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Distribution and ecology of *Ruspolia nitidula* (SCOPOLI 1786) and *Aiolopus thalassinus* (FABRICIUS 1781) (Orthoptera) in Slovakia

A. KRIŠTÍN, P. KAŇUCH & M. SÁROSSY

Abstract: Distribution and ecology of *Ruspolia nitidula* and *Aiolopus thalassinus* (Orthoptera) in Slovakia. In 2000-2006, the authors found *R. nitidula* on 87 localities (only 19 had been known before 2000) and *A. thalassinus* on 35 localities (9 before 2000) in Slovakia, at the northern limit of their range. For both these endangered species, habitat choice, abundance and phenology were analysed and in *R. nitidula* also the morphology was commented.

Key words: Orthoptera, distribution, habitat selection, *Ruspolia nitidula*, *Aiolopus thalassinus*.

Introduction

Bush cricket *Ruspolia nitidula* and grasshopper *Aiolopus thalassinus* are species of paleotropical and mediterranean origin (INGRISCH & KÖHLER 1998). *Ruspolia nitidula* figures in European national Red Lists as an endangered or critically endangered species and reaches the northern edge of its range in Europe in Slovakia (KRIŠTÍN et al. 2007). *A. thalassinus* is less endangered, but it is rare mainly on the northern edge of its range, which occurs in Europe in Poland (BAZYLUK & LIANA 2000). For both species, the northern range limits seem to have been stable for more than 100 years (KRIŠTÍN et al. 2007).

Much published and unpublished data on these species distribution were collected in 2000-2006 at the northern range limits (KRIŠTÍN & SÁROSSY 2002, CHLÁDEK & GAVLAS 2004, KRIŠTÍN 2004, KRIŠTÍN et al. 2004a, b, BERG & ZUNA-KRATKY 1997, MAAS et al. 2002). Most of authors assign the increase of data to more intensive research activity (BERG & ZUNA-KRATKY 1997, MAAS et al. 2002, KRIŠTÍN et al. 2007), extending our former fragmentary knowledge of the ecology, abundance and phenology of these species (i.e. MAŘAN 1965, BRAUN et al. 1995, DETZEL 1998, KOČÁREK et al. 2005, NAGY 2005).

The aim of this paper is to contribute to the knowledge of the: 1) distribution and phenology of *R. nitidula* and *A. thalassinus* in Slovakia (raw unpublished data used in KRIŠTÍN et al. 2007); 2) habitat and altitudinal distribution in relation to density; and 3) morphology of *R. nitidula* at the northern limit of its distribution.

Material and Methods

Between May and October 1995-2006, we checked out 418 localities in 175 mapping squares (one square area = 132 km²) using the Slovak fauna Databank (41 % of total squares in Slovakia, KRIŠTÍN et al. 2007). *Ruspolia nitidula* was mapped using acoustic identification (also with an ultrasound bat-detector at frequencies 95-120 kHz) mainly during dusk and at night. Stridulating individuals were regularly checked in the field. The species *A. thalassinus* was monitored and collected by sweeping the herbal layer (less so by individual collection). We collated the already-published data on the distribution of both species in Slovakia from 1897 to 2006, and also our data (Figs 1, 4, Appendixes 1, 2).

The assessment of habitat quality in *R. nitidula* was expressed through: 1) habitat type, 2) altitude, 3) maximum distance from the woody plants or forest edge (or solitary trees), 4) nearest woody plant species in the adjacent forest stand and 5) height of herbal layer. For *A. thalassinus* we registered: 1) habitat type, 2) altitude, 3) height of herbal layer. For the analyses of altitudinal species distribution in various habitats we used also already published data (l.c., Figs 2, 5). *R. nitidula* abundance was recorded by assessment of small-plot density on 1000 m² on a selected study plot in wet meadows of the Poiplie area (Kirt', 150 m a.s.l.; for a description of the plot, see in KRIŠTÍN & SÁROSSY 2002) by sweeping the herbal layer over the whole season (June-October). Abundance of *A. thalassinus* was checked by sweeping the herbal layer at selected breeding sites (Hrkovce 125 m a.s.l., Tvrdošovce 113 m a.s.l.) over the whole season (June-October) and by estimating the number of fast-flying adults. The phenology of occurrence and development in *R. nitidula* were checked from June to October: i) at regular, 7-14 day intervals in the above-mentioned Poiplie area locality in 2001, ii) irregularly within its whole range in Slovakia in 2000-2006 (as was done for *A. thalassinus*). Trapped individuals were measured directly in the field, using a digital calliper, and released.

Results and discussion

Ruspolia nitidula (SCOPOLI 1786)

Distribution in Slovakia

Before 1962, this species had been found in Slovakia only at 19 localities (reviewed by KRIŠTÍN & SÁROSSY 2004). Subsequently until 2000, there were no published data on its occurrence, apart from an occurrence in August 1982 in the Danube area (CHLÁDEK & GAVLAS 2004). In 2000-2006, suitable localities were mapped more intensively, and we found this species on 87 localities (we confirmed pre-1962 findings in ten localities). Summarizing all known published and our unpublished data, the species was found in total at 100 localities in 67 squares of the Slovak Fauna Databank (16 % of all squares; Fig. 1, Appendix 1). Possibly it was more intensive research that has detected this elusive species in greater number of localities; this apparent increase is not an indication of northward spreading (KRIŠTÍN et al. 2007). This evidence can be regarded as debatable, but finally, it supports improved species detection (BRAUN et al. 1995, BERG & ZUNAKRATKY 1997).

Habitats

This stenotopic species was found in Slovakia mainly in lowland habitats at altitudes 99–352 m a.s.l. (mean $\pm$ SD = 164 ± 60 m a.s.l., $n = 97$ localities). CHLÁDEK & GAVLAS (2004) mentioned that it also has occurred in Slovakia up to 430 m a.s.l. During its larval development it prefers wet meadows and wetlands as well as riparian hygrophilous vegetation along lowland streams (53 %), but it also occurs in wet ditches along roads (39 %), from which location type, data were not previously obtained. We recorded it even in ruderal vegetation in human settlements (5 %) and at xerothermous localities (3 %, Fig. 2), where we found only fast-flying adults. Considering the height of the herbal layer, in Slovakia the species prefers a height of 10–50 cm (87 % of localities, $n = 28$), avoids stands lower than 10 cm and it is rare in stands taller than 50 cm (13 %). In the localities where it is most abundant (Poipie area), it occurs mainly in grass stands of *Agropyron repens* and *Alopecurus pratensis*. It is frequently found in association with woody vegetation, because at many localities (83 %), it occurred within 10 m of the nearest tree.

Abundance, phenology and morphology

Assessing small-plot density on 1000 m^2 by sweeping the herbal layer, we found a maximum density of 45 individuals/ 1000 m^2 . In Slovakia, the species was found between June 28 and October 1, highest abundance being during late July and in August. Male nymphs were found until August 12, female nymphs until the end of August; more females than males survived until the end of September (Fig. 3). The first adults were found on July 26. There was no seasonal difference in hatching between males and females. Nymphal-stage females were more abundant than males (a 2:1 ratio at a regularly visited locality). In the adult stage, the ratio was 1:1.

We expected smaller-sized individuals to occur in suboptimal conditions at the northern boundary of the area, the theory being that suboptimal climatic and food conditions, in comparison with Mediterranean locations, would restrict growth. However, we discovered that the measured individuals ($n = 25$) had body sizes corresponding to the average values for the whole area. We found that the body size of females was 25.9–32.0 mm and of males was 20.8–27.8 mm (Table 1). HARZ (1969) gave 24–33 mm for females and 20–30 mm for males, over the whole range. The only larger dimensions we found were in the postfemur length of males, 17.2–19.0 mm as opposed to 15.0–16.5 mm given by HARZ (1969).

Aiolopus thalassinus (FABRICIUS 1781)

Distribution in Slovakia

Before 1962, this species had been found in Slovakia only at 9 identified localities (PUNGUR 1899, SCHNEEBERG 1931, GULIČKA 1954, 1967, MAŘAN 1954). Until 2000, there were no further published data on its occurrence.

In 2000–2006 suitable localities were mapped more intensively, and we found this species at 35 localities (we confirmed pre-1962 findings in three localities). Summarizing all known published and our unpublished data, the species had been found in a total of 41

localities in 29 squares of the Slovak Fauna Databank (6.7 % of all squares, Fig. 4, Appendix 2). Like the previous species, the increase in known localities is more probably the result of intensive research being carried out at dusk, when this species is most active (cf. GULIČKA 1954) than an indication of a northward spread (KRISTÍN et al. 2007).

Habitats

Breeding site localities and habitats should be distinguished from those of fast-flying adults (which are active very far from the hatching site – DETZEL 1998, MAAS et al. 2002). We found hatching sites and larvae habitats at altitudes of 99-140 m a.s.l. (mean $\pm$ SD = 114 ± 12 m a.s.l., $n = 11$ localities). Adults' habitats were located within a 98-1948 m a.s.l. band (281 ± 452 m a.s.l., $n = 39$). Five of these localities were at altitudes of: 800 (1 ad. F, August 22, 2001), 1200 (1 ad. M, August 6, 2004), 1440 (1 ad. M), 1620 (1 ad. M), and 1948 m a.s.l. (1 ad. F, August 21, 2001). Hatching sites of this species in Slovakia are in warm lowland country and are represented exclusively by saltmarshes (64 %) and wet meadows (36 %, $n = 11$ localities). Adults (without differentiating the sex) we found not only on the same habitats as larvae (wet meadows 49 % and saltmarshes 33 %), but also on adjacent xerothermous sandy dunes (5 %), and in extremely mesophilous meadows above 800 m a.s.l. (13 %, $n = 39$ localities, Fig. 5), where we suppose it occurs only for a short period and does not breed.

Abundance and phenology

We carried out small-plot density mapping of the species, obtaining a maximum density of >100 adults/ 1000m^2 at the saltmarsh near the village of Tvrdošovce in SW Slovakia (September 30, 2002), and > 50 nymphs/ 1000m^2 near Hrkovce in S Slovakia (August 8, 2001). The species is a very good flier, making it almost impossible to assess the density of adults and extent of its minimum territory. The populations in the best Slovak breeding sites can exceed 1000 nymphs of 4th instar/ 1 ha (the Tvrdošovce saltmarshes and the Hrkovce wet meadows).

In Slovakia, the species was found between July 9 (nymphs of the 4th instar, Hrkovce), and October 10 (Tvrdošovce). The first adults were found on July 22, the highest adult density was recorded from late August to the end of September, i.e. ca 14 days later than for *R. nitidula*.

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Zusammenfassung

Im Zeitraum 2000 bis 2006 konnte an 87 slowakischen Fundstellen, der nördlichen Verbreitungsgrenze, *R. nitidula* nachgewiesen werden (vor 2000 waren nur 19 Nachweise bekannt), von *A. thalassinus* gelang der Nachweis von 35 Fundstellen (bis 2000 waren es lediglich 9). Für beide Arten wurden Angaben zu Habitatwahl, Häufigkeit und Phänologie gegeben, für *R. nitidula* zusätzlich zur Morphologie.

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Author's addresses: Dr. Anton KRIŠTÍN
Dr. Peter KAŇUCH
Institute of Forest Ecology SAS
Štúrova 2, SK-960 53 Zvolen, Slovakia
E-mail: kristin@savzv.sk

Martin SÁROSSY
M. R. Štefánika 43, SK-082 21 Veľký Šariš, Slovakia

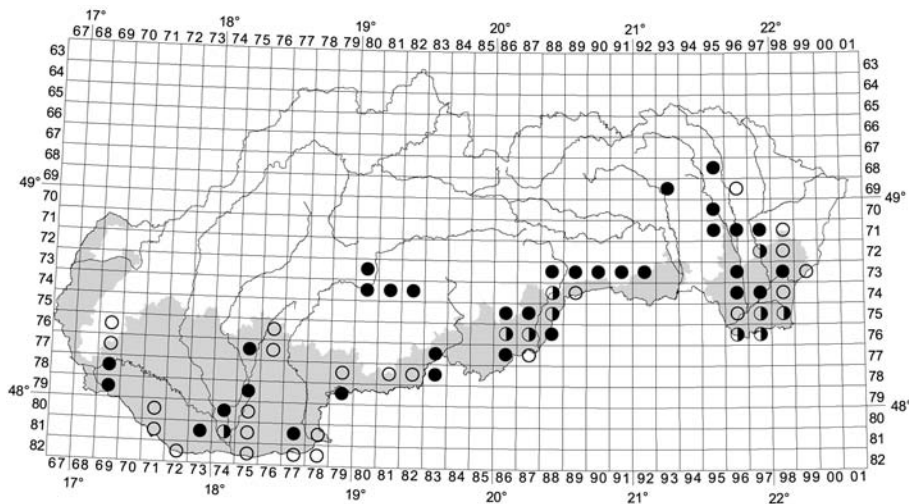


Fig. 1: Distribution of *Ruspolia nitidula* in mapping squares of the Slovak Fauna Databank (empty circles = published data, full circles = unpublished data, semi-full circles = published and unpublished data, light-grey area = Pannonian bioregion, white area of Slovakia = Carpathian [Alpine] bioregion).

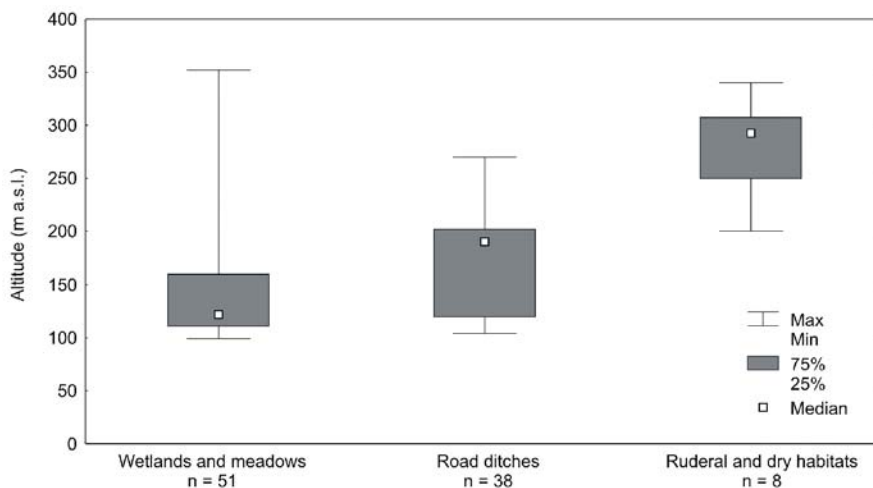


Fig. 2: Distribution of *Ruspolia nitidula* at different altitudes and in different habitats in Slovakia.

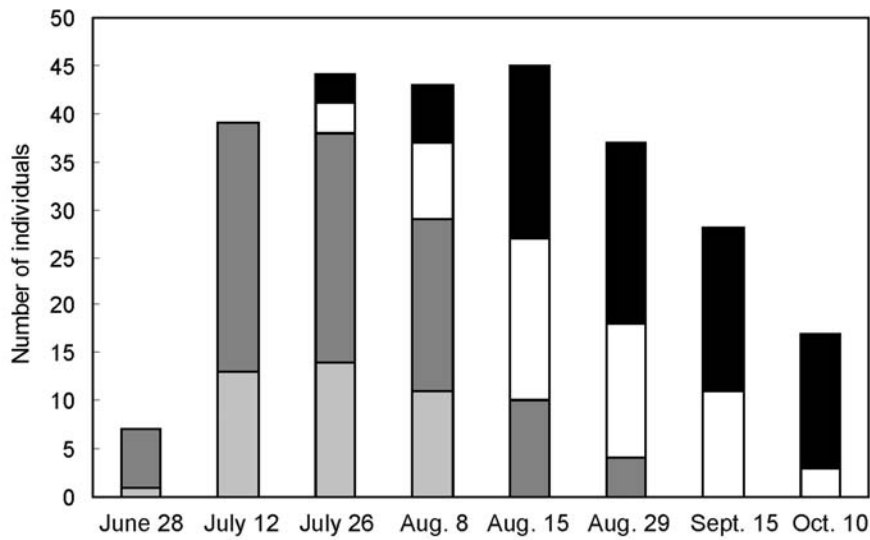


Fig. 3: Seasonal changes in occurrence of *Ruspolia nitidula* in Slovakia (locality Kirt', 2001, black = adult females, white = adult males, dark grey = females nymphs, light grey = males nymphs).

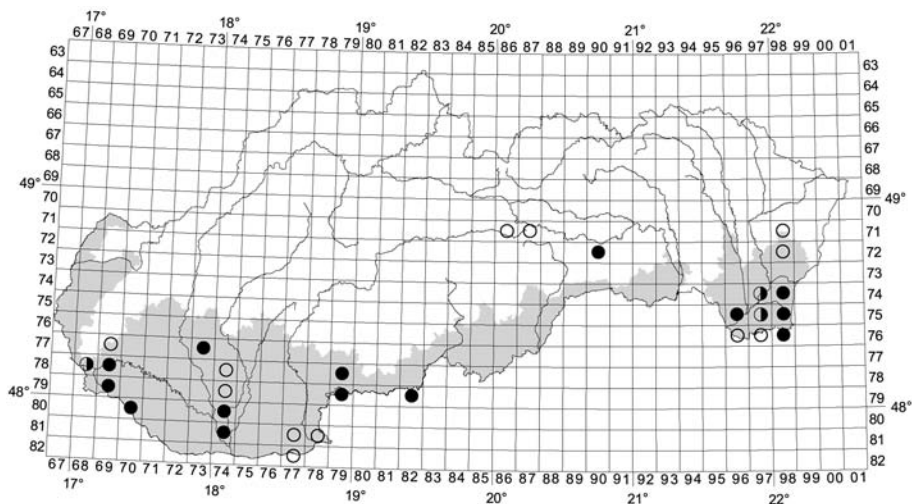


Fig. 4: Distribution of *Aiolopus thalassinus* in Slovakia in mapping squares of the Slovak Fauna Databank (for explanation, see Fig. 1).

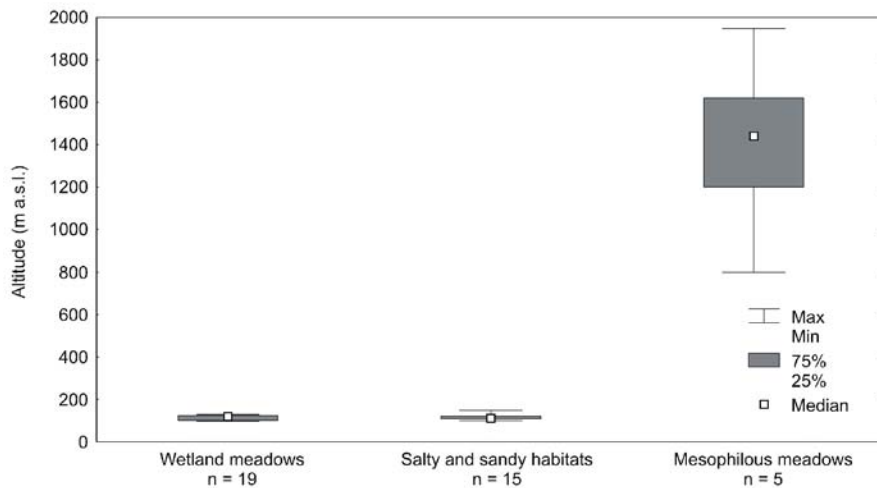


Fig. 5. Distribution of *Aiolopus thalassinus* at different altitudes and in different habitats in Slovakia.

Table 1: Morphological parameters (in mm, mean $\pm$ SD) for males and females of *Ruspolia nitidula* in Slovakia (from the 4th instar to imago).

Sex	Age	n	Body	Ovipositor	Antenna	Postfemur
Males	5 th instar	1	17.5	-	13.5	8.5
	6 th instar	1	24.0	-	20.4	13.0
	Imago	7	24.3 $\pm$ 2.3	-	33.8 $\pm$ 1.8	18.3 $\pm$ 0.6
Females	4 th instar	3	16.6 $\pm$ 1.7	4.7 $\pm$ 0.4	20.0 $\pm$ 0.9	9.1 $\pm$ 0.2
	5 th instar	3	20.5 $\pm$ 1.1	13.8 $\pm$ 1.0	21.6 $\pm$ 0.7	13.9 $\pm$ 0.8
	6 th instar	1	24.3	15.9	22.0	14.8
	Imago	8	27.7 $\pm$ 1.8	19.4 $\pm$ 1.5	30.1 $\pm$ 2.7	19.1 $\pm$ 1.0

Appendix 1: Distribution of *Ruspolia nitidula* in Slovakia. Unpublished distributional data are described in the following way: code of the Databank of Slovak Fauna (Figs. 1, 4) – name of the locality (or No. of localities = loc.) (altitude), number of trapped or listened specimens, growth stage [ad. = imago, n. = nymphs], sex [M = male, F = female, ex. = stage and sex not identified], date in format MM.DD.YYYY (author, when other than the authors of this paper).

Published data: 6996 (CHLÁDEK & GAVLAS 2004; GAVLAS 2005); 7198 (GULIČKA 1967); 7297 (MAŘAN 1965); 7298 (GULIČKA 1967); 7399 (VÁVRA, 1931); 7488 (MAŘAN 1965); 7489 (CHLÁDEK & GAVLAS 2004); 7498 (MAŘAN 1965; KRIŠTÍN et al. 2004a); 7588 (CHLÁDEK & GAVLAS 2004); 7596, 7597 (MAŘAN 1965; KRIŠTÍN et al. 2004a); 7598 (KRIŠTÍN et al. 2004a); 7669 (GULIČKA 1992); 7676 (MAŘAN 1965); 7686, 7687 (GULIČKA 1992); 7696 (CHYZER 1897; KRIŠTÍN et al. 2004a); 7697 (KRIŠTÍN et al. 2004a); 7769 (GÖRTLER 1946; GULIČKA 1954); 7776 (KRIŠTÍN & SÁROSSY 2002); 7787 (GULIČKA 1992); 7879, 7881, 7882 (KRIŠTÍN & SÁROSSY 2002); 8071 (MAŘAN 1965); 8075 (CHLÁDEK & GAVLAS 2004); 8171 (MAŘAN 1965); 8174 (KRIŠTÍN 2004); 8175 (CHLÁDEK & GAVLAS 2004); 8178 (MAŘAN 1965; KRIŠTÍN 2004); 8272 (FEDOR 2001); 8275 (CHLÁDEK & GAVLAS 2004; KRIŠTÍN et al. 2004b); 8277, 8278 (MAŘAN 1965).

Unpublished data: 6895 – Lomné (170 m a.s.l.), 1 ad. M, 09.25.2004; 6993 – Veľký Šariš (270 m a.s.l.), 4 ad. M, 09.15.2004, 1 ad. M, 08.25.2005; 7095 – Hlinné (152 m a.s.l.), 4 ad. M, 08.30.2005; 7195 – Vranov n/Topľou, 2 loc. (135 m a.s.l.), 2 ad. M, 09.09.2002; 7196 – Vranov n/Topľou (132 m a.s.l.), 4 ad. M, 08.30.2005; 7197 – Vinné (150 m a.s.l.), 3 ad. M, 08.29.2003; 7297 – Michalovce (115 m a.s.l.), 1 ad. M, 08.29.2003; 7380 – Sliač (340 m a.s.l.), 1 ad. M, 10.08.2004; 7388 – Brzotín, Slaná (270 m a.s.l.), 5 ad. M, 08.08.2004, 16 ad. M, 08.24.2005; 7389 – Rožňava, 2 loc. (290 m a.s.l.), 5 ad. M, 08.08.2004, 34 ad. M, 08.24.2005; 7390 – Hrhov (210 m a.s.l.), 2 ad. M, 08.15.2004; 7391 – Drieňovec (190 m a.s.l.), 3 ad. M, 08.15.2004; 7392 – Moldava n/Bodvou (215 m a.s.l.), 3 ad. M, 08.11.2003; 7396 – Trebišov (110 m a.s.l.), 3 ad. M, 08.27.2003; 7398 – Senné (106 m a.s.l.), ca 100 ex., 08.30.2005; 7480 – Zvolen (295 m a.s.l.), 4 ad. M, 1 ad. F, 09.04.2004; 7481 – Lieskovec (310 m a.s.l.), 3 ad. M, 09.04.2004; 7482 – Pstruša, (352 m a.s.l.), 2 ad. M, 08.23.2004; 7488 – Bohúňovo (201 m a.s.l.), 46 ad. M, Plešivec (230 m a.s.l.), 42 ad. M, 08.24.2005; 7496 – Zemlinske Hradište (104 m a.s.l.), 1 ad. M, 08.28.2003; 7497 – Oborín, 2 loc. (cca 105 m a.s.l.), 2 ad. M, 08.28.2003; 7586 – Uzovská Panica (188 m a.s.l.), 2 ad. M, 08.12.2003; 7587 – Kaloša (193 m a.s.l.), 1 ad. M, Figa (196 m a.s.l.), 5 ad. M, Stránska (180 m a.s.l.), 4 ad. M, Behynce (176 m a.s.l.), 21 ad. M, Tornaľa (183 m a.s.l.), 39 ex., 08.24.2005; 7588 – Starňa (200 m a.s.l.), 11 ad. M, Gemerská Panica (194 m a.s.l.), 29 ad. M, Čoltovo (227 m a.s.l.), 16 ad. M, 08.24.2005; 7686 – Rimavská Sobota (242 m a.s.l.), 2ad. M, 08.05.2002; 7687 – Radnovce (170 m a.s.l.), 3 ad. M, Rumince (168 m a.s.l.), 2 ad. M, Barca (198 m a.s.l.), 1 ad. M, 10.08.2004; 7597 – Malý Horeš (102 m a.s.l.), 1 ad. M, 08.24. 2006; 7598 – Leles-Kapoňa (102 m a.s.l.), 1 ad. M, 08.25. 2006; 7688 – Lenka (213 m a.s.l.), 1 ad. M, 10.08.2004; 7696 – Streda nad Bodrogom (165 m a.s.l.), 2 ad. F, 08.24. 2006; 7697 – Strážne (104 m a.s.l.), 2 ad. M, 1 ad. F, 08.24. 2006; 7775 – Melek (185 m a.s.l.), 1 ad. M, 08.01.2002; 7783 – Muľa (160 m a.s.l.), 2 ad. F, 1 ad. M, 08.15.2001; 7786 – Gemerské Dechtáre (305 m a.s.l.), 5 n. F, 06.29.2001; 7869 – Most pri Bratislave (135 m a.s.l.), 1 ad. M, 10.06.2004; 7883 – Bušince (162 m a.s.l.), 1 ad. M, 08.15.2001; 7969 – Čunovo (130 m a.s.l.), 12 ad. M, 09.20.2004; 7975 – Nitriansky Hrádok (123 m a.s.l.), 3 ad. M, 08.02.2002; 7979 – Hrkovce (130 m a.s.l.), 1 ad. M, 1 ad. F, 08.08.2001; 8074 – Nesvady (120 m a.s.l.), 2 ad. M, 08.01.2002; 8173 – Drieňovec (111 m a.s.l.), 2 ad. F, 2 n. F, 08.03.2005; 8174 – Detvice (112 m a.s.l.), 2 n. M, 08.03.2005; 8177 – Štúrovo - Nána (110 m a.s.l.), 2 ad. M, 08.04.2004.

Appendix 2. Distribution of *Aiolopus thalassinus* in Slovakia. For legend, see Appendix 1.

Published data: 7186 (KRIŠTÍN et al. 2002a, b); 7187 (KRIŠTÍN et al. 2002a, b); 7198 (GULIČKA 1967; FEDOR 2002); 7298 (GULIČKA 1967); 7497, 7597, 7696, 7697 (KRIŠTÍN et al. 2004a); 7769 (GULIČKA 1954); 7868 (SCHNEEBERG 1931); 7874, 7974 (KRIŠTÍN 2004); 8177, 8178 (MARAN 1954; KRIŠTÍN 2004); 8277 (KRIŠTÍN et al. 2004b).

Unpublished data: 7290 – Hekerová (1200 m a.s.l.), 1 ad. M, 08.06.2004; 7497 – Beša (101 m a.s.l.), 14 ad. F, 11 ad. M, 08.23.2005 (M. Balla); 7498 – Kapušanské Kľačany (100 m a.s.l.), 3 ad. F, 09.24.2004 (M. Balla); 7596 – Brehov (105 m a.s.l.), 1 ad. F, 08.24.2006; 7597 – Več (102 m a.s.l.), 30 ex./ 1000 m², 07.14.2005; 7598 – Kapušanské Kľačany (102 m a.s.l.), 4 ad. F, 8 ad. M, 08.24.2006; 7698 – Malé Trakany (101 m a.s.l.), 1 ad. F, 8 ad. M, 08.25.2006; 7773 – Hájske (119 m a.s.l.), 3 ad. M, 09.28. 2006; 7868 – Bratislava (132 m a.s.l.), 1 ad. M, 10.09.1993 (V. Janský); 7869 – Podunajské Biskupice (130 m a.s.l.), 1 ad. F, 08.11.1929 (coll. SNM); 7879 – Hrkovce (126 m a.s.l.), 2 ad. M, 1 ad. F, viac ako 60 n., 08.08.2001; 7969 – Čunovo (130 m a.s.l.), 6 ad. F, 08.03.1995 (V. Janský), Čilistov (130 m a.s.l.), 3 ad. F, 07.09.1931 (coll. SNM); 7979 – Hrkovce, 3 loc. (ca 125 m a.s.l.), viac ako 40 n., 08.08.2001; 7982 – Kováčovce (150 m a.s.l.), 1 ad. F, 07.30.2002; 8070 – Dobrohošť (123 m a.s.l.), 3 ad. F, 08.03.1999 (V. Janský); 8074 – Imeľ (111 m a.s.l.), 1 n., 08.03.2005; 8174 – Detvice (112 m a.s.l.), 1 n., Imeľ (109 m a.s.l.), 1 n., 08.03.2005.

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Autor(en)/Author(s): Kristin Anton, Kanuch Peter, Sárossy Martin

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