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Distribution and Decline of *Bradyporus dasypus* (Illiger, 1800) (Orthoptera: Tettigoniidae) in Serbia and the Republic of Macedonia

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Abstract: *Bradyporus dasypus* (Illiger, 1800) is known to inhabit the eastern parts of the Balkan Peninsula but the knowledge on its distribution is largely based on old literature. In Serbia, we could not confirm this cricket from localities reported during the previous centuries. It probably demises here, limiting the range to only a few recent populations in the southernmost parts of the country. The distribution of this species is better understood in the Republic of Macedonia where the historical distribution roughly matches the recent one. *Bradyporus dasypus* is known from natural steppe, mixture of forests and steppe, and semi-natural habitats. A strong decline started from the north and was likely caused by increased human activity, changes in agricultural practices and overall habitat deterioration. This resulted in species extinction from Hungary and its listing as Endangered (EN) in Serbia. We suggest that this insect should receive greater conservation importance in the near future.

Key words: Orthoptera, Tettigoniidae, *Bradyporus dasypus*, insect conservation, Red List, threats, Serbia, Macedonia

Introduction

Bradyporus dasypus (Illiger, 1800) belongs to the subfamily Bradyporinae, commonly referred to as "armoured crickets". This insect is brachypterous, black-coloured, with a noticeable metallic, copper-like sheen. Being an attractive and easily recognisable species, it is relatively well studied, with a few recent publications summarising the knowledge of its biology, ecology and distribution (Iorgu 2009, Kolics *et al.* 2010, Lemonnier-Darcemont *et al.* 2009).

The centre of distribution of *B. dasypus* is located in the eastern parts of the Balkan Peninsula, with confirmed records from Northern Greece, Macedonia, Albania, Serbia, Bulgaria, European Turkey, Romania and Hungary (Harz 1969, Iorgu 2009, Kolics *et al.* 2010, Lemonnier-Darcemont *et al.* 2009, Tatu & Tăuşan 2012, Ünal 2011). Currently, the species is known to be extinct in Hungary (Kolics *et al.* 2010) and from some localities in Romania (Iorgu 2009) and Serbia (Grebenščikov 1949). The same applies to the rest of Serbia, where it was only recently rediscovered in the southernmost of the country and these records are published here. This finding triggered more detailed field surveys, inspection of museum collections and compilation of existing distribution data. It enabled us to compare the historical and recent distribution of this species and provided us with additional information on its conservation status and possible threats in Serbia and Macedonia.

Material and Methods

In order to summarise the known data on the distribution of *Bradyporus dasypus*, we carried out a detailed study of literature from public libraries and on-

line sources. Specimens from the insect collection of Mladen Karaman held at the Department of Biology and Ecology at the Faculty of Sciences in Novi Sad (now ZZDBE – Zoological Collection of Department of Biology and Ecology) and Dragan Pavićević's private collection were also included in this publication. In addition, we collected data from photographs and reliable field observations. All known historical localities in Serbia were systematically revisited in 2012 in order to verify the species presence. We surveyed wide areas near Belgrade, Niš, Prokuplje and Preševo but due to the political situation the localities in the region of Kosovo remained out of reach.

All data were georeferenced allowing us to use QGIS 2.8 (www.qgis.org) for creating final maps and analysing spatial data. We calculated area of occupancy (AOO) and extent of occurrence (EOO) parameters following the guidelines given by IUCN Standards and Petitions Subcommittee (2013). These parameters were used to assess *B. dasypus* national Red List status for Serbia and Macedonia using the IUCN (2012a, 2012b) criteria.

Results and Discussion

The available data on the distribution of *Bradyporus dasypus* in Serbia and Macedonia are given in Tables 1 and 2 (see also Fig. 1). It shows that historical localities in Serbia include a much wider region and there are only a few recent records in the very south of the country. Recent records from the Republic of Macedonia seem to match the historical distribution but, with the noticeable lack of recent surveys, some localities may require confirmation.

Records of *Bradyporus dasypus* in Serbia

The distribution of *B. dasypus* in Serbia was not reviewed in detail by any recent publications, although there are many literature records from the 19th and 20th century (Table 1). Some of the oldest historical data mentioned the species occurring in the vicinity of Belgrade (Brunner von Wattenwyl 1882, Us 1938) where it soon became extinct (Grebenščikov 1949). The rest of the published data presented records from the Eastern and South-eastern Serbia, including the surroundings of Niš (Us 1938, Vasiliu & Agapi 1958), Mramor (Brunner von Wattenwyl 1882) and Čamurlija (Đorđević 1926, cited in Adamović 1975). More southern records include Dobrič Plain near Prokuplje, vicinity of Vranje (Pančić 1883), Steževac hill near Priština, Bela Palanka, Temska and Pirot (Adamović 1975). Us & Matvejev (1967) also reported the species for Kosovo, but it is not clear whether this refers to the above mentioned locality near Priština. The collected material (D. P.) includes three additional records from eastern and southern parts of Serbia (Table 2).

All our recent records of *B. dasypus* in Serbia originate from Preševo valley in the south of the country. The first record came during a butterfly survey on June 4th 2011 (12:00 h) when we observed six specimens. The specimens were found on the eastern hills of Suva Reka gorge, on the ground, alongside a macadam road not intensively used during the last decades. The habitat was a mixture of grassy and bushy terrains with sparse vegetation, close to the trees. This record was also confirmed on June 6th (12:45 h) and July 19th 2013 (14:30 h), when a total of nine (three males, six females) and 13 specimens (12 males, one female) were observed, respectively. The males specimens recorded in 2013 were localised mostly on *Crataegus* bushes by their loud call sound, while the observed single female was found on the ground near two singing males. Another recent record came from Aleksandar Simović, who photographed a single specimen on Mt. Rujan in May 2014. This locality is close to the previous one, just on the other side of Preševo Valley. The vegetation was also sparse, regularly grazed, with small trees and bushes.

Records of *Bradyporus dasypus* in Macedonia

The literature records for Macedonia originate from the work are given by Karaman (1961), recording *B. dasypus* in Gevgelija, Demir kapija, Ržaničino (Skopje), Kumanovo and Makovo-Bitola. Recently, Lemonnier-Darcemont *et al.* (2009) compiled a distribution map for this species with a detailed overview of published and observed occurrences from the Balkan Peninsula. Several new observations from Macedonia are available in resolution of 20" (Table 1, Fig. 1). This bush-cricket was collected by Mladen Karaman on many other occasions and many records came from Dragan Pavićević's private insect and photo collection (Table 2).

The majority of recent *B. dasypus* records for Macedonia came from personal communications by Marjan Komnenov, who observed the species in Mariovo, Krivolak, Osogovo (Sokolarci) and Veles (Babuna River). Mikšić & Mikšić (pers. comm.) observed many specimens in July 1961 on bushes and grasses 2 km south-east of Gevgelija, at the Vardar River Plains. Dragan Pavićević also observed some adults there in a habitat overgrown by dense blackberry bushes (*Rubus* sp.) and occasionally heard males call in from K'r hill. This hill is surrounded by wheat fields and interlaced by military trenches from WW I.

Habitats of *Bradyporus dasypus*

It was already noted that *B. dasypus* inhabits European steppe and most likely has a Moesian origin (Popov 2007). However, it was found in a wide range of

Table 1. Summary of the literature records on *Bradyporus dasypus* from Serbia and the Republic of Macedonia

Long.	Lat.	Locality	Reference or legator
21.87	43.43		Lemonnier-Darcemont *et al.* 2009
20.82	42.77		Lemonnier-Darcemont *et al.* 2009
22.53	42.07		Lemonnier-Darcemont *et al.* 2009
21.86	41.73		Lemonnier-Darcemont *et al.* 2009
21.19	41.05		Lemonnier-Darcemont *et al.* 2009
21.52	41.39		Lemonnier-Darcemont *et al.* 2009
21.86	41.39		Lemonnier-Darcemont *et al.* 2009
22.5019	41.1432	Gevgelija	Karaman 1961
22.2447	41.4077	Demir Kapija	Karaman 1961
21.6316	41.9275	Ržaničino Skopje	Karaman 1961
21.7219	42.1400	Kumanovo	Karaman 1961
21.4811	41.0653	Makovo-Bitola	Karaman 1961
21.7837	43.3125	Mramor	Brunner von Wattenwyl 1882
21.8992	42.5513	Vranje	Pančić 1883
21.6171	43.2818	Dobrič	Pančić 1883
21.8496	43.3692	Čamurlija	Djorđević 1926 in Adamović 1955
20.5078	44.7361	Beograd	Grebečnikov 1949
20.5078	44.7361	Beograd	Brunner von Wattenwyl 1882
20.5078	44.7361	Beograd	Us 1938
22.3097	43.2127	Bela Palanka	Adamović 1975
21.2033	42.6214	Steževac	Adamović 1955
22.5709	43.1655	Pirot	Adamović 1975
22.5456	43.2616	Temska	Adamović 1975
22.0188	43.3091	Niš	Us 1938
22.0188	43.3091	Niš	Vasiliu, Agapi 1958

habitats, including overgrown agricultural areas, places near wheat fields, bushes of *Paliurus spina-christi* (Adamović 1975), forests, ruderal vegetation, road sides, steppic and sylvosteppic biotopes, forest fringes and glades (Iorgu 2009), semi-open biotopes, moorlands, high grasslands, overgrown wastelands, along forests (mostly oak and beech) and edges of extensive cereal crops (Lemonnier-Darcemont *et al.* 2009). *Bradyporus dasypus* is characterised as lowland species but was recorded up to 1300 – 1650 m a.s.l. in the Mediterranean (Lemonnier-Darcemont *et al.* 2009).

In general, the habitat of this cricket can be described as dry grasslands and pastures with scarce trees and bushes in the zone of the European steppe and deciduous forests. However, it was also found in some wetlands and near agricultural fields where traditional, extensive agriculture probably sustained grassland vegetation and enabled the species to survive in newly created semi-natural habitats. These habitats host a variety of other important species in Eastern Europe but are is nowadays threatened by agriculture intensification or abandonment and should receive greater conservation importance (Cremene *et al.* 2005, Sutcliffe *et al.* 2014).

Decline of *Bradyporus dasypus*

First signs of decline of *B. dasypus* in Serbia were observed by Grebenščikov (1949), reporting its extinction from the vicinity of Belgrade. Our short surveys covering the most of the known historical localities could not confirm the presence of the species at many of the sites, and records from the very south of the country remained the only confirmed data for Serbia in more than 50 years (Figs. 1, 2). Moreover, we did not observe this species during a detailed six-year insect study in Temska Village and its surroundings. The same applies to numerous surveys in the wider area of Ni[illegible]. P. since 1978, M. P. since 2006) and Belgrade (Đ. P. since 1971, M. Đ. since 2005).

In the Republic of Macedonia, our study was less systematic. Although it is possible that *B. dasypus* has disappeared from some of the historical localities, the remaining populations are more numerous and spread throughout the country. The southern position and different agricultural practices, with the most of habitats being grazed and not turned into agricultural fields, may prove crucial for the survival of *B. dasypus*. As there are no recent data from the north of Macedonia and most of the historical localities were not studied repeatedly, more detailed field

Table 2. New data on the distribution of *Bradyporus dasypus* from Serbia and the Republic of Macedonia gathered from insect collections (coll), photographs (photo) and field observations (obs). Collection authority refers to the private collection of Dragan Pavićević (D. P.) and Mladen Karaman (ZZDBE)

Long.	Lat.	Date	No. of specimens	Locality	Type	Collection authority	Legator
21.7839	43.3135	6.1909	1♀	Mramor	coll	D. P.	Đorđević
21.7219	42.1400	23.6.1947	1♂	Kumanovo	coll	ZZDBE	Mladen Karaman
21.6316	41.9275	2.7.1954	2♂	Ržaničino, Skopsko	coll	ZZDBE	Mladen Karaman
21.6313	41.9276	25.7.1954	2♂, 1♀	Ržaničino	coll	ZZDBE	Mladen Karaman
21.4073	41.9797	3.8.1954	1♀	Vodno	coll	ZZDBE	Mladen Karaman
21.5727	41.4727	10.6.1955	1♀	Babuna Mt.	photo		Guido Nonveiller
21.6372	40.9737	12.7.1956	2♂, 2♀	Skočivir	coll	ZZDBE	Mladen Karaman
21.6922	42.0939	21.7.1957	1♂	Romanovce	coll	ZZDBE	Mladen Karaman
21.6476	42.3122	12.6.1957	2♂, 1♀	Preševo	coll	D. P.	R. Lazarević
22.5289	41.1376	7.1961		Gevgelija 2km SE	obs		Mikšić & Mikšić
21.6922	42.0938	1.7.1962	1♂	Romanovce	coll	ZZDBE	Mladen Karaman
21.7734	40.9985	18.7.1967	12♂, 1♀	Kajmakčalan, Redir	coll	ZZDBE	Mladen Karaman
22.2407	41.4117	30.8.1967	1♀	Demir Kapija	coll	ZZDBE	Mladen Karaman
22.7166	41.1841	21.7.1970	1♂	Dojran	coll	ZZDBE	Mladen Karaman
21.4332	41.2011	3.8.1970	5♂	Prilep-Bitola	coll	ZZDBE	Mladen Karaman
21.6369	40.9738	7.1976	1♂	Nidže Mt., Skočivir	coll	D. P.	Z. Spirkoski
22.5395	41.1343	2.7.1982	7♂, 3♀	Gevgelija, K'r hill	coll	D. P.	Dragan Pavićević
21.6721	40.9614	19.6.1989	1♀	Nidze Mt.	coll	D. P.	Gabor Mesaroš
21.7670	42.3117	5.2013		Rujan Mt.	obs		Bojan Zlatković
22.1205	41.5276	23.6.2002		Krivolak	obs		Marjan Komnenov
22.1205	41.5276	5.7.2003		Krivolak	obs		Marjan Komnenov
21.9555	41.6967	6.2004	1♂, 1♀	Creska-Bekirlija	obs		Bratislav Grubač
21.7975	41.6814	4.6.2008	1♀	Veles, Babuna river	coll	D. P.	Marjan Komnenov
21.6501	42.2654	4.6.2011		Preševo, Suva reka	obs		Miloš Popović, Milan Đurić, Filip Franeta
20.6682	42.4064	6.2012	1f	Orahovac	coll	D. P.	Unknown
22.2736	41.8999	2.6.2012		Osogovo, Sokolarci	obs		Marjan Komnenov
21.6501	42.2673	16.6.2013	3♂, 6♀	Preševo, Suva reka	obs		Milan Đurić
21.6501	42.2673	19.7.2013	12♂, 1♀	Preševo, Suva reka	obs		Slobodan Ivković, Laslo Horvat
21.7986	41.6790	21.5.2013		Veles, Babuna river	obs		Marjan Komnenov
22.0231	41.8489	2013		Ovče polje	photo		Bojan Zlatković
21.7755	42.3134	5.2014		Rujan	photo		Aleksandar Simović
21.7033	41.0269	7.7.2014		Mariovo	obs		Marjan Komnenov

surveys are needed for an overall insight into the distribution and occurrence trends of this species.

The decline of *B. dasypus* started from the northern part of its geographical range, limiting its distribution to southern and eastern parts of the Balkan Peninsula (Fig. 2). It seems that this insect originated from the Balkans and spread with the increase in grassland areas after glaciations (Allen *et al.* 1999), grazing by wild animals and introduction of extensive human agricultural practices (Lemonnier-Darcemont *et al.* 2009, Sutcliffe *et al.* 2014). A similar pattern is found in another steppe species, the spadefoot toad, expanding from the Balkans and declining in recent history (Eggert *et al.* 2006) but also for the European ground squirrel (Koshev 2008, Kryjt[illegible] *et al.* 2009) and many steppe birds (Galushin 2004, Palacín & Alonso 2008, Tella *et al.* 1998). This decline was caused by large-scale changes in semi-natural steppe habitats due to abandonment, overgrowing, modern agriculture practices and urbanisation.

National Red List status

Assessing the species under IUCN criteria A was not possible as the species decline happened more than ten years ago, and it is not possible to estimate its de-

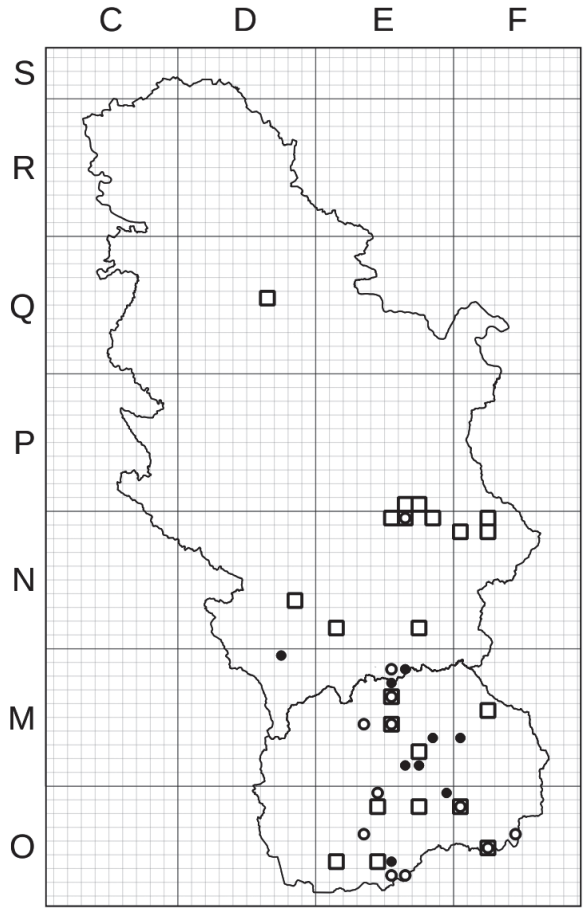

Fig. 1. Distribution of *Bradyporus dasypus* in Serbia and the Republic of Macedonia. Records are presented as 10×10 km points over a standard UTM map (Zone 34T). Squares indicate literature data; circles indicate unpublished observations, photographed specimens or data from insect collections. Unpublished records after 2000 are given as black circles

cline in the future due to lack of data. In addition, the absence of precise data on population size is limiting us to use only B criteria for assessing red list status of *Bradyporus dasypus*.

Total AOO and EOO for the species in Serbia are 8-32 km^2 and 297 km^2, respectively. The populations are severely fragmented and living in two isolated locations. Continuing decline may be inferred by decrease in habitat quality due to abandonment/intensification of agriculture, and from the overall trend in species distribution. There are no recently confirmed localities in the north of Republic of Macedonia, thus the rescue effect is unlikely to occur. Taking these facts into consideration, the species was qualified as Endangered (EN) in Serbia, criteria B1ab (i, ii, iii, iv) + 2ab (i, ii, iii, iv), but further studies on its distribution in Kosovo may downgrade its status.

In the Republic of Macedonia, the species was recently assessed as Least Concern according to the IUCN criteria (Lemonnier-Darcemont *et al.* 2014). According to data that were available in this study it may qualify to Lower Risk – Near Threatened (AOO = 12-120 km^2, EOO = 1857 km^2 and inferred continuing decline) and should be studied in more details.

Although there is no global initiative on *Bradyporus dasypus* protection, some steps were made to protect this cricket on a national level. Currently, it was included in the regional red lists for some areas in Romania (Iorgu 2009) and declared protected in Serbia (Official Gazette of Republic of Serbia No. 5/2010). In Bulgaria, the species is not regarded as threatened and is not protected under national law (Chobanov, pers. comm.).

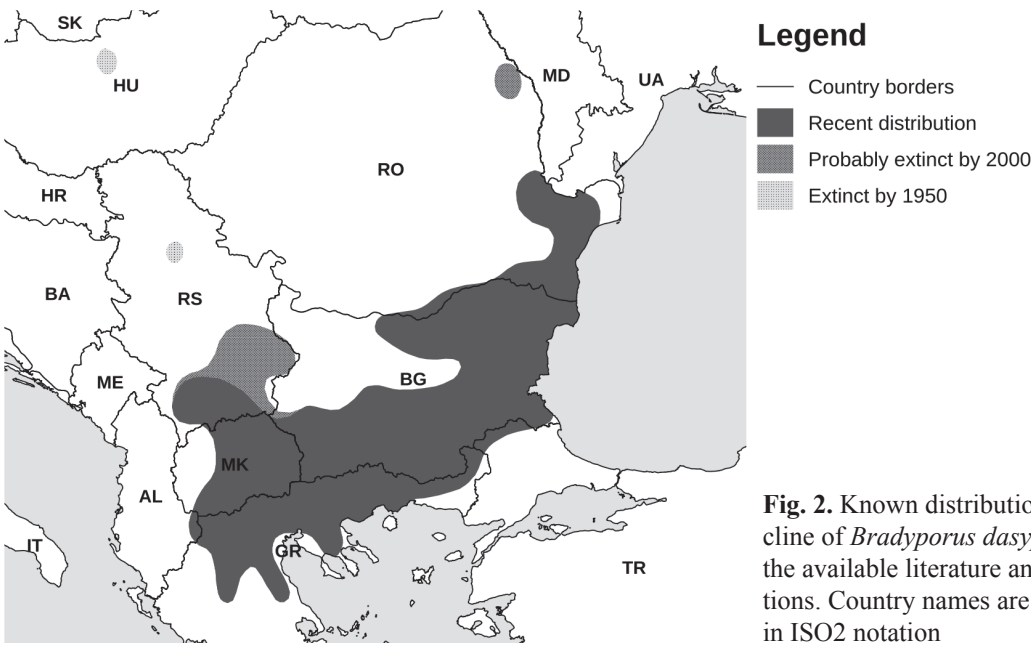

Fig. 2. Known distribution and observed decline of *Bradyporus dasypus* compiled from the available literature and field observations. Country names are given on the map in ISO2 notation

Conclusion

The data presented here indicate that *Bradyporus dasypus* may become threatened in the near future as a result of agriculture changes. In addition, it may serve as a good indicator species for the quality of semi-natural habitats of South-eastern Europe. More detailed studies on its distribution and ecology should help understanding species decline and plan its conservation.

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