NORTH-WESTERN JOURNAL OF ZOOLOGY 9 (1): 185-190
Article No.: 132101

http://biozoojournals.3x.ro/nwjz/index.html

A review of distribution and ecology of three Orthoptera species of European importance with contributions from their recent north-western range

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Received: 21. June 2011 / Accepted: 11. September 2012 / Available online: 26. December 2012 / Printed: June 2013

Abstract. We reviewed the distributions of three Orthoptera species, *Pholidoptera transsylvanica*, *Paracaloptenus caloptenoides* and *Odontopodisma rubripes*, which are of European importance according to the Habitats Directive. We analysed all available records about the population density, habitat selection and accompanying Orthoptera species in their habitats. Such information is fundamental for the management programmes which aim to maintain the species' favourable conservation status. However, due to limited data, these protected species remain largely unknown within their whole ranges.

Key words: bush-crickets, grasshoppers, biological conservation, endemism, Natura 2000.

Occurrence of ten Orthoptera species, listed in the Annex II of the Habitats Directive (Council Directive 92/43/EEC 1992, Consolidated version January 1, 2007), determines areas of the Natura 2000 network. Several of these species exhibit a considerable degree of endemism in Europe (Rácz 1998, Kenyeres et al. 2009). Despite this, data on their geographical range and ecology are unclear, very sketchy and often contradictory (e.g. Likovitch 1957, Nagy 1991, Rácz 1998, Nagy et al. 1999). However, such information is fundamental for management programmes which aim to maintain favourable conservation status of the species. Although a lack of data is common in protected insects (Samways et al. 2010), species such as *Pholidoptera transsylvanica* (Fischer, 1853), *Paracaloptenus caloptenoides (Brunner von Wattenwyl, 1861)* and *Odontopodisma rubripes* Ramme, 1931, represent one of the least known protected orthopterans within their whole ranges. Besides the legal protection in the European Union, the species *O. rubripes* is categorized as vulnerable applying the IUCN Red List criteria (IUCN 2010). Only relatively recently new records about the present northern range have been published for *P. caloptenoides* and *O. rubripes* (Gavlas 2005, Iorgu et al. 2008, Nagy et al. 2008, Berg 2009, Chobanov 2009, Nagy et al. 2010). These three species reach their current northern or north-western range in Slovakia, but data are rather deficient (Gavlas 2005, Krištín 2005). Hence, in this short note we aimed to reconstruct current geographical ranges and analyse data about the ecology of these species.

Based on the review of all available published (since 19th century) and our own field data, maps of the recent European distribution were updated and outlined. A distribution survey in Slovakia was carried in 945 sites of 367 squares of the Slovak Fauna Databank (DFS, dimensions of square: N6′ and E10′, ca. 132 km²) during April – November 1994–2012. The surveyed DFS squares represented 85% of all in the territory of Slovakia (n = 430). For each observation, the altitude, composition and height of the vegetation were recorded. Population density was quantified by sweeping the herb and shrub layer with hand-nets along 100 m transects of 1 m width (*P. caloptenoides* and *O. rubripes*). The abundance of *P. transsylvanica* was also assessed by stridulation of adult males (Jordan et al. 2003). All caught individuals were identified by hand. Furthermore, the presence of other accompanying Orthoptera species was recorded.

Pholidoptera transsylvanica

The species has paleoegeic and Ponto-Mediterranean origin, exhibiting endemic distribution in south-eastern Europe (Fig. 1A). The centre of its distribution area is in the Carpathian Mountains in Romania (Harz 1969, Kis 1980, Iorgu et al. 2008) and Ukraine (Likovitch 1957, Storozhenko & Gorochov 1992), and marginally in Hungary (Nagy et al. 1998, 1999, Jordán et al. 2003) and Serbia (Frivaldszkyi 1867, Čejchan 1958, Heller 2011). The northernmost occurrence was recorded in Slovakia (Čejchan 1989, Gavlas 2005, Krištín et al. 2009). The occurrence at the border area also suggests occurrence in Bieszczady Mountains in Poland, nevertheless, the species has not been identified in this country until recently (Theuerkauf et al. 2005). An occurrence of the species in southern European countries such as Croatia, Bosnia and Herzegovina is doubtful (Harz 1969, Heller 2011). Čejchan (1958) mentioned an occur-

rence in Bulgaria; however, it does not appear in current lists of Bulgarian Orthoptera species (Popov 2007, Chobanov 2009).

We found the species in 29 sites within 18 DFS squares in Slovakia (Fig. 2A, Appendix 1), 14 of these sites (48%) are located within the Sites of Community Importance (further SCI). Its local distribution is adjacent to the species' area in Ukraine (Likovitch 1957, Storozhenko & Gorochov 1992) and in Hungarian karst (Nagy et al. 1999, Jordán et al. 2003). Altitudes of sites in Slovakia ranged from 250 (Laborecká vrchovina Mts.) to 1200 m a.s.l. (Volovské vrchy Mts.), with an average of 567.1±250 m a.s.l. (n = 28 sites). In Romania, the upper altitudinal limit is shifted even higher (1675 m a.s.l., Harz 1969, 1760 m a.s.l., own unpublished

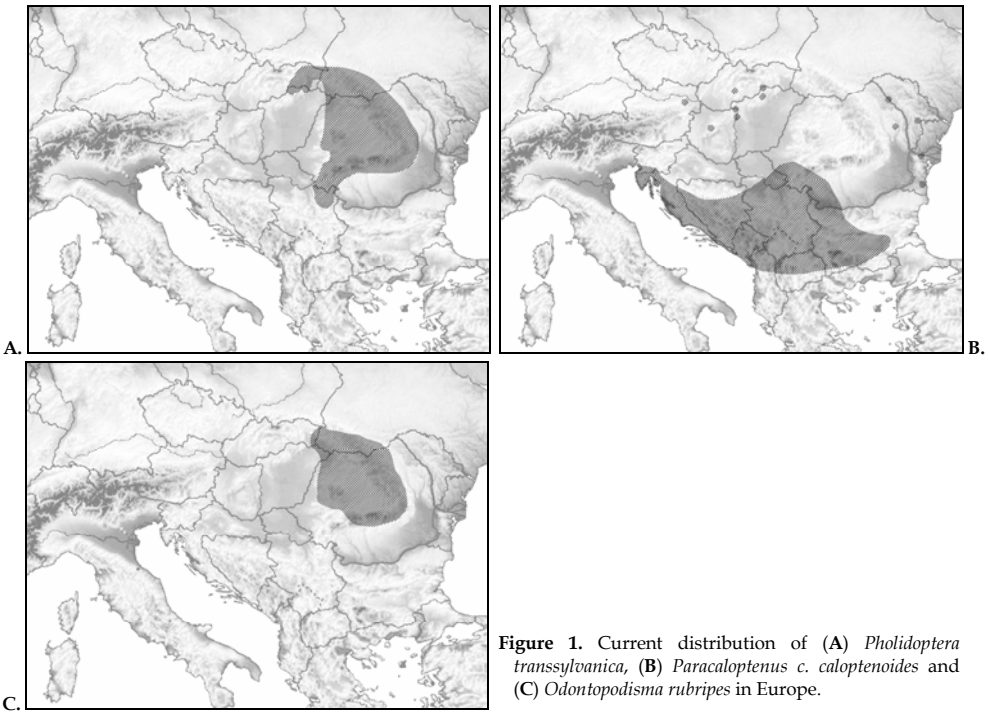

Figure 1. Current distribution of (**A**) *Pholidoptera transsylvanica*, (**B**) *Paracaloptenus c. caloptenoides* and (**C**) *Odontopodisma rubripes* in Europe.

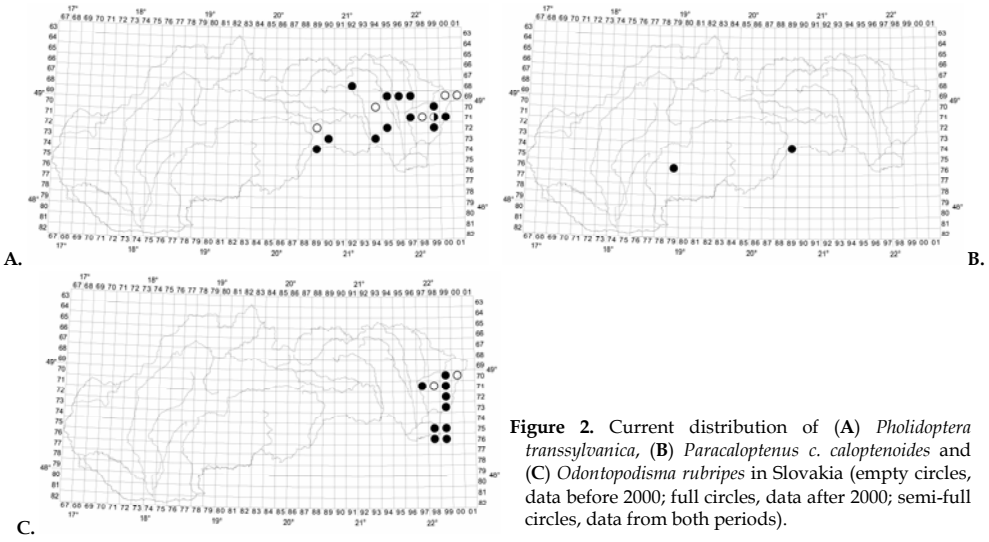

Figure 2. Current distribution of (**A**) *Pholidoptera transsylvanica*, (**B**) *Paracaloptenus c. caloptenoides* and (**C**) *Odontopodisma rubripes* in Slovakia (empty circles, data before 2000; full circles, data after 2000; semi-full circles, data from both periods).

record).

The species is classified as a mesophilous, sylvicolous, arbusticolous, chorthobiont with fairly broad ecological valence (Rácz 1998, Jordán et al. 2003). In Slovakia it occurs as geobiont and thamnobiont, especially in understory and herb layer in three habitat types: ecotones of beech (79%) and oak forests (14%) and open oak forests on limestone (7%), mainly in *Corno-Quercetum pubescentis-Petraeae* association (Jordán et al. 2003, Krištín et al. 2009). Stridulation in males and courtship behaviour was observed mostly in understory taller than 50 cm (83% of sites, n = 29), less in understory of 10–50 cm (17%). In its central range in Romania the species occurs also in forest edges and open forests as in Slovakia, however, it also occupies peat bogs and mown meadows there (Knechtel & Popovici-Biznosanu 1959). We observed adults from early July to late September. The most abundant populations were in the Slovak karst (550 m a.s.l.) with 20–35 males/ 1000 m^2 in August 2007–2010, (Krištín et al. 2009). Smaller local densities of 8–20 males/ 1000 m^2 (August 2009) were at higher altitudes (800–900 m a.s.l.) at the edges of beech forests in Čergov Mountains. The data concerning population density is missing from the other parts of the species range.

In the main habitat (ecotone of beech forests), the species often occurred in assemblages with *Poecilimon schmidti*, *Isophya stysi*, *Odontopodisma rubripes*. Common occurrence with montane species *Tettigonia cantans*, *Omocestus viridulus* and eurytopic species *Pholidoptera griseoaptera*, *Phaneroptera falcata*, *Euthystira brachyptera* was typical. In ecotones of oak forests it was accompanied by *Leptophyes albovittata*, *Oecanthus pellucens*, *Stenobothrus lineatus* and in oak forests of Slovak karst also by *Pachytrachis gracilis*, *Pterolepis germanica*, *Pholidoptera fallax*, *P. griseoaptera*, *I. stysi*, *Calliptamus italicus* and *Psophus stridulus*.

<u>*Paracaloptenus caloptenoides*</u>

The species has Ponto-Mediterranean origin (Ingrisch & Köhler 1998). The nominate subspecies *P. c. caloptenoides* is primarily known from south-eastern Europe: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Hungary, Macedonia, Romania, Slovenia (Us 1992), and Serbia (Frivaldszkyi 1867, Willemse 1973, Harz 1975, Heller 2011). The populations occurring in northern latitudes in Austria (Berg 2009), Slovakia (Gavlas 2005, Krištín et al. 2009), Hungary (Rácz 1998), northern Romania and Moldavia (Iorgu et al. 2008), exhibit a relict character. However, the distribution pattern is patchy even in the centre of the species range in Bulgaria (Popov 2007), Serbia, and doubtful in Ukraine (Heller 2011) (Fig. 1B).

We found the species in five sites within two DFS squares only (three sites in vicinity of Silica, Slovak karst and two sites at Sitno Mt., Štiavnické vrchy Mts.; Fig. 2B, Appendix 1). All five sites were located within SCI. The local population in central Slovakia (Sitno) is completely isolated (Gavlas 2005) while more abundant local populations in Slovak karst were adjacent to stable populations in the Aggtelek karst in Hungary (Nagy et al. 1999). Altitudes of Slovak populations (520–760 m a.s.l.) were similar to Hungary. In Romania, the species' altitudinal limit is significantly higher (1800 m a.s.l., Harz 1975).

This geobiont species prefers short and thin xerophilous grassy-herbaceous stands in warm areas of Slovakia. It is characteristic for subpannonic steppe grasslands, semi-natural dry grasslands and scrubland faces on calcareous substrates, making them habitats of European importance. Similar habitats are preferred also in other parts of its area; karst areas of Hungary, Slovenia, Croatia, Montenegro, Romania and Bulgaria. In Romania and Bulgaria, for example, it occurs in mountain grassy stands also (Knechtel & Popovici-Biznosanu 1959, Harz 1975, Iorgu et al. 2008). Adults occurred from mid-July to late September in Slovak sites. The most abundant populations were found in the Slovak karst, strictly localized in karst grike fields and sink holes (50–100 adults/ 1000 m^2, August 2007–2010). On the other hand, the species was rare (< 10 ad./ 1000 m^2, August 2006–2009) in short grass and neighbouring bare grounds of the Sitno Mountain. Foraging and courtship behaviour took place only on bare ground or in grass lower than 10 cm in all known sites.

In Slovak karst the species occurred together with xero-thermophilous sub-mountain and mountain species *P. fallax*, *Isophya kraussii*, *Metrioptera bicolor*, *Metrioptera brachyptera*, *P. stridulus*, and also with thermophilous species *Melanogryllus desertus*, *O. pellucens*, *C. italicus* and *Stenobothrus crassipes.* At the Sitno Mt., it was accompanied mainly by the eurytopic species *M. bicolor*, *Metrioptera roeselii*, *Chorthippus parallelus* and thermophilous *C. italicus* and *S. crassipes.*

<u>*Odontopodisma rubripes*</u>

The compact range of the species distribution ex-

tends across the mountains and basins of Eastern and Southern Carpathians as well as lowland areas along Tisza (Tisa) River in north-eastern Hungary and south-western Ukraine (Likovitch 1957, Harz 1975, Nagy 1991, Storozhenko & Gorochov 1992, Nagy et al. 2008, 2010, and own data), and in north-western Romania (Iorgu et al. 2008). Nevertheless, the knowledge about distribution in the northern (Nagy 1991, Gavlas 2005) and southern (Iorgu et al. 2008, Chobanov 2009) parts of its range has not been well defined up to now (Fig. 1C). For example, in Bulgaria, the species was mentioned from several sites also by Popov (2007). However, recent revision of the museum collections resulted in doubts due to occurrence of two sibling species (*Odontopodisma montana* and *Odontopodisma decipiens*). Thus *O. rubripes* is not expected in Bulgaria and Serbia nowadays (Chobanov 2009).

We found the species in eleven sites within nine DFS squares in eastern Slovakia (Fig. 2C) while it was recorded only in two sites before 2006 (Vihorlat Mts. and Bukovské vrchy Mts., Holuša 1996). Only four of all known sites (36%, n=9) are located within SCI. The species was observed in riparian stands along the Slovak and Ukraine part of the Tisa River and also in other higher elevated sites in eastern Slovakia. Such occurrence confirmed general pattern in species range, hence presence in mountain and lowland habitats. Occurrence in eastern Slovakia is adjacent to continual distribution in south-western Ukraine (Likovitch 1957, 1959, Storozhenko & Gorochov 1992) and north-western Hungary (Nagy et al. 2008, 2010). Slovak populations were in altitudes 98–815 m a.s.l., similar to neighbouring Ukraine (Likovitch 1959). However, at the southern range, it occurs in much higher altitudes (Domogled, up to 1800 m a.s.l., Harz 1975).

It is an arbusticol thamnobiont species, feeding mostly on shrubs (Kis 1962, Harz 1975, Nagy 1991, Rácz 1998). In Slovakia it occurs primarily in shrub understory dominated by *Rubus fruticosus* and *Rubus caesius*, in lowlands also *Clematis vitalba*, *Solidago canadensis*, *Humulus* sp. at the edges and clearings in floodplain poplar-willow forests (42%), oak and oak-hornbeam forests (33%) and beech forests (25%, n = 12). The species was found also in peat bogs in Romania (Knechtel & Popovici-Biznosanu 1959). Adults were recorded already from mid-June; what was the earliest in all three studied Orthoptera species. The highest abundance reached lowland populations along the Tisa River (20–30 ad./ 100 m² of floodplain forest edge, July 2008–2010). Mountain populations were found to be less abundant (1–4 ad./ 100 m² of forest edge, July 2008–2010). We observed foraging and courtship behaviour only in herbal and shrub layer taller than 50 cm.

In riparian habitats of the Tisa River the species occurred primarily in association with hygrophilous species feeding on shrubs and on tall herbaceous vegetation (*Conocephalus fuscus*, *Conocephalus dorsalis*, *Leptophyes discoidalis*, *L. albovittata*, *P. schmidti*) or grass (*Omocestus rufipes*, *Chorthippus brunneus* and *C. parallelus*). In shrubs at the edges of oak and oak-hornbeam forests, the species accompanied *P. schmidti*, *P. transsylvanica*, *P. falcata*, *Phaneroptera nana*, *P. griseoaptera* and *O. pellucens*. Higher elevated habitats of *O. rubripes* were occupied also by *P. griseoaptera*, *Tettigonia cantans*, *O. viridulus*, *Chorthippus montanus* and *Chrysochraon dispar*.

Conclusion

All these three species examined have a limited distribution within SE and Central Europe, and they are currently listed as species of European importance in Habitats Directive of Natura 2000. Although our initial analysis reviewed all available sources, the figures about the species' distributions are not complete and many gaps are still there. Moreover, ecology of species remain largely unknown (population structure, habitat selection, foraging strategies and threatening factors), because none specific study was performed yet. However, this study presents the first comprehensive data. The occurrence of these species is located within Slovak SCI in various degrees, representing 100% in *P. caloptenoides*, 48% in *P. transsylvanica* and only 36% in *O. rubripes*. The need for further research on appropriate habitat management is urgent to maintain species' favourable conservation status. On the other hand we may conclude also that more focus is needed in the future when listing these Orthoptera among species of European importance.

Acknowledgements. The research was supported by the Slovak Grant Agency VEGA 2/157/11, and the Slovak Research and Development Agency APVV-0497-10. The authors are grateful to colleagues Miloš Balla, Štefan Danko, Vladimíra Fabriciusová, Miroslav Fulín, Ervín Hrtan, Vladimír Hrúz, Milan Mikuš, Anna Sliacka and Peter Tuček which helped with field collections.

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+ 1 page Appendix

Appendix 1. Records of three Orthoptera species of European importance in Slovakia
(DFS mapping squares, site name, * located within SCI, altitude, abundance, M – males, F – females, date).

Pholidoptera transsylvanica
Published data: 6997, 6900*, 6901*, 7094, 7198*, 7199*, 7289 (compiled by Gavlas 2005); 7489 (Krištín et al. 2009).
Unpublished data: 6892 – Lysá*, Sabinov (950 m a.s.l.), > 100 ad., 30. 7. 2009, Drienica, Sabinov (650 m a.s.l.), 10 ad., 30. 7. 2009, Háj, Sabinov (750 m a.s.l.), 10 ad., 30. 7. 2009; 6995 – Dobrá near Domaša (320 m a.s.l.), 5 M, 5. 8. 2010; 6996 – Dobrá near Domaša (260 m a.s.l.), 5 M, 5. 8. 2010; 7099 – Morské oko East* (657 m a.s.l.), 2M, 1F, 18. 8. 2010, Morské oko Southeast* (670 m a.s.l.), 2M, 1F, 18. 8. 2010; 7197 – Vinné (260 m a.s.l.), 2 M, 3. 8. 2010; 7199 – Remetské Hámre* (450 m a.s.l.), 2 M, 18. 8. 2010, E. Hrtan lgt; 7100 – Inovce north (433 m n.m.), 2M, 27. 8. 2010, Inovce west (480 m n.m.), 1M, 27. 8. 2010, Inovce southwest (460 m n.m.), 1M, 27. 8. 2010, E. Hrtan lgt.; 7295 – Dargov (345 m a.s.l.), 10 M, 12. 7. 2010; 7299 – Priekopa* (300 m a.s.l.), 1M, 3. 8. 2010; 7390 – Hrhov* (330 m a.s.l.), 10 M, 30. 7. 2010; 7394 – Slanec* (430 m a.s.l.), 2 M, 18. 7. 2010; 7489 – Silica, Sokolia skala (500 m a.s.l.), 5 M, 29. 7. 2010, 7489 – Silica, Pod Fabiankou* (520 m a.s.l.), 2 M, 29. 7. 2010.

Paracaloptenus caloptenoides
Published data: 7679 (Gavlas 2005); 7489 (Krištín et al. 2009).
Unpublished data: 7489 – Silica, northeast* (590 m a.s.l.), > 100 ad., 29. 7. 2010, Silica, east* (605 m a.s.l.), max 18 ad., 9. 8. 2009; 7679 – Sitno, Ilija* (760 m a.s.l.), max. 10 ad., 11. 8. 2009.

Odontopodisma rubripes
Published data: 7000, 7198* (compiled by Gavlas 2005).
Unpublished data: 7099 – Morské oko, Remetské Hámre* (650 m a.s.l.), 1F, 18. 8. 2010, E. Hrtan lgt.; 7197 – Vinné (208 m a.s.l.), 1M, 1F, 18. 6. 2010;
7199 – Vyšná Rybnica* (260 m a.s.l.), 2F, 3. 8. 2010; 7299 – Priekopa* (280 m a.s.l.), 1M, 1F 5. 7. 2010, Š. Danko lgt., Kolibabovce south (175 m a.sl.) 1F, 1n, 4. 8. 2010, Kolibabovce east (175 m a.s.l.) 1M, 1F, 4. 8. 2010; 7399 – Krčava (130 m a.s.l.), 1M, 1F 5. 7. 2010; 7598 – Malé Trakany northeast (105 m a.s.l.), 20 ad., 18. 7. 2010, Solomonove, Ukraine (109 m a.s.l.), 1M, 1F, 14. 7. 2008; 7599 – Esen, Ukraine (107 m a.s.l.), 20 ad., 14. 7. 2008; 7698 – Malé Trakany southeast (100 m a.s.l.), >100 ad., 21. 7. 2009; 7699 – Solovka, Ukraine (118 m a.s.l.), 8M, 5F, 3n, 14. 7. 2008.