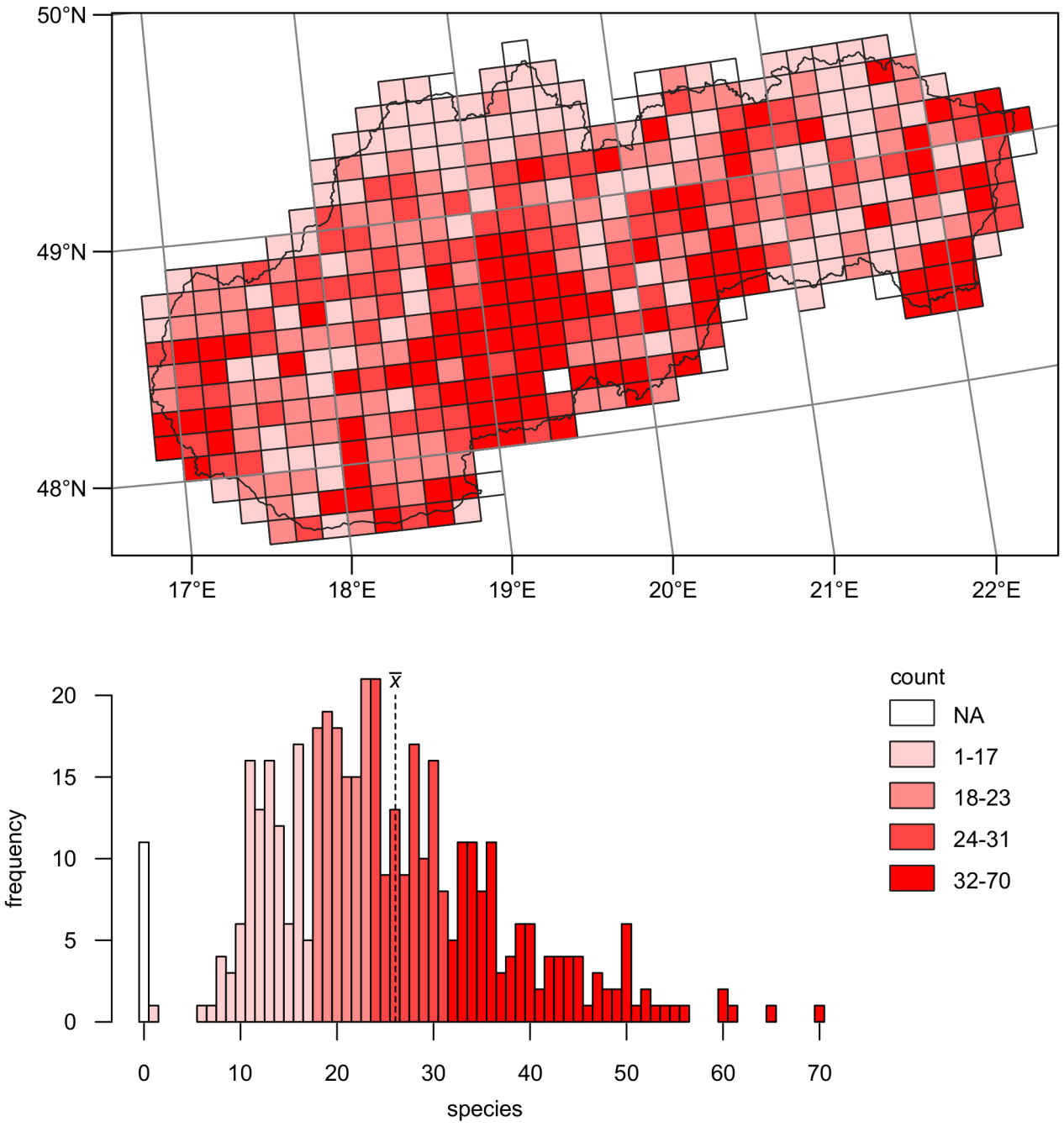

FIGURE 3. Number of recorded species in grid cells of the Central European mapping grid system (Ehrendorfer & Hamann 1965) in Slovakia; the histogram shows frequency of counts categorized in quartile ranking and the mean value (n = 430 grid cells; NA—not applicable).

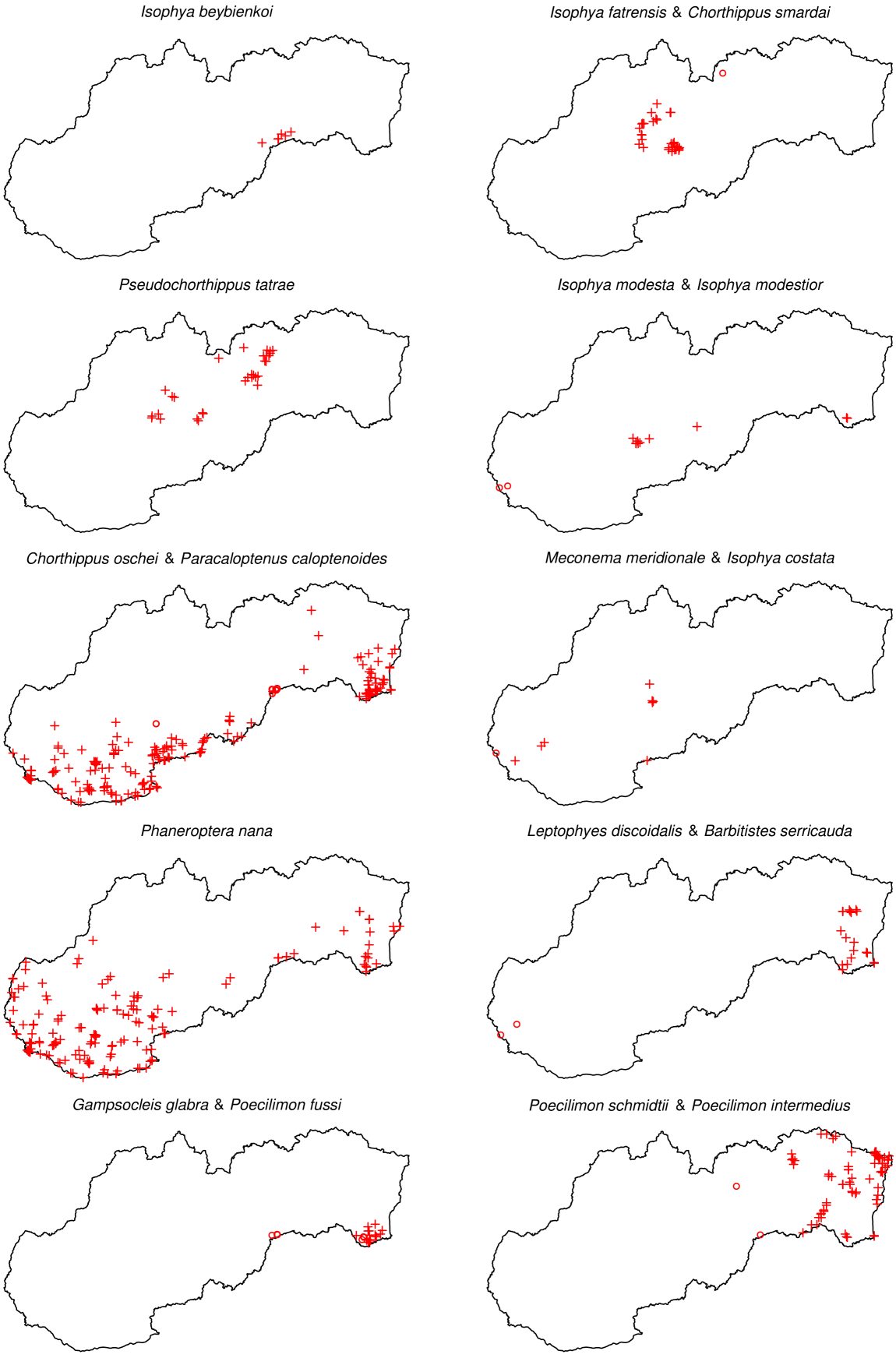

FIGURE 4. Distribution of 17 Orthoptera species in Slovakia (marks represent location of mapping sites; in combined maps, an open circle denotes the second species from the map heading).

Poecilimon schmidti (Fieber, 1853)

This Ponto-Mediterranean species is distributed in Europe from Slovenia in the west to E Romania and NE Greece in the southeast and reaches its northern range margin in E Slovakia and S Poland (Hochkirch *et al.* 2016). It is the most frequent *Poecilimon* species in Slovakia and was documented for the first time by Bíró (1885) from the Tokaj Mts. However, only five sites in Slovakia were known until 1998, later 56 in 2015 (Krištín & Jarčuška 2016) and now 72 in 2019, but all of them only in E Slovakia (Fig. 4). In the last 20 years we found the species between 105 and 950 masl. (in 7.2% of grid cells), and in 2015 we found it as a new species for Poland (Jarčuška *et al.* 2015). The species inhabits broadleaved forest ecotones (Krištín & Jarčuška 2016).

Gampsocleis glabra (Herbst, 1786)

This is a widespread species in Eurasia, occurring from Spain to Mongolia, but the populations are strongly fragmented or regionally extinct in Western and Central Europe (Hochkirch *et al.* 2016). Before 2005, the species had only been found at six sites in S Slovakia (Mařan 1954a; Čejchan 1959, 1985; Fedor *et al.* 2004). Later, in 2005–2006, we found it at 12 sites in SE Slovakia (Krištín *et al.* 2007c). Today we know 21 isolated sites (1.4% of grid cells) only in E Slovakia but, despite the increased sampling effort, we could not confirm the population in SW Slovakia (cf. Fedor *et al.* 2004) (Fig. 4). In Slovakia, the species inhabits warm lowland habitats, where reproduction sites include desiccating wet meadows and sandy dunes along wet depressions at elevations of 98–150 masl., and the adults can occur also in ruderal vegetation along reproductive sites (Krištín *et al.* 2007c).

Platycleis affinis Fieber, 1853

This Mediterranean species belong to the rare and less frequent pseudopsammophilous species, occurring mostly in sandy habitats of SW and SE Slovakia (Mařan 1952c, 1954a, Čejchan 1961). It was first recorded in Devín (SW Slovakia, August 1929) at xerotherms of the Malé Karpaty Mts (Schneeberg 1931). Later, it was found in sandy sites at Čenkov, near the villages Mlyňany and Gabčíkovo (SW Slovakia), Somotor and Streda nad Bodrogom (SE Slovakia; Mařan 1952c, 1954a, Čejchan 1961). During the last 20 years we found relatively well preserved but less abundant populations in lowland sandy sites along the Danube River in Chotín (Svätý Peter), Rusovce and Čunovo and in xeric steppes near Kráľovský Chlmec, Strážne and Veľký Kamenec (SE Slovakia). One isolated population is near Šahy (south of C Slovakia); altogether, it occurs at 16 sites and in 2.4% of grid cells (Fig. 5). This species prefers bare sandy plots with scarce grassy and herbal vegetation on sandy dunes.

Tesselana veyseli (Koçak, 1984)

The species has Ponto-Mediterranean distribution and it has been found north beyond the borders of Pannonian area only very seldom (Holuša & Chládek 1998; Krištín *et al.* 2004a, b). It was first recorded in Slovakia near Senec (W Slovakia, 3 F, August 1929; Schneeberg 1931). Later the distribution was summarized by Görtler (1946), Mařan (1954a), Holuša & Chládek (1998) and it was found in xeric sites, mainly in SW and SE Slovakia. During the last 20 years we confirmed it at about 60 xeric sites across all of S Slovakia up to 49 °N (Fig. 5).

Pholidoptera frivaldszkyi (Herman, 1871)

The species has a disjunct range, with strongholds in the southern Carpathians (Harz 1969; Kaňuch *et al.* 2014) and isolated occurrences in Ukraine and Russia (Kaňuch *et al.* 2017). In Central Europe, it has been found only in Slovakia, in four isolated areas (Poľana Mts, Tatry Mts, Slovenský raj NP and Slanské vrchy Mts). Ebner (1914) published the first records from Slovakia, when he found viable populations in the High Tatra Mts (Štrba and Štrbské Pleso area) in August 1910. Later, Holuša (1996) summarized the distribution, when he mentioned the occurrence from the Slanské vrchy Mts and Slovenský raj NP and Krištín (2000), completing the records from the Poľana Mts in C Slovakia. Recently the species has been known from 12 sites (1.2% of grid cells) in these four main areas of C and E Slovakia (Fig. 6). It inhabits traditionally managed fragments of mountain hay meadows (580–1190 masl.), and the most abundant populations (> 100 M/ ha) were found in the Slanské vrchy Mts and Slovenský raj NP area.

Pholidoptera transsylvanica (Fischer, 1853)

The stronghold of the distribution of this species of Community interest (Annex II and IV of Habitats Directive) is Romania and Ukraine in the Carpathian Mts. The northern range margin is located along Polish-Slovakian border (Krištín *et al.* 2019a). From Slovakia, it was mentioned for the first time by Bíró (1885) from the Vihorlat Mts.

Later, the species was mentioned from Bukovské vrchy Mts (NE Slovakia, site Runina) by Chyzer (1897) and from Stužica by Mařan (1952d), but despite the increased sampling effort in the last 20 years, we could not confirm the species there. Until 1998, only six sites in Slovakia were known (Holuša 1996). During the last 20 years we found *P. transsylvanica* at 65 sites (5.3% of grid cells) due to the increased sampling effort (Fig. 5). It inhabits grassland habitats surrounded mostly by beech, oak and mixed forests up to 1120 masl. (Krištín & Kaňuch 2013) and its syntopic occurrence with related species *Pholidoptera aptera* is very rare (Dorková *et al.* 2020).

Pachytrachis gracilis (Brunner von Wattenwyl, 1861)

This species occurs on the Balkan Peninsula from N Greece to NE Italy, S Slovakia and W Ukraine (Hochkirch *et al.* 2016). It was recorded for the first time in Slovakia in 1998, on the xeric oak forest steppes near the village Plášťovce in the south of C Slovakia (Krištín 1998). Later we found abundant populations (12–50 adults/1000 m^2) in xeric habitats along oak forest margins near the village Silica in the Slovak Karst, SE Slovakia (Krištín *et al.* 2009), close to populations known in Hungary (Nagy *et al.* 1999). In spite of increased sampling effort in the last 20 years, we know this species from only 11 sites (1.4% grid cells) of S Slovakia, where there are two main areas of distribution (southern slopes of Krupinská planina hills and Slovak Karst NP, Fig. 5). It inhabits high forbs and shrubs on oak forest margins, forest clearings and open forests. The species has never been found in W Slovakia until now.

Rhacocleis germanica (Herrich-Schäffer, 1840)

This Mediterranean species has similar distributional patterns and habitat demands as *Pachytrachis gracilis*. It is widespread in SE Europe and reaches its northernmost range margin in Slovakia (Hochkirch *et al.* 2016). It was first mentioned in Slovakia by Chyzer (1897) and Pungur (1899) near Bardejov (N Slovakia) (probably by mistake, because this is far outside the species range), later near Plášťovce (Krupinská planina hills) by Mařan (1954a), all these without sampling details. Later, until 2004 published data were lacking, when an abundant population was found near the village Súdovce (Štiavnické vrchy Mts) by Gavlas (2004). In 2008, its distribution was summarized and seven sites were published by Holuša & Kočárek (2008) from Slovakia. Nowadays, we know the species from 28 sites (2.9% of grid cells), when we recorded it during the last 20 years in S Slovakia from Salka (Ipeľská pahorkatina hills) at the southwest of the country up to the village Silica (Slovak Karst) to the east (Fig. 5). Slovak populations are in contact with populations in N Hungary (e.g. Nagy *et al.* 1999). We recorded the most abundant populations in xeric forest steppes along the oak forests margins near the villages Chrámec, Súdovce and Plášťovce in S Slovakia (mostly > 100 adults/1000 m^2).

Tetrix bolivari Saulcy, 1901

This species occurs in S Europe via the Near East to Iran and Uzbekistan and in C Europe reaches the northern range margin in S Slovakia (Hochkirch *et al.* 2016). Occurrence data up to 1963 was published by Čejchan (1963), having the first record in 1949, and he mentioned the species from six lowland sites of S Slovakia. Later, Holuša (1996) and Holuša & Kočárek (2000) summarized the distribution in Slovakia, showing a new occurrence in westernmost Slovakia close to the species occurrence in Moravia. In the last 20 years, we found the species at 42 sites and in 7% of grid cells (Fig. 5) along rivers in lowland areas of the entire Pannonian area of S Slovakia up to 49 °N (wet grassland along the Hornád River). Abundant populations (30–60 ad. /1000 m^2) can be found in clay banks of ponds and salt marshes, and wet meadow depressions, sand and gravel pits, gravel banks and similar moist habitats with bare ground.

Tetrix ceperoi (Bolívar, 1887)

This is a widespread species in S and W Europe that inhabits moist open habitats, often with a sandy substrate (Hochkirch *et al.*2016). Distribution in Slovakia was summarized and revised by Holuša (1998), when he mentioned the occurrence at four sites of westernmost Slovakia (Záhorie area), and the first species records were from there in September 1982. We were able to confirm distribution of the species only in W Slovakia during our mapping until 2019, when we found it in wet depressions of sand pits near the village Sekule (e.g. 3M, 6 F, July 2010) and near the village Krivosúd - Bodovka (2M, 1F, September 2019) (Fig. 5). More data are needed to complete the knowledge on its distribution.

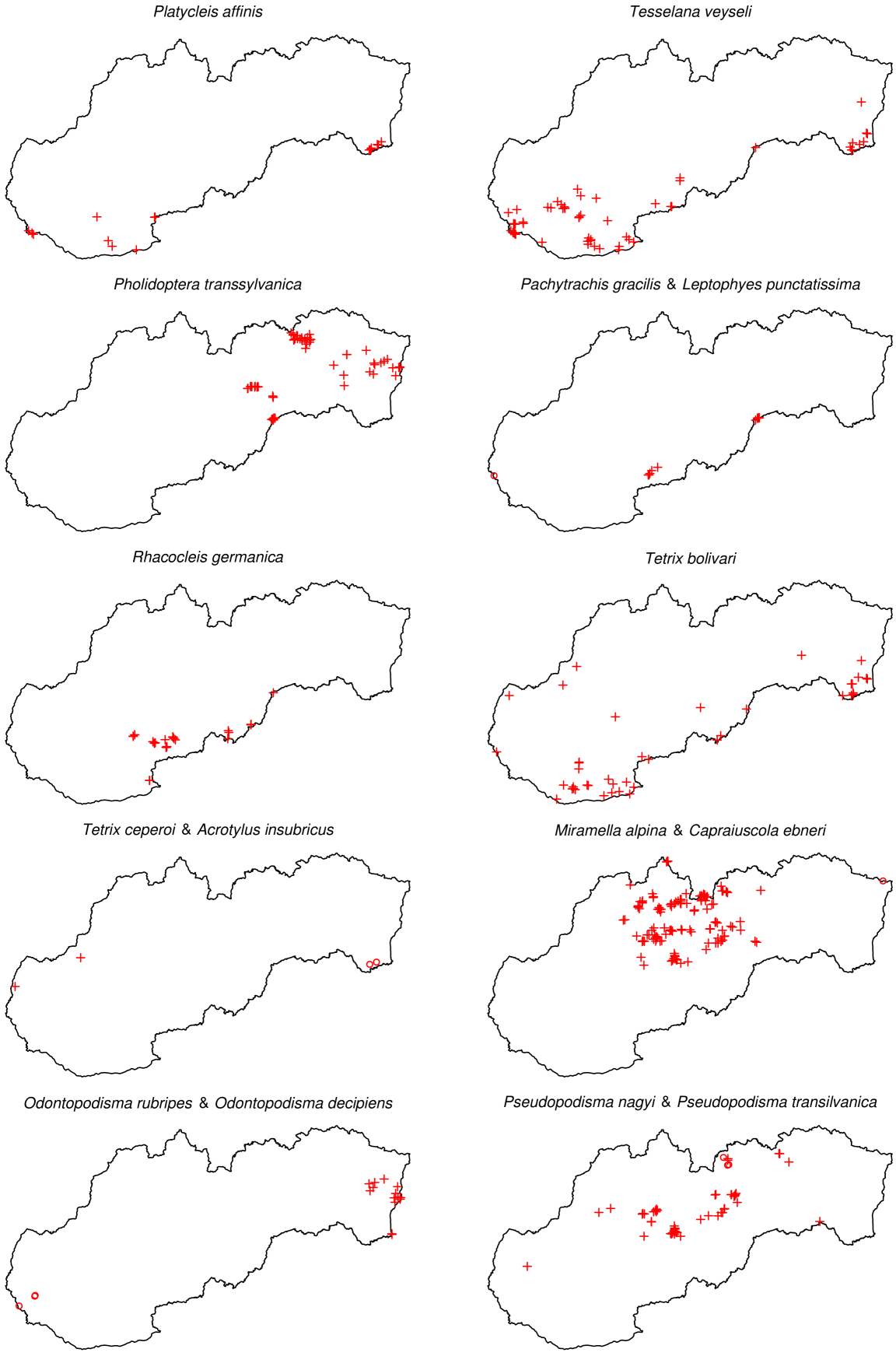

FIGURE 5. Distribution of 14 Orthoptera species in Slovakia (marks represent location of mapping sites; in combined maps, an open circle denotes the second species from the map heading).

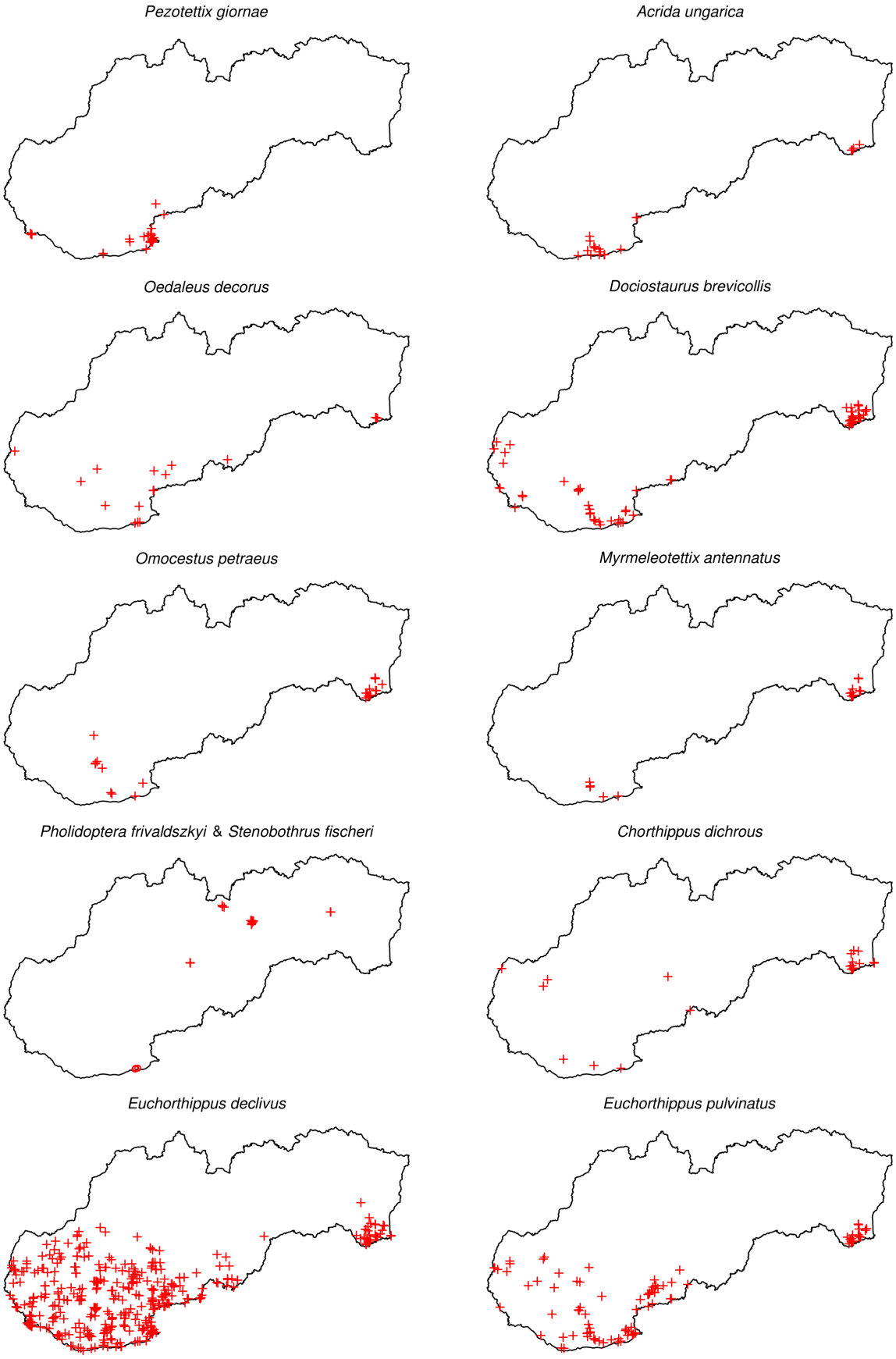

FIGURE 6. Distribution of 11 Orthoptera species in Slovakia (marks represent location of mapping sites; in the combined map, an open circle denotes the second species from the map heading).

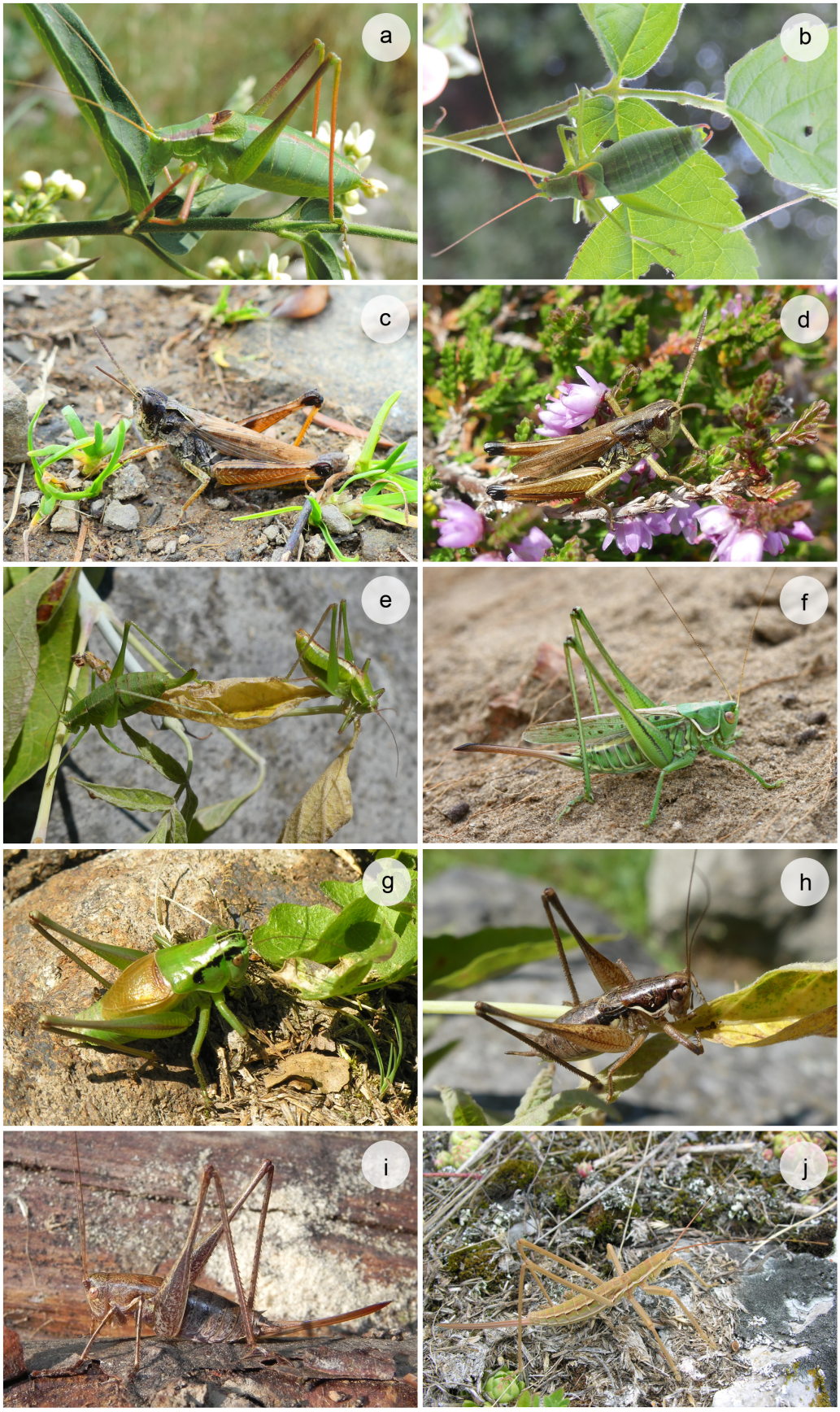

PLATE 1. Endemics and endangered Ensifera species in Slovakia: a) *Isophya beybienkoi*, b) *Isophya fatrensis*, c) *Pseudochorthippus tatrae*, d) *Chorthippus smardai*, e) *Poecilimon fussii*, f) *Gampsocleis glabra*, g) *Pholidoptera frivaldszkyi*, h) *Pachytrachis gracilis*, i). *Rhacocleis germanica*, j) *Saga pedo.* (all the photos A. Krištín)

PLATE 2. Selected zoogeografically important species in Slovakia: a) *Leptophyes discoidalis,* b) *Poecilimon schmidtii*, c) *Platycleis affinis*, d) *Tesselana veyseli*, e) *Paracaloptenus caloptenoides*, f) *Miramella alpina*, g) *Pseudopodisma nagyi*, h) *Pezotettiix giornae*, i) *Dociostaurus brevicollis*, j) *Chorthippus dichrous* (all the photos A. Krištín).

Acrotylus insubricus (Scopoli, 1786)

This Paleotropic species is one of the pseudopsammophilous orthopterans in Slovakia, reaching its northernmost range margin in Hungary (Nagy 2005) and S Slovakia (Hochkirch *et al.* 2016). It was published for the first time from the area of Slovakia in the 19th century in E Slovakia, near the village Somotor (Chyzer 1897; Pungur 1899). Later published data include the same sandy site (1F, September 1951, Mařan 1954a), then three new sites in SW Slovakia—one in the Kováčovské kopce Hills near Štúrovo (1F, April 1952; 1M, August 1955—Mařan 1954a, 1958b) and two in sandy habitats near the villages Chotín (8M and 7F, August 1960) and Čenkov (6M and 7F, August 1960), both published by Čejchan (1961). In spite of the increased sampling effort in these known and similar sites and sandy habitats in the last 20 years, we could only confirm the species in two sites of E Slovakia and only in 2019 (Fig. 5). A population of 30 individuals (20 F and 10 M) was found in sandy habitats with sparse herbaceous vegetation near the village Svätuše (25 October—11 November 2019) (Balla & Krištín 2019). A second population (3M, 4 F) was found (in March 2020) in bare sandy dunes near the village Somotor in the area published 120 years ago (Chyzer 1897; Pungur 1899). The nearest documented sporadic occurrence to W Slovakia was recorded in Hungary (Nagy 2005), when we found a population in sandy habitats in N Hungary, near the village Szödliget in September 2019, some 20 km from the Slovak border (Balla & Krištín 2019).

Capraiuscola ebneri (Galvagni, 1953)

The species is a Carpathian endemic, inhabiting the high mountain grasslands in Romania and Ukraine and reaching its NW range margin in NE Slovakia and SE Poland (Hochkirch *et al.* 2016). In Slovakia, it was first documented by Čejchan (1958a, b) from the Bukovské vrchy Mts (near Nová Sedlica, August 1957, > 100 ind.) as *Miramella ebneri* ssp. *carpathica*. However, this species was probably mentioned there already by Chyzer (1897), but under the name *Miramella alpina*, since this species had never been documented in the Eastern Carpathians (Bukovské vrchy Mts) and its distribution is known only from mountains in C Slovakia (Fig. 5). During our Orthoptera mapping we confirmed abundant *C. ebneri* populations only in a small area in the high mountain grasslands of a Bukovské vrchy mountain ridge, higher than 1100 masl. (> 80 adults/ ha, Riaba skala in July 1999—Krištín & Mihál (2000) and in July 2018, Jarčuška 2019).

Odontopodisma decipiens Ramme, 1951

This species has a mostly S European range; it reaches the northern range margin in Slovakia and seems to be in contact with populations in NE Austria (Hochkirch *et al.* 2016; Zuna-Kratky *et al.* 2017). In Slovakia, the species was mentioned for the first time without sampling details by Schneeberg (1931) as *Podisma schmidtii* from Devínska Kobyla near Bratislava (W Slovakia); later it was documented there several times as a rare species (Dobšík 1950; Gulička 1974; Chládek 1999; Gavlas 2003). Čejchan (1985) summarized the species distribution in Slovakia, when he mentioned the occurrence at only four sites of the Malé Karpaty Mts, with the northernmost site at Plavecké Podhradie (1F, August 1953). Nowadays, we confirmed the populations only in the Malé Karpaty Mts in the westernmost Slovakia in old abandoned gardens and vineyards and shrubland along oak forest edges (Fig. 5). The species survives there in small sized populations (< 10 ad. /300 m transects of skirt habitats) as an "early season" species, already an adult in June.

Odontopodisma rubripes (Ramme, 1931)

This Species of Community interest (Annex II and IV of Habitats Directive) has rather small range in the Carpathians and Pannonian basin of C and NW Romania, W Ukraine and NE Hungary and its northern range margin is located at E Slovakia (Krištín & Kaňuch 2013). In Slovakia, the species was mentioned for the first time by Mařan (1954a) in the Vihorlat Mts and near Ulič in NE Slovakia; later Holuša (1996) confirmed the occurrence in the Vihorlat Mts. Recently we know the species from 15 sites (2.3% of grid cells) from the East Slovakian hills, lowland and the Vihorlat Mts between 95 (Tisa River) and 900 masl. (Vihorlat Mts) (Fig. 5). In Slovakia, it occurs primarily in shrub understory dominated by *Rubus* spp. at the edges and clearings in floodplain poplar-willow forests, oak, oak-hornbeam and beech forests, sometimes in very abundant populations (e.g. > 1000 adults/ ha, forest edges along Tisa River, July 2013).

Pseudopodisma nagyi Galvagni et Fontana, 1996

The species has been described on the basis of small differences with *P. fieberi* and *P. transilvanica* in the male

aedeagus (Galvagni & Fontana 1996). Along with other two taxa the specific status of *P. nagyi* was recently supported also by multivariate morphometric analysis and molecular data (the cytochrome *b* gene analysis) by Kisfali *et al.* (2017). Both analyses indicated a strong species-delimitation within the genus *Pseudopodisma*. The species *P. nagyi* is known from N Hungary, Slovakia and SE Czechia (Hochkirch *et al.* 2016). Until 1996, it was treated as *Pseudopodisma fieberi* (Scudder, 1898), and the first records from the area of today's Slovakia were mentioned by Pungur (1899) and Ebner (1914). Holuša (1996) later summarized the distribution data, mentioning it from 20 sites. During the last 20 years we found *P. nagyi* at 52 sites and in 5.7% of grid cells (Fig. 5). It inhabits grasslands and forest edges and clearings rich in herbal vegetation at elevations between 580 m and 1,550 masl., mostly in C and N Slovakia, while in N Slovakia it can be found only a few kilometres distant from *P. transilvanica* sites.

Pseudopodisma transilvanica Galvagni et Fontana, 1993

The species occurs along the Eastern and Southern Carpathians and the Apuseni Mountains in Romania. An isolated area was found in the Belianske Tatry Mts in N Slovakia (Galvagni and Fontana 1996). The first occurrence data (September 1954 and August 1961) were published by Galvagni and Fontana (1996) from Tatranská Kotlina (E part of the Belianske Tatry Mts). Later, it was mentioned by Chládek (2003b) from the Spišská Magura Mts (Repisko Mt; N Slovakia) and Chládek & Gavlas (2005) from the Nízke Tatry Mts in C Slovakia. In the last 20 years we found it on two sites, near the already published localities in Spišská Magura (Bachledova dolina valley) and the Belianske Tatry Mts (near Tatranská Kotlina) between 900 and 1200 masl. (Fig. 5). Further research and data are needed on this and all species of the genus *Pseudopodisma* in Slovakia.

Pezotettix giornae (Rossi, 1794)

This Mediterranean and wingless species is widely distributed in the southern part of Europe, N Africa and the Near East (Hochkirch *et al.* 2016). In Slovakia, it was mentioned for the first time only 20 years ago by Kočárek (1999) in the Kováčovské vrchy hills in the SW part of country. The species occurrence was expected there for a longer time, as it has wide distribution and abundant populations in neighbouring area of N Hungary near the Slovak border, known there from the beginning of the 19th century (Nagy *et al.* 2010). In the last 20 years we found the species at 28 sites and in 10.5% of grid cells up to 330 masl. (Fig. 6). Abundant populations (mostly > 100 adults/1000 m^2) were located in xeric habitats along Danube and Ipeľ Rivers, mostly close to the Slovak Hungarian and Austrian border from Bratislava (W Slovakia) to Šahy and Dudince on the south of C Slovakia. The species inhabits the xeric steppes there and also anthropogenic habitats along roads and railways; hence, we assume that this wingless species can also spread along these corridors by transportation.

Acrida ungarica (Herbst, 1786)

This species is widely distributed in S Europe along the Mediterranean and in Slovakia it belongs among the rare pseudopsammophilous species, occurring mostly in sandy habitats of SW and SE Slovakia (Hoffer 1937; Mařan 1952c, 1954a) in contact with populations in Hungary (Hochkirch *et al.* 2016). It was first mentioned in Slovakia without sampling details by Frivaldszky (1868), later by Bíró (1885) and Chyzer (1897) from the Somotor sandy area (SE Slovakia). Later, in the 1940s, 1950s and 1960s, it was also found in SW Slovakia (sandy sites Čenkov, Štúrovo and Chotín) and confirmed in several sites of SE Slovakia (Beša, Cejkov, Horeš, Hrušov near Kráľovský Chlmec, Kapoňa, Kráľovský Chlmec, Plešany, Somotor, Svätá Mária, Veľký Kamenec) (Hoffer 1937; Mařan 1952c, 1954a; Gulička 1992; Gulička in litt.). Forty to fifty years later, during the past 20 years, we recorded a strong decline in SE Slovakia upon checking all the known sites (10) from 1950–1960s. We found low abundant populations (< 20 adults/1000 m^2) or single specimens on only two sandy sites (Horeš near Kráľovský Chlmec and a dune near Veľký Kamenec). However, we still recorded relatively well preserved reproductive sites in sandy habitats of SW Slovakia (near Chotín, Svätý Peter, Nesvady—the northernmost sandy sites, Marcelová and on the embankments along the Danube River—Zlatná na Ostrove, Komárno, Iža, Patince; everywhere there > 50 adults/1000 m^2) and an isolated sandy area near Šahy in the south of C Slovakia (up to 10 adult individuals in 2018–2019). Nowadays, we know the species from 19 sites (2.9% of grid cells) (Fig. 6).

Oedaleus decorus (Germar, 1826)

This pseudopsammophilous species has very similar distributional patterns and habitat demands as *Acrida ungarica* and other species inhabiting sandy sites in C Europe, reaching the northernmost range margin in Slovakia

(Mařan 1952c, 1954a; Čejchan 1961; Hochkirch *et al.* 2016). It has dispersed distribution in the Pannonian area and in Slovakia, it was first recorded in Svätý Jur, near Bratislava (1F), in 1929 (Schneeberg 1931). Later, in 1950s and 1960s, quite abundant populations were recorded in SE Slovakia (8 sites) and SW Slovakia (4 sites) by Mařan (1952) and Gulička (in litt.), but until year 2000 the published data were missing. In the last 20 years, we found the species at 17 sites (2.9% of grid cells), most of them in SW Slovakia (e.g. sandy dunes Čenkov and Šaľa—there > 50 adults/1000 m^2, Nesvady, Hurbanovo, Šahy), Fiľakovo—Čamovce (S Slovakia, > 50 adults/1000 m^2) and Horeš, Svätuše (E Slovakia, < 20 adults/1000 m^2) (Fig. 6) up to 470 masl. As it is a good flyer, it was even found in some xeric rocky sites (rocky steppes, quarries), which are quite distant (> 30 km) from the reproductive sites (Plášťovce forest steppe,—S Slovakia, Nitra—Kalvária steppe—SW Slovakia). It is regionally extinct in the neighbouring Czech Republic (Holuša *et al.* 2013) and Austria (Zuna-Kratky *et al.* 2017).

Dociostaurus brevicollis (Eversmann, 1848)

This is one of the most frequent and abundant psammophilous species in sandy dunes, sandy soils and xeric localities in the Pannonian region of Slovakia, reaching the NW range margin in Slovakia (Hochkirch *et al.* 2016), while the last single site is known recently from neighbouring Czechia (Holuša *et al.* 2013). The species was first registered in Slovakia by Frivaldszky (1868). We found it at more than 60 sites and in 7.4% grid cells up to 350 masl. in the last 20 years (Fig. 6). The most abundant populations (> 100 ind/1000 m^2) were recorded in the SW of the country (sandy areas in the Danube lowland north up to Nitra, a sandy area in the Záhorie region and the xeric steppes around Bratislava), SE Slovakia (Veľký Kamenec, Horeš, Somotor, Kráľovský Chlmec, Beša) and less abundant populations were found in C Slovakia (aluvial sandy habitats along the Ipeľ River).

Omocestus petraeus (Brisout de Barneville, 1856)

This Ponto-Mediterranean species is characterized as a petrophilous species inhabiting rocky steppes and sandy areas, and it reaches its northern range margin in S Slovakia and S Moravia. The first records from Slovakia were mentioned by Táborský (1933) from xeric habitats near Bratislava (Petržalka and Pezinok, W Slovakia). Later, the psammophilous form *O. p. psammophilus* was mentioned from the sandy areas of S Slovakia by Mařan (1954a) and Čejchan (1961). Chládek (1985) summarized its distribution in the former Czechoslovakia and from Slovakia mentioned seven xeric sites from SW and SE Slovakia. Recently (in the last 20 years) it is known from 22 xeric and lowland sites (3.1% of grid cells) in SW and SE Slovakia (Fig. 6).

Myrmeleotettix antennatus (Fieber, 1853)

This psammo- and xerothermophilous species has scattered distribution in Central Europe, and is extinct in several areas along the NW range margin (Hochkirch *et al.* 2016). It was first mentioned from the area of Slovakia without sampling details by Frivadszky (1868), but the first specimens were documented in July and September 1951 (sandy sites Somotor and Svätá Mária, E Slovakia) and August 1952 (sandy sites Čenkov and Chotín and xerotherm steppe near Štúrovo, SW Slovakia) (Mařan 1952c). In the last 20 years we found small populations or single specimens on 15 sandy sites of SE (Strážne, Opátske piesky, Veľký Kamenec, Horeš, Hrušov, Svätá Mária, Somotor, Kerestúr, Svätuše, Plešany, Moľva, Beša; e.g. Krištín *et al.* 2004a) and SW Slovakia (Čenkov, Mašán, Chotín, Nesvady, Révayovská Pustatina), altogether in 2.1% of grid cells (Fig. 6). The species inhabits well preserved sandy plots with scarce herbal vegetation (and species *Stipa* sp., *Gypsophila* sp., *Dianthus serotinus*, *Verbascum phoeniceum*); we found the highest abundance near the village Nesvady (Líščie diery: 3M, 4 F, August 2002) and the Čenkov sandy steppe (2M, 2F, July 2003) in SW Slovakia (Krištín *et al.* 2004b).

Stenobothrus fischeri (Eversmann, 1848)

This *Stenobothrus* species is the rarest species of the genus in Slovakia and reaches its NW range margin there (Hochkirch *et al.* 2016). The first record of this species (2F) in Slovakia was documented in July 1953 at the Čenkov sandy steppe (Mařan 1954a); later, the species was mentioned from Slovakia without sampling details by Gulička (1992). Within the last 20 years we confirmed this species only in the area of the Čenkov sandy steppe and forest steppe (SW Slovakia, Krištín *et al.* 2004b), and it has not been found at E Slovakian sandy sites (Krištín *et al.* 2004a, 2011)(Fig. 6). Similar to Hungary, the species was found in co-occurrence with other pseudopsamophiles: *M. antennatus*, *P. affinis*, *O. decorus* (i.e. Nagy 1958; Rácz 1986). Within the Čenkov area, we found the most abundant population in scarce herbal stands *(Stipa* sp., *Ephedra distachya*, *Dianthus serotinus)* in June (e.g. June 2000, 19M,

16F), less in July (July 2003—4 M, 10 F), and in September there were no specimens there. Hence, it is possible that it has not recorded more frequently as it is an "early season" species (Krištín *et al.* 2004b).

Chorthippus dichrous (Eversmann, 1859)

The species is distributed from SE Europe to C Asia, while in Europe it occurs from E Austria, SE Czechia and C Italy to S Greece and S Russia (Hochkirch *et al.* 2016). Slovakia is located on the northern edge of its range, when abundant populations were found in SE Slovakia (near Somotor and Svätá Mária villages) for the first time in July and September 1951 (Mařan 1954b). In the last 20 years we were able to confirm it at several sites of the East Slovakian Lowland (Krištín *et al.* 2011) and several grassland sites of SW and W Slovakia (e.g. Gavlas 1999), in total, at 20 sites and 3.8% of grid cells (Fig. 6). It was found mostly in wet grasslands, less in dry steppe habitats or in ruderal vegetation along river embankments and roads.

Euchorthippus declivus (Brisout de Barneville, 1848)

This species is widely distributed in Southern Europe from Spain to Ukraine. In Central Europe reaches the northern range margin in Slovakia and S Moravia (Hochkirch *et al.* 2016). In Slovakia, it was first time mentioned from Somotor (SE Slovakia) by Chyzer (1897) and later recorded and published from several sites in S Slovakia by Mařan (1954a). Holuša (1996) summarized the distribution in Slovakia up to 1996, with records at 23 sites in W and S Slovakia. During the last 20 years, we found the species very frequently, altogether at 403 sites and in 33.7% of grid cells) in lowland and hilly areas of the entire Pannonian area of S Slovakia nearly up to 49 °N (Fig. 6). It is locally the most abundant grasshopper species and inhabits mainly dry to semi-dry grasslands and ruderal vegetation at elevations between 100 and 930 masl. (Panská Javorina Mt in Považský Inovec Mts, W Slovakia). In neighbouring Czechia and Austria is considered as an expanding species (Holuša *et al.* 2007; Zuna-Kratky *et al.* 2017).

Euchorthippus pulvinatus (Fischer von Waldheim, 1846)

The species occurs in Europe from Slovakia and Hungary in the north, to Greece, European Turkey in the south and eastern European Russia in the east and is missing in W Europe (Hochkirch *et al.* 2016). The first record in Slovakia was documented on August 1945 at two sites near Bratislava (W Slovakia) (Görtler 1946). Later, the species was mentioned from S Slovakia by Mařan (1954a) without the sampling details. In Slovakia, it is less frequently distributed as *E. declivus*, when within the last 20 years we confirmed this species at almost 90 sites (10.7% of grid cells, Fig. 6) in lowland and hilly areas of the entire Pannonian area of Slovakia (e.g. Krištín *et al.* 2004a,b, 2011). It was found sometimes together with congeneric *E. declivus* but was mostly less abundant. It inhabits mainly dry, warm grasslands, salt marshes and steppes with short swards, less often at the edge of forests or on oak forest steppes.

4. Published species without viable populations in Slovakia

Anacridium aegyptium (Linnaeus, 1764)

This species has a Circum-Mediterranean distribution in Europe and is considered to be only introduced to Slovakia, similar as in neighbouring countries (Zuna-Kratky *et al.* 2017). Sometimes it was introduced into new areas together with agricultural products (Obenberger 1926). In Slovakia, the occurrence data was recorded even in winter (1F, December 2003, Wiezik & Gavlas 2004), and no viable population has thus far been found in Slovakia.

5. Species missing in Slovakia for more than 50 years

Leptophyes boscii Fieber, *1853*

This Balkan species has limited distribution in S Europe (Hochkirch *et al.* 2016) with its northern range margin in the SW Czechia near Český Krumlov (Kočárek *et al.* 2005; Marhoul *et al.* 2019). It was first recorded in Slovakia near Devín (2 M, August 18, 1929, J. Roland ex Schneeberg 1931), later under Heštún Mt near Pernek (august 1953, Gulička 1954); both sites are located in the westernmost Slovakia. Gulička (1967) also mentioned it from E Slovakia (Senderov near Vinné), but it was probably misidentified with *Leptophyes discoidalis*, which he did not

mention and recently is relative frequent there. Since that time it has not been found in Slovakia, when the nearest occurrence is still known from Vienna forest Mts, W of Vienna, some 40 km from the Slovak border (Zuna-Kratky *et al.* 2017). The occurrence data from W Slovakia needs updated information.

Tetrix fuliginosa (Zetterstedt, 1828)

The species is distributed in the boreal area of the N Europe, mostly beyond 60 °N and the data from Poland and Slovakia are doubtful (Hochkirch *et al.* 2016). In Slovakia, it was first recorded in July 1964 near Oravská Polhora (NW Slovakia, 1M, Čejchan 1983b). Only one new site (Kremnické vrchy Mts) has been mentioned in Slovakia since then (Kočárek *et al.* 2005), updated information is needed.

Acrotylus longipes (Charpentier, 1845)

This species was mentioned in Slovakia only once, from a sandy site near Kráľovský Chlmec (SE Slovakia) by Gulička (1992), but without the sampling details. The nearest sites to Slovakia are located in C and S Hungary (Nagy 1958; Nagy 2005; Hochkirch *et al.* 2016), and we suggest that it can occur rarely at sandy sites of S Slovakia.

Aiolopus strepens (Latreille, 1804)

This well flying species has Mediterranean distribution, when the northernmost occurrence was documented in C and S Hungary (Nagy 1958; Nagy 2005; Hochkirch *et al.* 2016), which is the nearest distribution to Slovakia. It has never been recorded in Austria (Zuna-Kratky *et al.* 2017). Only a single occurrence (1 F found) in Slovakia was published, from the Bratislava area (W Slovakia) by Táborský (1933).

Epacromius coerulipes

This halophytic and thermophilous species has very local distribution in C Europe and in the Pannonian Basin; it is distributed around the Neusiedler See in Austria (Zuna-Kratky *et al.* 2017) and in C, E and S Hungary, mainly in salt marshes (Hochkirch *et al.* 2016). It was recorded only once in Slovakia, in a salt steppe near Kamenín (SW Slovakia, 1 adult) during autumnal sampling (Mařan 1954a). Updated information from Slovakia is highly needed, as the occurrence can be expected in SW and SE Slovakia near the Austrian and Hungarian sites.

Calliptamus barbarus (Costa, 1836)

This species is widely distributed from N Africa across W and S Europe to China, Mongolia and India. In Europe, it occurs from the Canary Islands (Spain) to Cyprus and from the Normandy (France) to S Russia. In Slovakia, it has been found only at the warmest sandy sites. It was first recorded there in July and September 1951, in Somotor and Svätá Mária (SE Slovakia), and later in August 1952 in Čenkov (SW Slovakia) as an abundant species by Mařan (1952a, b) and Čejchan (1961). Mařan (l.c.) considered it as a pseudopsammophilous species occurring together with rare species as *A. ungarica*, *M. antennatus* and *O. decorus*. Despite intensive surveys and checking the genitals of several hundreds of *Calliptamus* specimens, new data on occurrence from the last 20 years are missing. However, we suggest, the species can still survive at sandy sites, as the nearest common occurrence is known in NW Hungary (Kenyeres *et al.* 2019).

Celes variabilis (Pallas, 1771)

This species has been found at only five sites, all of them more than 50 years ago: It was first recorded in Slovakia by Chyzer (1897) from the Somotor site (E Slovakia); later, Görtler (1946) confirmed the species at the same site (2 ind., August 1936). Mařan (1952c, 1954) published records from the sites Čenkov (S Slovakia, 1 ind., August 1952) and Chotín (S Slovakia, without sampling details). The last records in Slovakia were probably published by Čejchan (1957) from the village Sekule (W Slovakia, 4M, 4F, August 1955). Gulička (1974) mentioned an occurrence without sampling details from Devínska Kobyla (W Slovakia). In spite of the increased sampling effort at all of these sites and similar habitats in the last 20 years, we could not confirm this species. The nearest recent known area of *C. variabilis* occurrence is in Austria (Zuna-Kratky *et al.* 2017), some 60 km distant W of the Slovak border.

Locusta migratoria (Linnaeus, 1758)

The species is widespread in Africa and Eurasia. In Europe, it is found in the Mediterranean, but swarms of this species have also reached northern European countries in the past and reproduced there occasionally (Hochkirch *et*

al. 2016). In Slovakia, it was recorded more frequently in the past (Kočárek *et al.* 2005), and the last documented record (Malženice near Trnava, 1F, in 1948) was found with a photo in the written inheritance of Slovak orthopterologist Ján Gulička (Krištín & Tuček 2019). Species records in Poland in 2001–2017 suggest the possibility of a recent occurrence of this species in Slovakia (Żurawlew *et al.* 2019).

6. Species with a debatable taxonomic position

Tetrix bipunctata (Linnaeus, 1758) & *Tetrix kraussii* Saulcy, 1888

The taxonomic status of these two taxa of the "*Tetrix bipunctata* agg." has not been definitely settled (Lehmann 2004; Zuna-Kratky *et al* 2017). Thus far, only data on *Tetrix bipunctata* have been published within Czechia, Slovakia and the Pannonian basin (Mařan & Čejchan 1977; Kočárek *et al.* 1999; Kočárek *et al.* 2005; Nagy 2005, l.c.).

Platycleis albopunctata (Goeze, 1778) & *Platycleis grisea* (Fabricius, 1781)

Both of these species are considered as valid species (Cigliano *et al.* 2020). In neighbouring Czechia, they are considered as subspecies, with *P. a. albopunctata* distributed in the W of country and *P. a. grisea* only in the southeast (Kočárek *et al.* 2005). In Austria, they are treated as valid species, while *P. grisea* is widely distributed there, frequently abundant in the E of the country, and *P. albopunctata* only in its westernmost margin (Zuna-Kratky *et al.* 2017). In Poland, *P. albopunctata* is widely distributed in the W and N, while *P. grisea* only in the SE of the country (Bazyluk & Liana 2000, www.orthoptera.pl). In this checklist we considered *P. grisea* as a valid species, occurring widely (574 sites and 48.4% of grid cells) in Slovakia. Thus far, we have no evidence on the occurrence of *P. albopunctata* in Slovakia.

7. Published, but unclearly documented or misidentified species

Barbitistes ocskayi Charpentier, 1850

This Balkan species was mentioned from NE Slovakia (Stužica, 1F, August 1957) probably by mistake in the paper of Čejchan (1958a). The nearest and isolated distribution is known in S Slovenia and N Croatia, with a more continual range in NW Bulgaria, SW Romania, C Serbia, southern Bosnia and Herzegovina, Montenegro, Albania and NW Greece (Hochkirch *et al.* 2016).

Poecilimon elegans Brunner von Wattenwyl, 1878

The species was mentioned by Zacher (1910) from the Chočské vrchy Mts (June 1907), probably by mistake, since the species has limited distribution along the Adriatic Sea in Italy, S Slovenia and N Croatia (Hochkirch *et al.* 2016).

Pholidoptera littoralis (Fieber, 1853)

The species was mentioned probably by mistake in the papers of Chyzer (1897) and Görtler (1946) and with a question mark also in the first Czechoslovak checklist (Mařan & Čejchan 1977). However, the nearest distribution is in southernmost Hungary (Nagy *et al.* 2003), in Romania and the Mediterranean (Hochkirch *et al.* 2016), and actually we exclude its occurrence in Slovakia.

Tessellana tessellata (Charpentier, 1825)

This species was mentioned by mistake in a paper of Gulička (1967), as the species is distributed far from Slovakia in SW and SE Europe and SE from E Ukraine (Hochkirch *et al.* 2016).

Gampsocleis abbreviata Herman, 1874

This species was mentioned by mistake in a paper by Majzlan & Fedor (1997), since the species is distributed along the Mediterranean Sea from S Slovenia to S Greece (Hochkirch *et al.* 2016).

Oedipoda germanica (Latreille, 1804)

This species was mentioned by mistake in a paper by Majzlan *et al.* (2000). The nearest isolated populations occur in NW Czechia and more continual distribution is farther away in W and SW Europe (Kočárek *et al.* 2005; Hockirch *et al.* 2016).

Isophya tatrica Mařan 1957, *Gomphocerus sibiricus* Linnaeus, 1767, *Melanoplus frigidus* (Boheman, 1834)

The occurrence of these three species is mentioned from the High Tatra Mts (N Slovakia) without sampling date, site and material examined (Majzlan 1994). *I. tatrica* is nomen nudum, and the specimens belong to the species *Isophya camptoxypha* (Kočárek & Holuša 2007). The species *Gomphocerus sibiricus* and *Melanoplus frigidus* have boreo-alpine distribution in the Alps and Mediterranean Mountains as well in N and NE Europe (Hochkirch *et al.* 2016); we have excluded their occurrence in Slovakia.

Chorthippus eisentrauti (Ramme, 1931)

This species is distributed only in the Alps (Hochkirch *et al.* 2016; Zuna-Kratky *et al.* 2017). However, Chládek (2003a) mentioned this difficult-to-determine species as the first record in Slovakia from the Pieniny Mts (N Slovakia) from August 1981 (3 M and 3 F). We could not confirm the species in spite of frequent sampling in the area during the last 20 years.

Isophya pyrenaea Serville, 1839

This species is distributed only in France and N Spain and was mistaken with *I. kraussii*, *I. camptoxypha*, *I. pienensis* and *I. brevicauda* in several orthopterological publications from C Europe (Hochkirch *et al.* 2016). The species *Isophya kraussii* Brunner von Wattenwyl, 1878, was published in the first Czechoslovak checklist (Mařan & Čejchan 1977) under the name *I. pyrenaea.* Later, in the second checklist it was already corrected and accepted in the literature as *Isophya kraussii* (Kočárek *et al.* 1999, 2005).

8. Expected species registered in the vicinity of Slovakia

Poecilimon brunneri (Frivaldszky, 1868)

The species has a SE European type of distribution and is widely distributed on the SE Balkan Peninsula. It has an isolated subpopulation in Hungary and occurs from mid-Serbia and S and E Romania to N Greece and Turkey. The isolated site in Hungary is located E of Budapest near Gödöllö (Nagy 2003b, 2005), some 50 km SE of the Slovak border.

Gryllotalpa stepposa Zhantiev, 1991

In Europe, this widely distributed species has been reported from Hungary and the E Balkans (Hochkirch *et al.* 2016). N Hungary near Slovakia seems to be the NW range margin (Iorgu *et al.* 2016), and so the species may be overlooked in Slovakia.

Myrmecophilus nonveilleri Ingrisch & Pavićević, 2008

The Serbian Ant-cricket is known from W Serbia, Bulgaria and Hungary; its distribution is generally poorly understood, and it is also likely to occur in Slovakia (Hochkirch *et al.* 2016).

Troglophilus cavicola (Kollar, 1833)

This cave-dwelling species is frequently distributed in neighbouring Austria (SW of Vienna), with regular occurrence some 80 km W from Slovakia (Zuna-Kratky *et al.* 2017) and it could perhaps also be found in similar habitats in Slovakia.

Dociostaurus maroccanus (Thunberg, 1815)

This species was recorded several times in Hungary during its outbreaks (Nagy 1990, 1994). It was found, e.g. in the Bükk Mts, Szentlélek, some 20 km S of the Slovak border. It is possible, after the occurrence of a mass outbreak in Hungary that a swarm could reach Slovakia. However, outbreaks of this species have generally become rare (Latchininsky 1998).

Stenobothrus rubicundulus Kruseman & Jeekel, 1967

The species was mentioned with a question mark in the first Czechoslovak Orthoptera checklist (Mařan & Čejchan 1977). It is endemic to Europe, where it occurs on the Balkan Peninsula from the Peloponnesus to Austria and the SW Carpathians, in N Italy and the Alps to SE France (Hochkirch *et al.* 2016). The regular species occurrence in the Mödling area (SW of Vienna; Zuna Kratky *et al.* 2017), some 60 km SW of the Slovak border, suggests the possible occurrence in Slovakia.

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APPENDIX 1. List of 129 Orthoptera species recorded in Slovakia up to 2019 (* – species with maps in Figures 4–6; F%sites – relative frequency of occurrence within 1998 sites; F%cells – relative frequency of occurrence within 430 grid cells; biogeographical regions: P – Pannonian, A – Alpine; ? – uncertain occurrence; RL – IUCN Red list categories and criteria).

Taxon	F%sites	F%cells	Bioregion		Red list		Listed in previous checklists	
	n=1988	n=430	P	A	RL Category	RL Criteria	Mařan & Čejchan (1977)	Kočárek *et al.* (1999)
ENSIFERA								
TETTIGONIIDAE								
Phaneroptera falcata (Poda, 1761)	33.8	61.6	P	A	LC		+	+
Phaneroptera nana Fieber, 1853*	8.1	22.0	P	A	LC			+
Leptophyes albovittata (Kollar, 1833)	49.3	71.8	P	A	LC		+	+
Leptophyes boscii Fieber, 1853	0	0	P		DD		+	+
Leptophyes discoidalis (Frivaldsky, 1867)*	1.0	3.3	P	A	NT			+
Leptophyes punctatissima (Bosc, 1792)*	0.1	0.2	P		NA			
Barbitistes constrictus Brunner von Wattenwyl, 1878	11.8	23.4	P	A	LC		+	+
Barbitistes serricauda (Fabricius, 1798)*	0.1	0.5	P	A	NT		+	+
Isophya beybienkoi Mařan, 1958*	0.3	1.0	P	A	CR	B1ab (iii,v)	+	+
Isophya camptoxypha (Fieber, 1853)	4.8	10.0		A	LC		as *I. brevipennis*	+
Isophya costata Brunner von Wattenwyl, 1878*	0.1	0.2	P		CR	B1ac		
Isophya fatrensis Chládek, 2007*	1.7	2.6		A	NT			
Isophya kraussii Brunner von Wattenwyl, 1878	11.5	23.4	P	A	LC		as *I. pyrenaea*	+
Isophya modesta (Frivaldsky, 1867)*	0.5	1.2	P	A	VU	B1ac		
Isophya modestior Brunner von Wattenwyl, 1882*	0.1	0.5	P	A	DD			
Isophya pienensis Mařan, 1954	7.0	11.9		A	NT		+	overlooked
Isophya posthumoidalis Bazyluk, 1971	0.9	1.4		A	NT			+
Isophya stysi Čejchan, 1957	4.2	8.6	P	A	NT		as *I. modestior stysi*	+
Poecilimon fussii Fieber, 1878*	0.4	0.5	P		CR	B1ac	+	+
Poecilimon intermedius (Fieber, 1853)*	0.1	0.5	P	A	EN	B1ac, D		+
Poecilimon schmidtii (Fieber, 1853)*	3.6	7.2	P	A	LC		+	+
Polysarcus denticauda (Charpentier, 1825)	4.4	9.8	P	A	LC		+	+

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APPENDIX 1. (Continued)

	F%sites	F%cells	Bioregion		Red list		Listed in previous checklists	
	n=1988	n=430	P	A	RL Category	RL Criteria	Mařan & Čejchan (1977)	Kočárek *et al.* (1999)
Meconema thalassinum (Degeer, 1773)	13.3	30.5	P	A	LC		+	+
Meconema meridionale Costa, 1860*	0.4	1.4	P	A	NA			
Conocephalus fuscus (Fabricius, 1793)	20.4	43.4	P	A	LC		+	+
Conocephalus dorsalis (Latreille, 1804)	5.1	14.8	P	A	LC		+	+
Ruspolia nitidula (Scopoli, 1786)	15.6	34.4	P	A	LC		+	+
Tettigonia cantans (Fuessli, 1775)	45.7	55.6	P	A	LC		+	+
Tettigonia caudata (Charpentier, 1842)	1.8	5.0	P	A	LC		+	+
Tettigonia viridissima (Linnaeus, 1758)	41.3	70.4	P	A	LC		+	+
Decticus verrucivorus (Linnaeus, 1958)	45.0	64.7	P	A	LC		+	+
Gampsocleis glabra (Herbst, 1786)*	0.9	1.4	P		EN	B2ab (i-v)	+	+
Platycleis affinis Fieber, 1853*	0.8	2.4	P		NT		+	+
Platycleis grisea (Fabricius, 1781)	28.4	48.4	P	A	LC		+	+
Montana montana (Kollar, 1833)	0.7	1.7	P		NT		+	+
Tesselana veyseli (Koçak, 1984)*	2.9	8.6	P	A	LC		+	+
Bicolorana bicolor (Philippi, 1830)	39.5	64.9	P	A	LC		+	+
Metrioptera brachyptera (Linnaeus, 1761)	18.4	27.4	P	A	LC		+	+
Roeseliana roeselii (Hagenbach, 1822)	70.4	92.1	P	A	LC		+	+
Pholidoptera aptera (Fabricius, 1793)	18.9	25.1	P	A	LC		+	+
Pholidoptera fallax (Fischer, 1853)	4.7	6.4	P	A	LC		+	+
Pholidoptera frivaldszkyi (Herman, 1871)*	0.8	1.2		A	EN	B1ac	+	+
Pholidoptera griseoaptera (De Geer, 1773)	63.9	84.0	P	A	LC		+	+
Pholidoptera transsylvanica (Fischer, 1853)*	3.2	5.3	P	A	NT		+	+
Pachytrachis gracilis (Brunner von Wattenwyl, 1861)*	0.7	1.4	P		CR	B1abc		+
Rhacocleis germanica (Herrich-Schäffer, 1840)*	1.3	2.9	P	A	VU	B1ac	+	+
Ephippiger ephippiger (Fiebig, 1784)	9.6	17.2	P	A	LC		+	+
Saga pedo (Pallas, 1771)	0.7	2.1	P	A	CR	B1abc	+	+

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APPENDIX 1. (Continued)

	F%sites	F%cells	Bioregion		Red list		Listed in previous checklists	
	n=1988	n=430	P	A	RL Category	RL Criteria	Mařan & Čejchan (1977)	Kočárek *et al.* (1999)
RHAPHIDOPHORIDAE								
Tachycines asynamorus Adelung, 1902	0.1	0.5	P	A	LC		+	+
GRYLLOTALPIDAE								
Gryllotalpa gryllotalpa (Linnaeus, 1758)	6.5	16.5	P	A	LC		+	+
MYRMECOPHILIDAE								
Myrmecophilus acervorum (Panzer, 1799)	1.7	5.7	P	A	LC		+	+
GRYLLIDAE								
Nemobius sylvestris (Bosc, 1792)	1.6	4.3	P	A	LC		+	+
Pteronemobius heydenii (Fischer, 1853)	1.6	6.0	P		LC		+	+
Acheta domesticus (Linnaeus, 1758)	1.1	4.8	P	A	LC		+	+
Eumodicogryllus bordigalensis (Latreille, 1804)	1.1	3.8	P		LC		+	+
Gryllus campestris Linnaeus, 1758	29.6	48.9	P	A	LC		+	+
Melanogryllus desertus (Pallas, 1771)	3.4	11.0	P	A	LC		+	+
Modicogryllus frontalis (Fieber, 1844)	1.9	7.4	P	A	LC		+	+
Oecanthus pellucens (Scopoli, 1763)	31.5	49.6	P	A	LC		+	+
CAELIFERA								
TRIDACTYLIDAE								
Xya pfaendleri Harz, 1970	1.5	5.0	P		NT		+	+
Xya variegata (Latreille, 1809)	0.8	2.4	P		NT		+	+
TETRIGIDAE								
Tetrix bipunctata (Linnaeus, 1758)	12.2	31.0	P	A	LC		+	+
Tetrix bolivari Saulcy, 1901*	2.1	7.6	P		NT		+	+
Tetrix ceperoi (Bolívar, 1887)*	0.1	0.5	P		DD			+
Tetrix fuliginosa (Zetterstedt,1828)	0	0		A	DD		+	+
Tetrix subulata (Linnaeus, 1758)	11.9	29.4	P	A	LC		+	+

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APPENDIX 1. (Continued)

	F%sites	F%cells	Bioregion		Red list		Listed in previous checklists	
	n=1988	n=430	P	A	RL Category	RL Criteria	Mařan & Čejchan (1977)	Kočárek *et al.* (1999)
Tetrix tenuicornis (Sahlberg, 1893)	14.5	39.9	P	A	LC		+	+
Tetrix tuerki (Krauss, 1876)	0.7	2.4		A	VU	B2ac	+	+
Tetrix undulata (Sowerby, 1806)	2.5	9.5	P	A	LC		?	+
ACRIDIDAE								
Calliptamus barbarus (Costa, 1836) only reprod. sites	0	0	P		DD		+	+
Calliptamus italicus (Linnaeus, 1758)	29.3	48.9	P	A	LC		+	+
Paracaloptenus caloptenoides (Brunner von Wattenwyl, 1861)*	0.7	1.0	P	A	CR	B1abc		
Anacridium aegyptium (Linnaeus, 1764)*	0	0	P	A	NA		+	+
Miramella alpina (Kollar, 1833)*	6.6	10.5		A	LC		+	+
Capraiuscola ebneri (Galvagni, 1953)*	0.1	0.2		A	LC		+	+
Odontopodisma decipiens Ramme, 1951*	0.2	0.5	P	A	VU	B2ac	+	+
Odontopodisma rubripes (Ramme, 1931)*	0.8	2.6	P	A	VU	B1ac	+	+
Podisma pedestris (Linnaeus, 1758)	1.9	5.3		A	LC		+	+
Pseudopodisma nagyi Galvagni et Fontana, 1996*	2.6	5.7		A	LC		+	+
Pseudopodisma transilvanica Galvagni et Fontana, 1993*	0.2	0.2		A	DD			+
Pezotettix giornae (Rossi, 1794)*	6.6	10.5	P		VU	B1ac		+
Acrida ungarica (Herbst, 1786)*	1.0	2.9	P		VU	B1ac	+	+
Mecostethus parapleurus (Hagenbach, 1822)	4.9	14.1	P	A	NT		+	+
Stethophyma grossum (Linnaeus, 1758)	3.2	9.3	P	A	LC		+	+
Acrotylus insubricus (Scopoli, 1786)*	0.2	0.5	P		CR	B1ac	+	+
Acrotylus longipes (Charpentier, 1845)	0	0	P		DD			+
Aiolopus strepens (Latreille, 1804)	0	0	P		DD			+
Aiolopus thalassinus (Fabricius, 1781)	3.4	7.6	P		LC		+	+
Epacromius coerulipes (Ivanov, 1887)	0	0	P		DD		+	+
Celes variabilis (Pallas, 1771)	0	0	P		RE		+	+

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APPENDIX 1. (Continued)

	F%sites	F%cells	Bioregion		Red list		Listed in previous checklists	
	n=1988	n=430	P	A	RL Category	RL Criteria	Mařan & Čejchan (1977)	Kočárek *et al.* (1999)
Locusta migratoria Linnaeus, 1758	0	0	P		NA		?	overlooked
Oedaleus decorus (Germar, 1826)*	0.9	2.9	P		NT		+	+
Oedipoda caerulescens (Linnaeus, 1758)	21.5	39.4	P	A	LC		+	+
Psophus stridulus (Linnaeus, 1758)	8.4	16.0		A	NT		+	+
Sphingonotus caerulans (Linnaeus, 1767)	1.5	5.3	P	A	NT		+	+
Arcyptera fusca (Pallas, 1773)	2.7	5.0		A	NT		+	+
Chrysochraon dispar (Germar, 1834)	48.5	79.0	P	A	LC		+	+
Euthystira brachyptera (Ocskay, 1826)	71.0	82.8	P	A	LC		+	+
Dociostaurus brevicollis (Eversmann, 1848)*	3.2	7.4	P		LC		+	+
Omocestus haemorrhoidalis (Charpentier, 1825)	28.9	58.0	P	A	LC		+	+
Omocestus petraeus (Brisout de Barneville, 1856)*	1.2	3.1	P		NT		+	+
Omocestus rufipes (Zetterstedt, 1821)	12.6	27.2	P	A	LC		+	+
Omocestus viridulus (Linnaeus, 1758)	28.7	39.4	P	A	LC		+	+
Stenobothrus crassipes (Charpentier, 1825)	9.0	16.9	P	A	LC		+	+
Stenobothrus eurasius Zubovskii, 1898	1.2	2.6	P	A	VU	B2ac	+	+
Stenobothrus fischeri (Eversmann, 1848)*	0.2	0.5	P		CR	B1ac	+	+
Stenobothrus lineatus (Panzer, 1796)	44.0	67.1	P	A	LC		+	+
Stenobothrus nigromaculatus (Herrich-Schäffer, 1840)	3.5	6.4	P	A	LC		+	+
Stenobothrus stigmaticus (Rambur, 1838)	6.3	12.2	P	A	LC		+	+
Gomphocerippus rufus (Linnaeus, 1758)	26.2	52.3	P	A	LC		+	+
Myrmeleotettix antennatus (Fieber, 1853)*	0.8	2.1	P		EN	B2ac	+	+
Myrmeleotettix maculatus (Thunberg, 1815)	3.1	9.1	P	A	LC		+	+
Stauroderus scalaris (Fischer de Waldheim, 1846)	0.1	0.2		A	DD		+	+
Chorthippus albomarginatus (Degeer, 1773)	15.1	35.6	P	A	LC		+	+
Chorthippus apricarius (Linnaeus, 1758)	47.5	75.9	P	A	LC		+	+

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APPENDIX 1. (Continued)

	F%sites	F%cells	Bioregion		Red list		Listed in previous checklists	
	n=1988	n=430	P	A	RL Category	RL Criteria	Mařan & Čejchan (1977)	Kočárek *et al.* (1999)
Chorthippus biguttulus (Linnaeus, 1758)	57.7	91.9	P	A	LC		+	+
Chorthippus brunneus(Thunberg, 1815)	55.9	85.7	P	A	LC		+	+
Chorthippus dichrous (Eversmann, 1859)*	1.1	3.8	P		LC		+	+
Chorthippus dorsatus (Zetterstedt, 1821)	49.1	80.0	P	A	LC		+	+
Chorthippus mollis(Charpentier, 1825)	24.3	45.8	P	A	LC		+	+
Chorthippus oschei Helversen, 1986*	9.2	19.8	P	A	LC			
Chorthippus pullus (Phillipi, 1830)	0.7	2.1		A	VU		+	+
Chorthippus smardai Chládek, 2014*	0.1	0.2		A	DD			
Chorthippus vagans (Eversmann, 1848)	6.8	19.3	P	A	LC		+	+
Pseudochorthippus montanus (Charpentier, 1825)	14.4	37.2	P	A	LC		+	+
Pseudochorthippus parallelus (Zetterstedt, 1821)	80.0	95.9	P	A	LC		+	+
Pseudochorthippus tatrae (Harz, 1971)*	1.5	3.6		A	DD			+
Euchorthippus declivus (Brisout de Barneville, 1848)*	20.0	33.7	P	A	LC		+	+
Euchorthippus pulvinatus (Fischer von Waldheim, 1846)*	4.6	10.7	P		LC		+	+