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STATUS OF THE POTENTIALLY INVASIVE ASIAN SPECIES *SCELIPHRON DEFORME* IN EUROPE, AND AN UPDATE ON THE DISTRIBUTION OF *S. CURVATUM* (HYMENOPTERA: SPHECIDAE)

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Abstract

We reviewed the distribution of the two Asian species of the genus *Sceliphron* Klug, introduced into Europe in the late 1970s to early 1980s: *S. (Hensenia) curvatum* (Smith) and *S. (Hensenia) deforme* (Smith). Both species are routinely considered as invasive in Europe, but the status and effects of their (eventual) invasiveness are yet to be documented and evaluated. We had a focus on two areas, the Balkan Peninsula and European Russia, based principally on the study of specimens collected over the last 15 years, but we also reviewed the extensive published evidence (including some very important internet-based records), and for *S. curvatum* we provided a concise overview of the entire European range. We confirmed that the latter recorded species, *S. deforme*, has been introduced into Europe at least twice, first in the central part of European Russia, and then in the SW Balkans, and we established that these introductions originated from different source populations, belonging to a geographically widely separated Asian subspecies. Based on the most recent evidence, we confirmed successful establishment of *S. deforme* in both areas, and documented its ongoing spreading: from central European Russia southwards/southeastwards, and most probably from the Balkans eastwards. We rectified several erroneous country records for *S. deforme* (France, Italy, Bulgaria, Greece, "central Europe"), which have been extensively perpetuated in several important publications about the invasive species in Europe in the last three years (*n.b.* – for Greece, we have positively documented its presence only now). For *S. curvatum*, we added a new country record (Georgia/Abkhazia), and provided a few important earlier records from the Balkans (Serbia, Greece,

Croatia, Bulgaria), which shift the timing of the previously published "first appearance" dates in the area (for two years for N Serbia and C Greece), or otherwise modify the knowledge of its history of spread. Since the most recent evidence suggests the rapid eastward advancing of both introduced species towards their respective westernmost/northernmost native range limits in western to central Asia, we considered it important to briefly review the state of knowledge about their possible coexistence in that area. We also provided detailed maps of their allochtonous ranges in Europe (currently exceeding the longitudinal span of 4,000 km) and westernmost part of their native ranges in Asia. Finally, we very briefly commented on some ecological aspects of their existence within the allochtonous range (parasitism, sex ratio, phenology).

KEY WORDS: *Sceliphron deforme, Sceliphron curvatum*, invasive Sphecidae, Europe, Balkans, Russia

Introduction

The guild of mud-daubing spider-hunting sphecid wasps of the subfamily Sceliphrinae is represented with two genera in Europe, *Sceliphron* Klug, 1801, and *Chalybion* Dahlbom, 1843, currently comprising 10 native and 3 established exotic species (BITSCH, 2010; PULAWSKI, 2011). The European fauna of the genus *Sceliphron* includes 4 native species, three of them being relatively widespread in southern and to a lesser extent in central and/or eastern Europe: *S. destillatorium* (Illiger, 1807), *S. madraspatanum* (F., 1871), and *S. spirifex* (L., 1758); the fourth species, *S. funestrum* Kohl, 1918, is distributed only in some peripheral Aegean islands (and also further east, in Asiatic Turkey) (VAN DER VECHT & VAN BREUGEL, 1968; HENSEN, 1987; SCHMID-EGGER, 2005). During the second half of the 20th century, two exotic species have become regular and widely represented members of the European fauna, the American *S. caementarium* (Drury, 1773) and Asian *S. curvatum* (Smith, 1870), as documented in numerous recent reports and reviews (PAGLIANO *et al*., 2000; GONSETH *et al*., 2001; ĆETKOVIĆ *et al*., 2004; BOGUSCH *et al*., 2005; SCHMID-EGGER, 2005; BITSCH & BARBIER, 2006; BITSCH, 2010; PROKOFIEV & SKOMOROKHOV, 2010; RASPLUS, 2010; SHORENKO & KONOVALOV, 2010; BARBIER, 2011; etc.). The third alien species, *S. deforme* (Smith, 1856), also from Asia, was positively recorded only in the restricted area of European Russia (MOKROUSOV, 2000, 2003, 2008, 2010) and in southernmost Montenegro (ĆETKOVIĆ *et al*., 2004), but controversial evidence is reported about its occurrence/establishment in some other southern European countries (BITSCH & BARBIER, 2006; DAISIE, 2008b; RASPLUS, 2010; RASPLUS *et al*., 2010; CABI, 2011b).

The two Asian species are chromatically distinctive, hence easily recognised among other members of the genus found in Europe (SCHMID-EGGER, 2005; BITSCH & BARBIER, 2006). They are closely related and belong to the subgenus *Hensenia* Pagliano & Scaramozzino, 1990, which is predominantly distributed in Asia; *S. funestrum* is the only native member of this subgenus in Europe, while the rest of the European *Sceliphron* fauna belongs to the nominotypical subgenus, distributed worldwide. Described in the second half of the 19th century, *S. curvatum* was treated as synonymous with *S. deforme* by several authors, the most influential being KOHL (1918) in his landmark generic monograph; its separate species status was restored by BOHART & MENKE (1976) and VAN DER VECHT (1984), but in part of the more recent literature, the failure to recognise the existence of two species has remained (e.g. KAZENAS, 2001). After HENSEN's (1987) revision, their separate status and identification seem to be well established, but the practical problems may appear due to poor understanding of the full range of variability in both species, particularly where the ongoing spreading has brought (or soon will bring) about the overlap of their allochtonous ranges in diverse newly established areas of colonisation.

In order to clarify the mentioned controversies about *S. deforme*, and in view of recent accumulation of new data, we are reviewing the state of knowledge of both introduced Asian species, with focus on the two principal areas: the Balkan Peninsula and European Russia. Also, for *S. curvatum* we are providing an

updated concise overview of the entire European range, since all recent reviews are partly deficient in that respect (e.g. DAISIE, 2008b, 2009; RASPLUS, 2010; RASPLUS *et al*., 2010; BARBIER, 2011; CABI, 2011a). Furthermore, given the current state, that the eastward spreading of both species in Europe could soon extend their allochtonous ranges into western Asia, it was of interest to include a brief consideration of the known western limits of their native ranges in Asia.

Material and Methods

The specimens listed in this paper are derived from several sources and collected partly by the co-authors, but also by a number of other persons in different periods and countries, most of them not particularly dedicated to the Sphecidae as a target taxon. Therefore, although not initially designed as a focused study of invasive species, this non-systematic accumulation of new data (including some important published records and other circumstantial facts) enabled a more comprehensive survey.

Some of the co-authors studied separate parts of the listed material, and also numerous other specimens (for comparative purposes) from the territories outside the focal area treated herewith; they are not listed, but are conveniently mentioned in respective sections. Some of the listed records are based only on the co-authors' observations in the field (mainly in the period after 2000) in cases when reliable identification was possible. A few records (of *S. curvatum*) are based only on collected or observed nest-cells where there was no possibility to examine adults, and they were used only for the areas where there is a minor chance that both species can occur.

Depositories of the studied material, listed herewith, are:

BGFB – University of Belgrade, Faculty of Biology collection (Belgrade, Serbia)
BOGU – Petr Bogusch personal collection (Hradec Králové, Czech Republic)
ĆETK – Aleksandar Ćetković personal collection (Belgrade, Serbia)
HLAV – Peter Hlavač personal collection (Košice, Slovakia)
LINZ – Biologiezentrum / Oberösterreichische Landesmuseen (Linz, Austria)
MMOK – Mikhail Mokrousov personal collection (Nizhniy Novgorod, Russia)

In addition, several records are based on numerous photographs available from diverse internet forums (as a particularly valuable growing source of contemporary data), principally from:

Opredelenie perponchatokrylykh (osy, pchely, murav'i) [Identification of hymenopterans (wasps, bees, ants)] (http://molbiol.ru/forums/lofiversion/index.php/t133599.html);
HymIS forum (http://www.forum.hymis.de);
Le monde des insectes (http://www.insecte.org/forum);
Forum Entomologi Italiani (http://www.entomologiitaliani.net/public/forum/phpBB3/viewforum.php?f=135);
Biodiversidad Virtual (http://www.biodiversidadvirtual.org/insectarium/Subfamilia-Sceliphrinae-Chalybion-Sceliphron-cat17006.html).

We regarded these records as published, and we referenced them accordingly (sometimes only by the members-defined pseudonyms, as available), regardless of the fact that some have been incorrectly identified, or even not identified. All other published records for the focal areas are also included in the list, assuming that all/most of them are correctly identified. Also, we consulted the comprehensive map compiled by BITSCH & BARBIER (BARBIER, 2011), from the electronic Atlas Hymenoptera (Sphecidae) (http://zoologie.umh.ac.be/hymenoptera/page.asp?ID=1), for additional data in western Europe.

All our identifications are based on recent comprehensive treatments (HENSEN, 1987; SCHMID-EGGER, 2005; BITSCH & BARBIER, 2006), but with the improved interpretation of some characters resulting from this study. Taxonomic improvements are particularly relevant for the identification from photographs; a wider taxonomic treatment that resulted from our survey will be published separately (ĆETKOVIĆ *et al.*, unpublished).

Results

In total, we studied 93 specimens of *S. deforme* (49♀ 44♂) and 100 specimens of *S. curvatum* (84♀ 16♂) from the focal areas (listed herewith), as well as numerous additional specimens of *S. curvatum* from central Europe (Austria, Czech Republic, Slovakia; not listed), and a few available specimens of *S. deforme* from Asia (China, Japan: 6♀ 1♂; not listed); a few were included only from the observations of adults. About 10 specimens are listed from internet-based sources (1♀ of *S. deforme*, 6♀ of *S. curvatum* and 3♀ of ambiguous identity; see the elaboration below), and many more are only mapped (from the countries outside the focal areas).

We are presenting all the available data for the area extending from the westernmost Balkans, through Ukraine and European Russia to western/central Asia, both as a list of records and in two respective detailed maps (Figs. 2 & 3). Records based on the material we studied are presented in full detail, and the already published data are conveniently condensed. All the listed records, as well as most of the available data for Europe, are also presented in a large scale synoptic map (Fig. 1). This map is intended to be as comprehensive as possible, particularly with respect to the recently colonised peripheral areas of the expanding allochtonous range of *S. curvatum*; however, it is certainly not exhaustive, since new records are accumulating quite rapidly in some better covered areas. A selection of the most characteristic years of first detections for each alien species across Europe is shown, marking the observed "milestones" in the respective range limits expansion in different directions; the three expansion centres, as initially detected, are emphasised: Austria – 1979, Russia – 1984, and Montenegro – 2002 (the latter one dubiously, see below).

We mapped, as exactly as possible, about 270 different localities, from 27 countries of Eurasia (with only 7 Asian countries being within the respective native ranges of the two species); both kind of occurrences now exist in Russia, so we listed separately its European and Asian part. Also, we listed several erroneous country records for *S. deforme* (and elaborated in respective section). The approximate total longitudinal span of the (combined) allochtonous ranges of the two alien species in Europe currently exceeds 4,000 km, and both species are gradually approaching the westernmost limits of their respective natural ranges in Asia.

Sceliphron deforme (Smith, 1856)

Montenegro. Material: Ulcinj County, Vladimir Village, 26.08.2002. (leg. Ćetković A.): 3♀ [ĆETK] + several more observed collecting mud (reported in: ĆETKOVIĆ *et al.*, 2004).

Greece: Material: Corfu Isl., Dasia, 21.06.2011 (leg. Antić D.): numerous nest-cells and several adults observed in the room of a tourist resort house, 1♀ 1♂ reared from collected cells [ĆETK].

Russia (European). Material: Nizhegorodskaya Oblast: Arzamas Reg., Staraya Pustyn Village, 18.07.1984 (leg. Krivonogov): 2♀, 12.06.1986 (leg. Krivonogov): 1♂; (all others from this locality are leg. Mokrousov M.): 19.07.2000: 7♀ 1♂, 27.07.2000: 4♂, 02.07.2001: 1♀ 1♂, 07.07.2001: 1♀ 4♂, 27.06.2002: 1♂, 04.07.2003: 3♀ 4♂, 14.07.2003: 1♂, 16.07.2003: 3♂, 18.07.2003: 1♀, 20.07.2003: 1♂, 23-24.07.2003: 1♀ 1♂, 16.08.2003: 4♀, 20.08.2003: 1♀, 07.07.2004: 3♂, 14-15.07.2004: 1♀ 1♂, 21.07.2004: 1♀, 24.07.2004: 1♂, 19.07.2005: 1♀ 1♂, 26.07.2005: 3♀, 29.07.2005: 2♀, 20.07.2008: 2♂, 12.07.2010: 1♀,

14.07.2010: 2♀, 30.06.2011: 9♂, 12.07.2011: 2♀ 1♂ [MMOK] (this locality, without further details, reported in: MOKROUSOV, 2000, 2003); Dalnekonstantinovo Reg., Kurilovo Village, 03.08.2003 (leg. Mokrousov M.): 1♀ [MMOK]; Kstovo Reg., Zeleniy Gorod, 02.06.2006 (leg. Mokrousov M.): 1♀ [MMOK]; Priokskiy Reg., Nizhniy Novgorod, 28.06.2006 (leg. Ermilov): 1♀ [MMOK]; Ardatov Reg., Muchtolovo Village, 24.07.2008 (leg. Mokrousov M.): 2♀ 1♂ [MMOK]; Pervomaisk Reg., Lesozavod Village, 26.06.2009 (leg. Mokrousov M.): 1♂ [MMOK] (areas of collection before 2009, but without specimen, locality and date details, are reported in: MOKROUSOV, 2008). Mordovian Republic: Temnikov Reg., c. Temnikov, 27.07.2011 (leg. Mokrousov M.): 1♀ 1♂ [MMOK]; Temnikov Reg., Pushta Village, 30.07.2011 (leg. Ruchin A.): 1♀, 20.07.2011 (leg. Ruchin A.): 2♀ [MMOK]; Mordovian State Natural Reserve «Mordovskiy», 27.07.2011 (leg. Mokrousov M.): 1♀ [MMOK], 30.07.2011 (leg. Mokrousov M.): 1♀ [MMOK].

Russia (Asian). Published records: Krasnoyarskiy Kray, Minusinskiy Reg., Malaja Minusa Village 29.08.2009: 1♀ (AKULOV, 2009; DANILOV, 2011); also, a dozen specimens were collected in 2011 by Akulov E. (AKULOV, 2011: personal communication).

Kazakhstan. Published records: Semipalatinsk [now Semey; type locality of ssp. *atripes* (Morawitz, 1888)] (HENSEN, 1987; PULAWSKI, 2011); Priirtysh'e, 10 km N of Semipalatinsk (KAZENAS, 2002); Zaysan (GUSSAKOVSKIJ, 1933, 1934, 1938 – cf. KAZENAS, 2002); Zaysanskiy rayon (KAZENAS, 2002); Almaty: Almaty okr., Chemolgan, Issyk (KAZENAS, 2002); Karzhantau, 30 km S of Lenger (KAZENAS, 2002); W Tien Shan Mts (KAZENAS, 2004 – cf. PULAWSKI, 2011).

Erroneous records (see explanation below): "Greece: Volos" (BITSCH & BARBIER, 2006); "Bulgaria: Hisarja" (BITSCH & BARBIER, 2006); "Italy: Emilie-Romagne, Bargellino" (BITSCH & BARBIER, 2006); "plusieurs pays d'Europe centrale" (BITSCH & BARBIER, 2006); "France" (DAISIE, 2008b; RASPLUS *et al*., 2010; CABI, 2011b).

Sceliphron curvatum (Smith, 1870)

Slovenia. Material: Portorož, at the students' dormitory, 22.06.2009 (leg. Bogusch P.): 2♂ [BOGU]. Published records: Prekomurje: Gančani, 12.08.1991; Barje: Lukovica, 07.07.1991; Kras: Brje pri Komnu, 11.08.1992 (GOGALA, 1995).

Croatia. Material: Bašanija, at the sea, 22.06.2009 (leg. Bogusch P.): 2♂ [BOGU]; Rovinj [NB: coordinates given on the label – 45º 26' 13º 41', are pointing away from Rovinj, so we mapped the city], 09.07.2004 (leg. Gusenleitner J.): 1♀ [LINZ]; Primošten, in the hotel "Zora", 01.07.1996 (leg. Bogusch P.): 3♀ [BOGU]; Krka River waterfalls near Skradin, 30.07.2002: photo of 1♀ (reported in: ĆETKOVIĆ *et al*., 2004); Makarska, Tučepi, 07.08.2003 (leg. Hlavač P.): 2♀ [HLAV]; Brač Isl., Sumartin, 31.08.2004 (leg. Kment P.): 1♀ [BOGU]; Brač Isl., Sumartin, 14.09.2005 (leg. Bogusch P.): 1♀ [BOGU]. Published records: Rovinj (2 km SE), 01. and 06.07.1996 (GUSENLEITNER, 1996); Krk Isl., Klimno, 07.1996: 3♀ (STRAKA *et al*., 2004); Cres Isl., 2003 (SCHMID-EGGER, 2005); Lovran, 20.06.2003: 2♂; Lovran, Sveta Jelena, 23.06.2003: 1♀; Pazin, Lindar, 17.06.2009: 1♂; Pazin, Gračišće, 17.06.2009: 2♂; Labin, Koromačno, 21.06.2003: 1♀; Labin, Most-Raša, 22.06.2003: 1♀; Pula, Medulin, 27.06.2004: 1♀; Zadar, Bibinje, 21-28.07.2001: 1♀ (all by JÓZAN, 2009).

Serbia. Material: Fruška Gora Mt, Banoštor Village, 22.04.2008 (leg. Ćetković A.): 1♂ [ĆETK]; Fruška Gora Mt, near old Beočin Village, 01.08.2008 (leg. Ćetković A.): 5♀ [ĆETK], + several more observed collecting mud; Fruška Gora Mt, Paragovo Village, 2009 (leg. Savić D.): 1♀ [ĆETK] (also photo at: SAVIĆ, 2009); Sremska Mitrovica: Zasavica, March 2003: several empty nest-cells (reported in: ĆETKOVIĆ *et al*., 2004); Pančevo, near Jabuka Village, 15.07.2009 (Ćetković A.: observation): 1 specimen; Belgrade, city area (Konjarnik, 10.06.1997: 1♀; Pašino Brdo, Sept. 2001: 1♂ + several empty nest-cells; autumn 2003: several empty nest-cells; central area, 05.09.2002: 1♀; 05.08.2003: 1♀; Miljakovac, 28.06.2003: 1♀ – all reported in: ĆETKOVIĆ *et al*., 2004); Belgrade, city area: Trg Republike, 19.07.2009 (Ćetković A.: observation): 1♂;

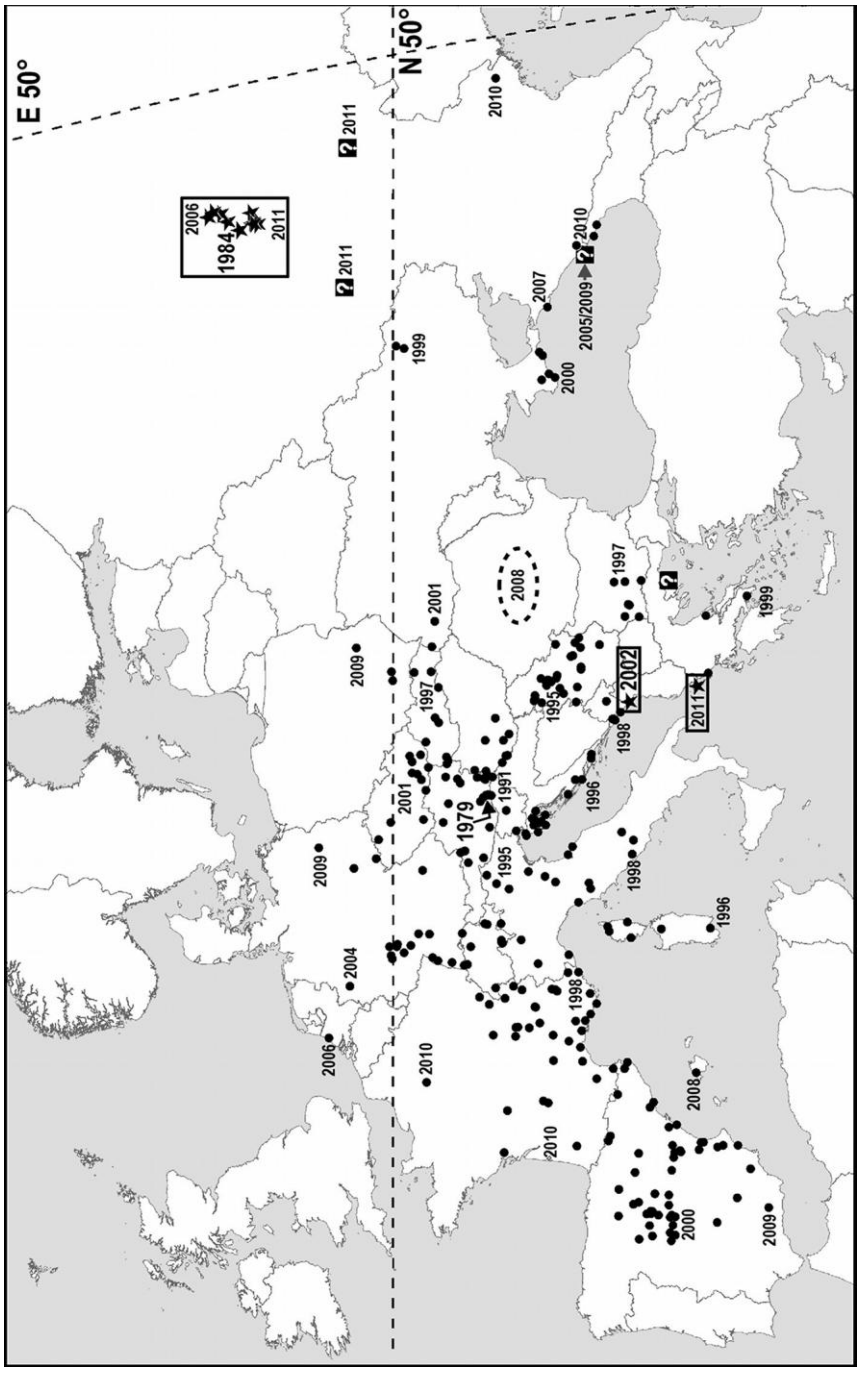

Figure 1. Distribution map of *Sceliphron (Hensenia) deforme* [black stars] and *Sceliphron (Hensenia) curvatum* [black dots] in Europe (question mark symbols denote the ambiguous identity of the recorded species). Most characteristic years of first detection are shown (no precise locality available from Romania).

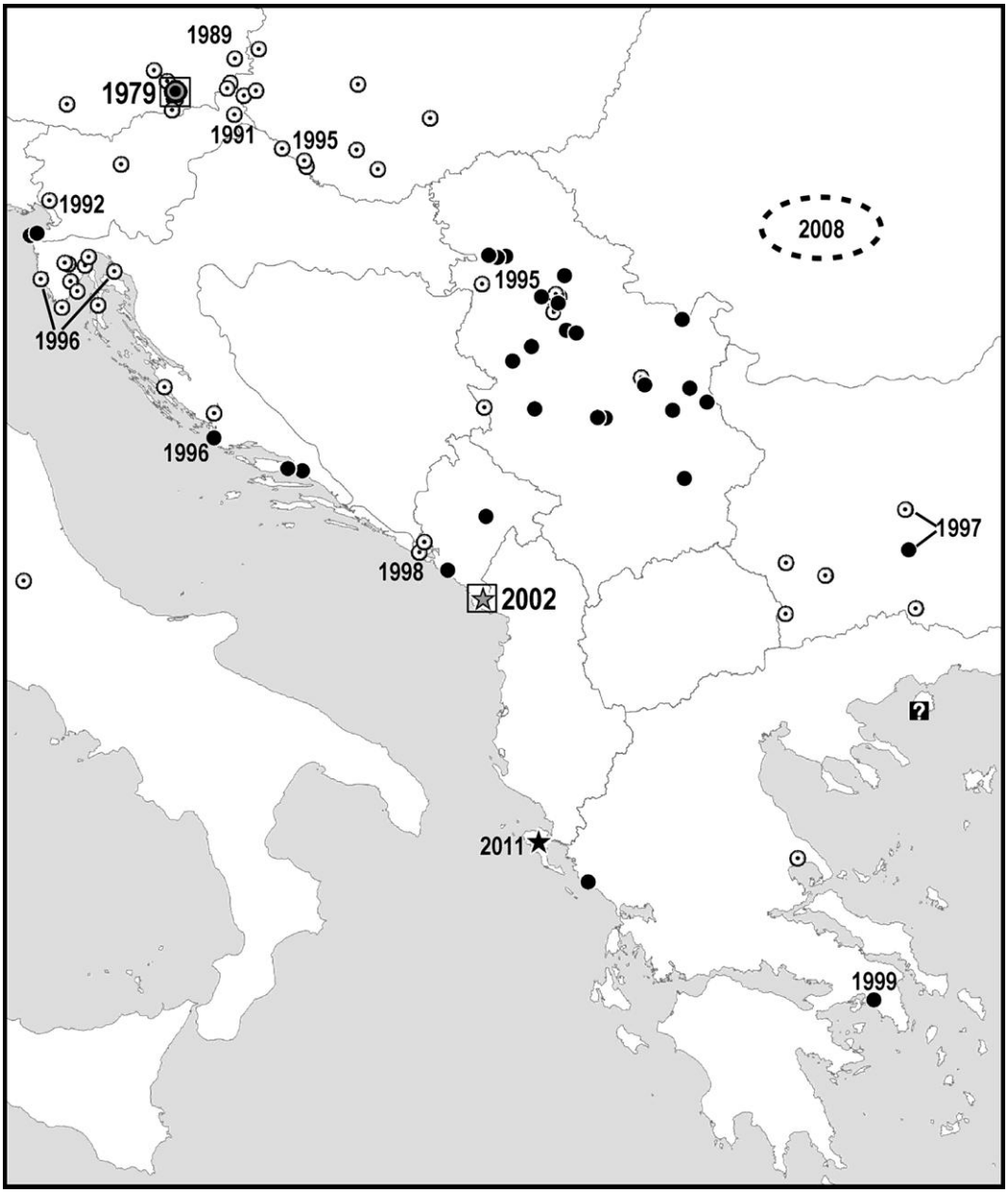

Figure 2. Distribution map of *Sceliphron (Hensenia) deforme* [gray star: published record; black star: new record] and *Sceliphron (Hensenia) curvatum* [empty dots with point: published records; black dots: new records] in the Balkans and adjacent areas (the remark on question mark symbol and the years as in Fig. 1).

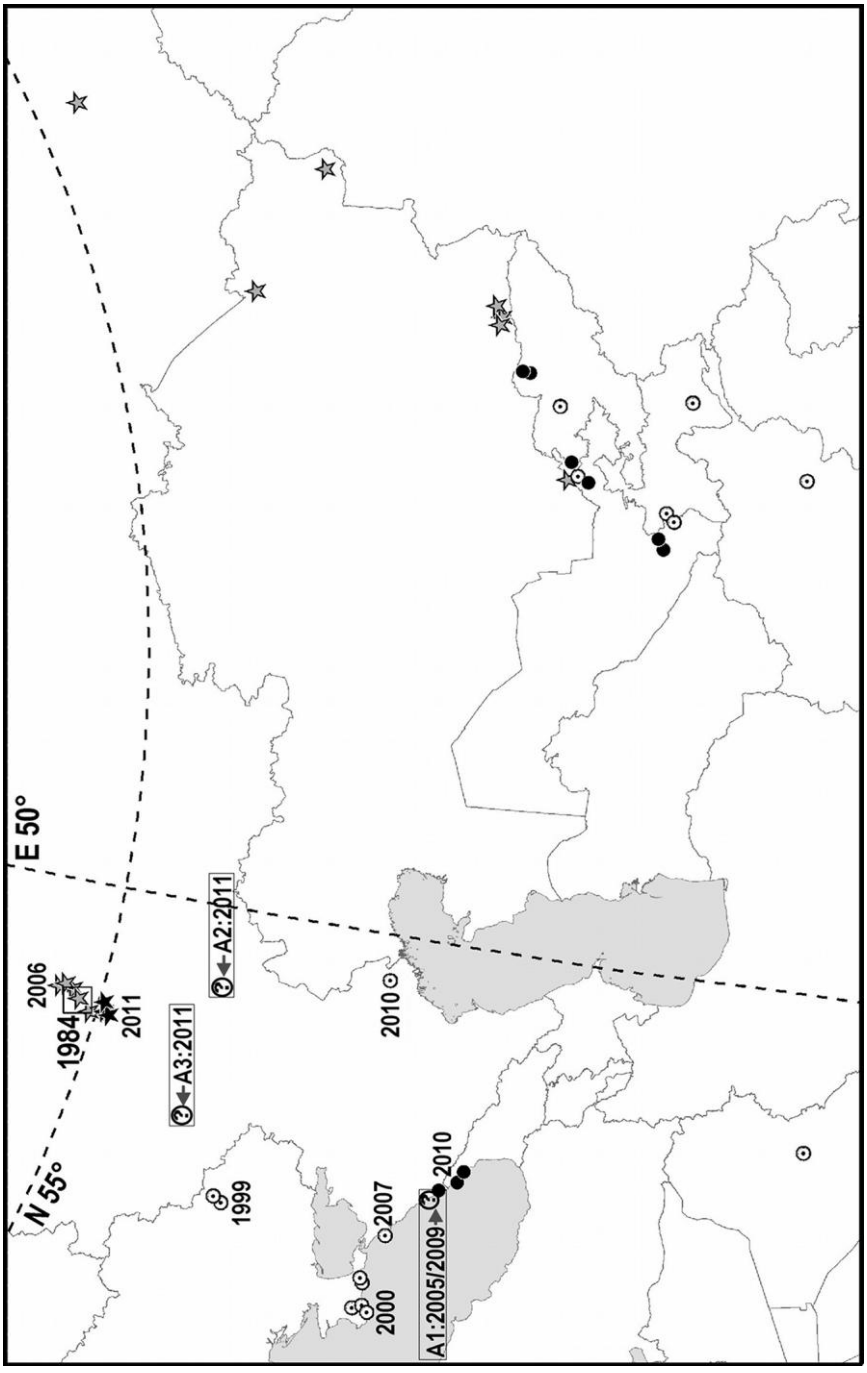

Figure 3. Distribution map of *Sceliphron (Hensenia) deforme* [gray stars: published records; black stars: new records] and *Sceliphron (Hensenia) curvatum* [empty dots with point: published records; black dots: new records] in easternmost Europe and western to central Asia (the remark on years as in Fig. 1, shown only for the allochtonous range); ambiguously identified internet-based records are labelled as follows: ?/A1 – Sochi Region, ?/A2 – Saratovskaya Oblast, ?/A3 – Voronezhskaya Oblast. The records shown for Asia represent the northwesternmost range limits in the known natural distribution of each species, according to available taxonomic interpretation.

Belgrade env., Surčin Village, summer 1995 (leg. Milivojević T.): 1♂ [ĆETK]; Belgrade env., Rakovica Village, 23.08.2004 (leg. Ognjenović S.): 5 nest-cells; 18.09.2004 (leg. Ognjenović S.): 1♀ + 9 nest-cells [ĆETK]; Belgrade env.: Sremčica/Lipovička šuma (04-08.07.2000: 3♀ 2♂ + numerous nest-cells observed; 17-31.07.2003: several nest-cells collected, 2♀ 2♂ emerged – all reported in: ĆETKOVIĆ *et al*., 2004); Sremčica/Lipovička šuma, 31.07.2004 (leg. Đorović, Lj.): 9 nest-cells (only 1♂ hatched, by 21.08) [ĆETK]; Kosmaj Mt, summer 1996 (leg. Milivojević T.): 1♂ [BFBG]; Mladenovac, 17.06.2006 (leg. Vasilić I.): 1♀ [BFBG]; Lajkovac, Ratkovac Village, 03.08.2003 (leg. Milutinović V.): 1♀ [BFBG]; Valjevo, Lelić Village, 14-15.08.2006 (unknown collector): 2♀ [BFBG]; Tara Mt: Beli Rzav Gorge, 16.07.2003: 7♀ + many more observed collecting mud (reported in: ĆETKOVIĆ *et al*., 2004); Arilje, Stupčevići Village, 30.07.2004 (leg. Popović S.): 1♀ [ĆETK]; Vrnjačka Banja, 15.06.2004 (leg. Bošković M.): 1♀ [BFBG]; Trstenik, Bučje Village, Sept. 2010 (leg. Nedović S.): 2 nest-cells [ĆETK]; Leskovac env., summer 2003 (leg. Plavšić J.): 1♂ [ĆETK]; Paraćin, Buljane Village, July 2010 (leg. Tomić A.): 1♀ [BFBG]; Ravanica Monastery, summer 2003: 4♀ + numerous nests-cells (reported in: ĆETKOVIĆ *et al*., 2004); Sokobanja, 30.09.2004 [found dead in hotel room] (leg. Pavićević D.): 1♀ [ĆETK]; Beli Timok Valley, Minićevo, Jakovac Village, 11.07.2007 (leg. Pavićević D.): 1♀ [ĆETK]; Zaječar, Planinica Village, Del Hill, 20.08.2004 (leg. Ognjenović S.): 14 nest-cells [ĆETK]; Donji Milanovac, Lepenski Vir, 24.09.2011 (leg. S. Čkrkić): 1♀, found dead in museum building [ĆETK].

Montenegro. Material: Boka Kotorska: Herceg-Novi, Igalo, 24-26.06.1998: 2♀ (reported in: ĆETKOVIĆ *et al*., 2004); Bečići (on beach), 26.08.2004 (leg. Bogusch P.): 3♀ 1♂ [ĆETK] ; Morača Monastery, 27.08.2004 (leg. Bogusch P.): 1♀ [BOGU]. Published records: Orijen Mt, 300 m, August 2005: photo of 1♀ (OLLIVIER, 2005).

Greece. Material: Athens env., May 1999 (leg. Luhovec): 1♀ [LINZ]; Párga, at Valtos beach, 09-12.08.2006 (leg. Bogusch P.): 2♀ [BOGU]. Published records: Volos, Platania env, 08.09.2001, 15.06.2002, 01.10.2002, 14.07.2003, 08.08.2003, 17.08.2003, 25.08.2003, 01.09.2003: total 10♀ (SCHMID-EGGER, 2005; STANDFUSS & STANDFUSS, 2006).

Bulgaria. Material: Trakia: Proslav, 15.07.1997 (leg. Zaykov): 1♀: [LINZ]. Published records: Hisarja, 1997: 3♀ ; Rila Mt, 2004 (SCHMID-EGGER, 2005); Rhodope Mts: Yurukovo Village (LJUBOMIROV, 2006); Rhodope Mts, Smolyan cca 1000 m (BOCH, 2009); Maleshevska Mt (GUÉORGUIEV & LJUBOMIROV, 2009).

Romania. Published records: No locality data, August 2008: photo of 1♀ and several nest-cells ("COSMLN", 2008); No locality data, August 2010: photo of 1♀ ("ALEXAANDRU", 2010).

Ukraine. Material: Zakarpatskaya Oblast, Uzhgorod reg., Kamenitsa Village, 24.07.2009 (leg. Mokrousov M.): 2♀ [MMOK]. Published records: Zakarpatskaya Oblast: Mezhgorskiy r-n, 15.07.–12.08.2001: 1♀; Har'kovskaya Oblast: Har'kovskiy r-n, 17.07.2001: 1♂, 03-05.06.2002: 1♀ 14♂; Zmievskoy r-n, 06.06.1999: 5♀ 1♂, 27.06.1999: 2♀, 21.06.2000: 1♀, 24.06.2001: 1♂; Crimea: Simferopol', 15.06.2000: 1♀; Jalta, 22-28.07.2000: 3♀, 08.2000: 5♀ 1♂ (all by SHORENKO, 2004); Crimea, Karadagh Nature Reserve, Feodosija (SHORENKO, 2005); Crimea, Alushta reg., Izobil'noe Village, 24.07.2007: 3 spec. (SHORENKO, 2007); Zapov. Karadaghskiy, 20.07.2009: 1♂ (SHORENKO & KONOVALOV, 2010).

Russia (European). Material: Krasnodarski Kray, Sochi Reg., c. Sochi, 16.06.2010 (leg. Mokrousov M.): 2♀ [MMOK]. Published records: Krasnodarski Kray, btw. Anapa and Novorossiysk, Malyi Utrish, 25-29.09.2007: 13 ♀ (PROKOFIEV & SKOMOROKHOV, 2010); Astrakhan, Rychansky settlement, 2010: photo of 1♀ (BOROZNOV, 2010).

Georgia/Abkhazia. Material: Gagra reg., c. Pitsunda, 13.06.2010 (leg. Mokrousov M.): 3♀ [MMOK]; Gudauta reg., c. Noviy Afon, 02.06.2010: 4♀ 1♂, 07.06.2010: 5♀, 10.06.2010: 2♀, 12.06.2010: 3♀ (leg. Mokrousov M.) [MMOK].

Iraq. Published records: Baghdad: Waziriya (ABDUL RASSOUL, 1976, from PULAWSKI, 2011).

Afghanistan. Published records: Kabul (BEAUMONT, 1970, from HENSEN, 1987).

Tajikistan. Published records: Kalai-Vamar, Roshan (HENSEN, 1987); Hissar Range (GUSSAKOVSKIJ, 1940, from PULAWSKI, 2011).

Uzbekistan. Material: W-Zeravshan Mts, Dzhindydaria Valley, 39º 12' N 67º 16' E, 1300 m, 03.07.1999 (leg. Makogonova I.): 1♀, det. as *S. deforme* by Kazenas in 2000 [LINZ]; Kashkadaria Reg., nr. Shakhrisabz City, 39º 03' N 66º 50' E, 650 m, 06.07.1999 (leg. Makogonova I.): 1♀, det. as *S. deforme* by Kazenas in 2000 [LINZ]; Tchatkal Mts, Bashkyzylsai River Canyon, 41º 11' N 69º 50' E, 1300 m, 05.08.1999 (leg. Makogonova I.): 2♀, det. as *S. deforme* by Kazenas in 2000 [LINZ]. Published records: N. Tashkent, Gr. Tchimgan (HENSEN, 1987 [listed as from Kazakhstan]); Tashkent Oblast' (ISLAMOV, 1986, from PULAWSKI, 2011); Zevar (GUSSAKOVSKIJ, 1935, from PULAWSKI, 2011 [listed as from Tajikistan]).

Kyrgyzstan. Material: N-slope of Kirghizsky Mt. Ridge, Ala-Artcha Valley, 1700 m, 07.06.1999 (leg. Makogonova I.): 1♀, det. as *S. deforme* by Kazenas in 2000 [LINZ]; Jalal-Abad Reg., Chatkal Valley 1 km W Ak-Tash Village, 41°42'11"N, 70°37'30"E, 21.06.1999 (leg. Mokrousov M.): 1♀ [MMOK]; Chuyskaja Reg., c. Bishkek, 08.07.1999 (leg. Mokrousov M.): 1♀ [MMOK]. Published records: Toktogul, 1999 (SCHMID-EGGER, 2005).

Sceliphron deforme or *curvatum* (specimens of ambiguous identity)

Greece. Published records: Thasos Isl., Pefkari Village, August, 2002: 1 specimen [observed by AĆ & JKĆ, without a possibility to distinguish between the two species] (ĆETKOVIĆ *et al*., 2004); hence, it remains indeterminable, and is labelled accordingly on the maps.

Russia (European). Published records: Sochi, August 2009: photo of 1♀, with a comment "occurring there in the last 4 years, as quite numerous, ..." (OGANESOV, 2009); Saratovskaya Oblast, pos. Burkin Buerak, 05-07.08.2011: photo of 1♀ (ZABALUEV, 2011); Voronezhskaya Oblast, Novousmanskiy Rayon, July/August 2011: photo of 1♀ ("KOLLEKCIONER", 2011).

Discussion

Sceliphron deforme: Review of the published distribution

The native range of this species includes vast areas in temperate to subtropical and, less extensively, tropical Asia, from eastern Kazakhstan, and Russian central Siberia (S Krasnoyarskiy Kray) to Amurskaya Oblast, Primorskiy Kray, and Japan in the north, and from north/northeastern India and Myanmar to Thailand, Laos, N Vietnam, Philippines, and Taiwan in the south, encompassing large areas in China and Mongolia (HENSEN, 1987; NEMKOV, 2009; DANILOV, 2011; PULAWSKI, 2011). Among the westernmost recorded countries, the inclusion of Uzbekistan, Kyrgyzstan, and Tajikistan (KAZENAS, 2002; NEMKOV, 2009; DANILOV, 2011) was probably based only on misidentifications (cf. PULAWSKI, 2011; see also below). Within this large range, five subspecies have been recognised, loosely based on a somewhat perplexing pattern of colouristic and morphological variability (HENSEN, 1987). As introduced, it has been reported from two widely separated locations in Europe: Russia and Montenegro.

The first record for Europe was published from Nizhegorodskaya Oblast (MOKROUSOV, 2000), in the central part of European Russia, and commented as the northernmost known location for this species, but without special reference to the fact that it was not known in Europe before. A few years later, MOKROUSOV (2003) published a species account in the "Red Book of Nizhniy Novgorod Oblast", where he treated *S. deforme* as

"the category V3 species – becoming rare due to human activities", but also regarded its populations as "stable in the last 30 years, based on collections". Also, he pointed out the fact that this is the single known population in European Russia, widely separated from its main range in Asia. Later on, the same author recognised the fact that *S. deforme* is actually an introduced species, and officially proposed its removal from the Red Book (MOKROUSOV, 2008, 2010; MOKROUSOV & ZRYANIN, 2010) as being "a synanthropic species with a tendency to spread, similar to its relative *S. curvatum* in western Europe". However, MOKROUSOV's reports on *S. deforme* in European Russia have not made their way to the wider audience involved in the studies of invasive alien insects: only his Red Book contribution (2003) was included in PULAWSKI's comprehensive bibliography of the Sphecidae (2011; also in earlier versions since 2007); also, only two titles are recently cited by Russian authors (PROKOFIEV & SKOMOROKHOV, 2010; DANILOV, 2011).

Unaware of MOKROUSOV's first two reports (available by 2003), ĆETKOVIĆ *et al*. (2004) published their "first record of *S. deforme* in Europe", based on the specimens collected in 2002 in Montenegro. This record was included in the subsequent wider treatment of the genus *Sceliphron* in Europe (SCHMID-EGGER, 2005), which had its principal emphasis on the first recorded Asian species – *S. curvatum*. Both ĆETKOVIĆ *et al.* (2004) and SCHMID-EGGER (2005) pointed out the necessity that all records of *S. curvatum* in Europe since 2002, and even most of the previous ones, be (re)checked for the possible presence of another (similar) alien species of the subgenus *Hensenia. .*Accordingly, SCHMID-EGGER (2005) thoroughly elaborated on the identity of all available European specimens and literature data (i.e. being or not being checked), on a country-to-country basis, also without any reference to the Russian records.

In the next wider treatment of *Sceliphron* in Europe, BITSCH & BARBIER (2006) inadvertently misinterpreted some of SCHMID-EGGER's (2005) elaborations regarding the identity issue of *S. curvatum* vs. *S. deforme*. Namely, in addition to the correctly cited Montenegrin record, they ascribed to SCHMID-EGGER (2005) some non-existent reports of *S. deforme*, from Italy ("un mâle pris à Bargellino, en Emilie-Romagne, le 20.VIII.1998" – p. 229), Bulgaria ("les trois femelles prises à Hisarja, ... le 22.VI.1997, précédemment identifiées comme *S. curvatum...*" – p. 230) and Greece ("à Volos ..., qui rapporte ces observations, rattache les exemplaires à l'espèce *S. deforme*..." – p. 230); they summarised the known European distribution of *S. deforme* as: "Signalée de plusieurs pays d'Europe centrale, de Grèce et d'Italie du Nord, mais non connue de France" (p. 235). Later on, BITSCH (2010) omitted, without comments, all other countries except Montenegro and tentatively Greece ("pourrait se trouver également en Grèce"), correctly interpreting the only confirmed and one uncertain record from ĆETKOVIĆ *et al*. (2004).

However, the erroneous treatment of the European range of *S. deforme* was partly retained and even extended in several subsequent publications (DAISIE, 2009; RASPLUS, 2010; RASPLUS *et al*., 2010; ROY *et al*., 2011), derived from the landmark EU/FP6 project "Delivering Alien Invasive Species Inventory for Europe" (HULME & ROY, 2010; etc). Most noteworthy are the detailed reviews of the status of invasive Hymenoptera in Europe (RASPLUS, 2010; RASPLUS *et al*., 2010 – both as chapters in the book "*Arthropod invasions in Europe*"). Following BITSCH & BARBIER (2006), RASPLUS (2010: p. 983) portrayed distribution of *S. deforme* as present in "Bulgaria, Greece, Italy and Montenegro", while in the same publication, RASPLUS *et al.* (2010: p. 755) listed Montenegro and France as invaded countries, they also gave the wrong year of introduction (1998), all based allegedly on ĆETKOVIĆ *et al.* (2004) as the only reference; in another place in the same paper, they correctly cited only "Balkans" (p. 678). The listing of France, derived from the unspecified data source incorporated earlier in the DAISIE (2008b) information system, probably appeared there as a technical error, since no other report of the species' occurrence in that country exists anywhere. Finally, comprehensive CAB International database on invasive species (CABI, 2011b) also reproduced the erroneous country record for France, citing the same source (DAISIE, 2008b).

Obviously, none of the above country records, except for Russia and Montenegro, was based on correct facts. Given the growing interest in the detection and monitoring of the invasive (and potentially invasive) species, we consider it very important to eventually rectify the ongoing perpetuation of published errors regarding *S. deforme* status in Europe, and to provide reliable evidence about the course of its introduction.

Sceliphron deforme: History of spreading – current state of evidence

As shown in the list of material, the earliest known specimens of *S. deforme* in the Nizhegorodskaya Oblast were collected in 1984, but according to observations of older colleagues (personal communication of MM), it appeared in this area even some years earlier. The very location of Staraya Pustyn' is the biological (field) station of the Nizhegorodsky State University, which regularly organised scientific/educational visits to central Asia and Russian Far East during the 1970s and 1980s. Therefore, the most plausible scenario of introduction could be a deliberate transportation of wasps' nests, possibly for rearing experiments. An alternative possibility would be a merely accidental transportation of nests (as unintentional shipment), which although considered common in numerous other cases of *Sceliphron* introductions (SCHMID-EGGER, 2005; etc.), is not so easily conceivable in this case.

The established population of *S. deforme* in the Nizhegorodskaya Oblast agrees with ssp. *atripes* (Morawitz, 1888), as defined by HENSEN (1987). This relatively dark subspecies inhabits the extensive northern part of the species range in Asia: from eastern Kazakhstan to Primorskiy Kray and Korea, including southern Siberia, Mongolia and parts of northern China. The distance between the Nizhegorodskaya Oblast and the nearest known occurrence within its native range is about 2,400-2,500 km (Kazakhstan: Karzhantau and Semipalatinsk, respectively), but it could have been transported from an even more remote area.

After its first detection in the early 1980s, *S. deforme* remained only locally distributed for the following two decades, with moderate but relatively stable population levels. Only in 2003 was it detected outside the Arzamas Region, and after that, it slowly extended its distribution about 70 km northwards by 2006 (Nizhniy Novgorod), and about 110 km southwards by 2011 (c. Temnikov, Mordovian Republic). Recently, it has become quite abundant in central and southern parts of the Nizhegorodskaya Oblast and northern parts of the Mordovian Republic, and it probably continues to spread further. As documented for *S. curvatum* (see below), the exact recording of new points in the ongoing range expansion often postdates the actual establishment of new local populations. Therefore, it is likely that the allochtonous range of *S. deforme* ssp. *atripes* in European Russia is already wider than we can currently document (see also below).

The situation with the introduction of *S. deforme* in the Balkans is quite different with respect to the source population/subspecies as well as to the status and dynamics of establishment/spread. Based only on three female specimens available from Montenegro and one from Greece, the recorded population obviously belongs to a more xanthic form (the single available male specimen is considerably darker, but this may not be a predominant state in the population, particularly since males in both *Hensenia* species are generally known to show higher incidence of melanism). However, their colour pattern does not agree with any of HENSEN's (1987) subspecies; tentatively, they may be regarded as closest to some southern Chinese populations of nominotypical subspecies ("ssp. *deforme* sensu lato"). Moreover, all specimens from the Balkans share a distinctive morphological feature (shape of the first metasomal segment), clearly different from that of the Russian populations (a detailed taxonomic treatment of European populations are presented in a separate paper – ĆETKOVIĆ *et al.*, unpublished). Apparently, two different subspecies of *S. deforme* have been the source populations for these two widely separated introductions into Europe. Generally, the inference about the subspecific affiliation of invading individuals, if reliable, could point to a wider area of their possible origin, and maybe also to the ecological preferences of the establishing populations.

ĆETKOVIĆ *et al.* (2004) recorded that the local population in Vladimir Village (southern Montenegro) was apparently quite numerous in 2002, but already in 2003 no activity of this species in the same area could be detected. In the meantime, there was no opportunity to check for the presence of this species in Montenegro, until the last two seasons (2010-2011) when one of the co-authors (MK) tried to find it in the wider area of the Montenegrin coast (including Vladimir Village), without a positive result. Therefore, based on the current evidence, it seems that the establishment of the local population in southeastern Montenegro, although initially successful, failed to turn into a persistent colonisation and successive spreading north/westwards (we must stress, however, that our monitoring efforts may not be sufficient to assert the very conclusive judgment here).

As elaborated by ĆETKOVIĆ *et al.* (2004), it is unlikely that the locality of the first record (Vladimir) was the place of initial establishment in the Balkans. This small settlement along the road that connects the most important Montenegrin port (the city of Bar) and the largest city in northern Albania (Shkodra) could be merely a point of an accidental secondary drop-out from the local transportation, originating from the primary colonisation area, probably in Albania. Regarding the relative paucity of data on Sphecidae from the Balkans, and particularly the fact that no record of any *Hensenia* species is known from Albania, FYR Macedonia, and most of the inland Greece and Montenegro, until recently we could have only hypothesised that some population(s) might exist somewhere else in the wider region of the first record. Eventually, this was corroborated with the most recent find from the northwestern Greek Island of Corfu, in June 2011. The island lies very close to the southern border of Albania, and the locality is about 260 km aerial distance from the Montenegrin record (Fig. 1, 2). This second record from the Balkans we consider as the decisive confirmation that *S. deforme* became effectively established in southeastern Europe, possibly more than 10 years ago; however, we cannot even roughly estimate the possible time of its initial arrival. Nevertheless, it seems obvious that its current rate of spreading is considerably lower than was established for the other introduced *Hensenia* species, and/or that its populations are by far less abundant, thus escaping detection.

Some most recent data based on internet sources (photographs) suggests that further spreading of *S. deforme* into southern/eastern European Russia has happened, either from the Balkan or the Nizhegorodsky introduction stock. The reliability of photograph-based identification of the two *Hensenia* species is extensively elaborated in a separate paper (ĆETKOVIĆ *et al*., unpublished); hence, here we will use only some relevant outcomes from that study. Accordingly, the one specimen of *Hensenia* of the 3 listed in the ambiguous records section ("*deforme* or *curvatum*"), photographed in the southernmost part of the Russian Black Sea coast (in Sochi; by OGANESOV, 2009), we regard most probably to be *S. deforme* (of xanthic form). The other, more recent record from southeastern European Russia (Saratovskaya Oblast; by ZABALUEV, 2011), we also regard more likely to be *S. deforme* (of somewhat darker colour form) than *S. curvatum*, although the viewing angle offers less decisive distinguishing characters. The third ambiguous Russian record, based on the photograph from Voronezhskaya Oblast (by "KOLLEKCIONER", 2011), more likely represents *S. curvatum*, but its poor quality prevents a decisive judgement. (Note, however, that we retained the labelling of all three respective localities for these important records as 'ambiguous identity', for now – in Figs. 1 & 3).

Since we have also documented (herewith) the arrival of *S. curvatum* in the Sochi region and neighbouring areas along the Black Sea coast, the assumption of a likely *S. deforme* presence represents the second co-occurrence of the two alien *Hensenia* species in Europe. OGANESOV (2009) commented on his photo-posting for Sochi: "occurring there in the last 4 years, as quite numerous, particularly in comparison with *S. destillatorium*"; this may be interpreted as a possibility that any or both of the two *Hensenia* species could have arrived and become established in the area by 2005. The location of the putative Sochi record is about

1,700 km aerial distance from the closest known area of the xanthic *S. deforme* (SW Balkan), and about 1,300-1,400 km from the much darker Nizhegorodsky populations. Hypothetically, the obvious resemblance in colour pattern suggests the Balkan stock as a probable source of this spreading. However, in such considerations, due care should be taken as to the possible environmental influence on the colour pattern variability, which is not well studied in any part of the species range – native or allochtonous (as elaborated in: ĆETKOVIĆ *et al.*, unpublished). The area of the second putative *S. deforme* record (in Saratovskaya Oblast) lies about 1,000 km north/northeast from Sochi, and about 400 km south/southeast from the closest Nizhegorodsky/Mordovian records (Figs. 1 & 3); hence, also hypothetically (i.e. if we correctly identified this darker specimen), its arrival is more likely derived from the southward expanding Nizhegorodsky stock. In any case, it is least likely that additional introduction(s) into southern/eastern European Russia happened directly from Asia.

These speculative considerations emphasise a need for more exact and detailed evidence to establish accurately and further track the ongoing processes of *S. deforme* spreading in southeastern Europe and Russia.

Sceliphron curvatum: Review of distribution and spreading

The native range of this species extends from Iraq to northern India and Nepal, and from Pakistan to Kyrgyzstan and eastern Uzbekistan (HENSEN, 1987; SCHMID-EGGER, 2005; PULAWSKI, 2011). The first appearance of *S. curvatum* in Europe was documented in southeast Austria in 1979 (VAN DER VECHT, 1984), and since the mid 1990's, a quite rapid expansion of its allochtonous range has been recorded throughout Europe (detailed reviews in: SCHMID-EGGER, 2005; BITSCH & BARBIER, 2006). The published chronology of its spreading in southeastern Europe includes: Slovenia in 1991/1992 (GOGALA, 1995), southwestern Hungary in 1995 (JÓZAN, 1998), westernmost Croatia in 1996 (GUSENLEITNER, 1996; STRAKA *et al*., 2004), northern Serbia in 1997 (ĆETKOVIĆ *et al*., 2004), central Bulgaria in 1997 (JACOBS, 2005; SCHMID-EGGER, 2005), coastal Montenegro in 1998 (ĆETKOVIĆ *et al*., 2004), central (coastal) Greece in 2001 (SCHMID-EGGER, 2005; STANDFUSS & STANDFUSS, 2006), and finally Romania in 2008 ("COSMLN", 2008).

Parallel with its spreading in the southeast of Europe, the species had a rapid range extension in other directions as well, so that its currently established range limits encompass: southern Sardinia by 1996 (PAGLIANO *et al*., 2000), central Italy by 1998 (PAGLIANO *et al*., 2000), southeastern France by 1998 (GONSETH *et al*., 2001), the Balearic Islands by 2008 (CASTRO, 2010), southern Spain by 2009 (LÓPEZ-VILLALTA, 2009; CASTRO, 2010), central Spain by 2000 (GAYUBO & IZQUIERDO, 2006; CASTRO, 2007), southwestern and northwestern France by 2010 (BARBIER, 2011), The Netherlands by 2006 (VAN DER POST, 2007), NW Germany by 2004 (JACOBI, 2005a), NE Germany by 2009 (OHL, 2010), Czech Republic by 2001 (BOGUSCH *et al*., 2004; STRAKA *et al*., 2004), southern Poland by 2009 (BURY *et al*., 2010), northeastern Ukraine by 1999 (SHORENKO, 2004), southwestern Russia by 2007 (PROKOFIEV & SKOMOROKHOV, 2010), and finally, the easternmost points in its European range by 2010: in southeastern European Russia (BOROZNOV, 2010) and Georgia/Abkhazia (this paper); also, the mentioned putative record from Voronezhskaya Oblast ("KOLLEKCIONER", 2011), if confirmed, would represent the northernmost occurrence of this species in eastern Europe. At the beginning of this century, *S. curvatum* also appeared in South America, being recorded first in Argentina in 2001 (COMPAGNUCCI & ROIG ALSINA, 2008) and then in Chile in 2007 (BARRERA-MEDINA & GARCETE-BARRETT, 2008).

Following the above listed set of the first country records for the area of southeast Europe, relatively few additional findings were reported from the Balkans, from southwest Bulgaria (LJUBOMIROV, 2006; GUÉORGUIEV & LJUBOMIROV, 2009; BOCH, 2009), western Croatia (JÓZAN, 2009) and Romania ("ALEXAANDRU", 2010),

contributing little to the previous knowledge of the *S. curvatum* distribution. In the meantime, we also accumulated a number of additional records from most countries of the region, presented herewith (Slovenia, Croatia, Montenegro, Serbia, Bulgaria, Greece – see Fig. 2), but without providing the additional (missing) country records. A few of them have brought about slight changes to the established range limits (in Greece), but more importantly, some modify the recorded history of the species spreading. Of particular interest are the recoveries of the two specimens from northern Serbia (Surčin in 1995 and Kosmaj Mt. in 1996), as well as one from Greece (Athens in 1999), which shift the respective timings of their published "first arrivals" (ĆETKOVIĆ *et al*., 2004; SCHMID-EGGER, 2005) to two years earlier. Correspondingly, our record from central Dalmatia (Primošten in 1996), from the same year as the two earliest country records taken some 200-250 km more northwestwards (GUSENLEITNER, 1996; STRAKA *et al*., 2004), corroborates the fact that the species was well established along most of the Croatian northwestern coastlands at the time of these simultaneous first detections (note that one of the records became available only 8 years later, and the other one only now). Similarly, our additional record of *S. curvatum* from central Bulgaria (Proslav in 1997) confirms the advanced state of its establishment at the moment of the first (published) record, in the same year (JACOBS, 2005; SCHMID-EGGER, 2005).

This re-assessed sequence of "first appearances" southeastwards along the possible spreading routes (cf. SCHMID-EGGER, 2005), from western Slovenia (1992) through the central Croatian coast (1996) and the southern Montenegrin coast (1998) to southern Greece (1999), and from eastern Austria (1987-1989) and northeastern Slovenia (1991), through northern Serbia (1995) to central/southern Bulgaria (1997), renders other intermediate dates less informative in revealing the dynamics of this process (e.g. the Hungarian record in 1995, westernmost Croatian record in 1996, etc.). This also emphasises the fact that the spatio-temporal pattern of discovery of a spreading species usually shows a time-lag relative to the dynamics of its real spread. Given that several important records have resulted from very accidental encounters (often by unprofessional persons), or otherwise from mainly non-systematic collecting, makes interpretations (reconstructions) of spreading dynamics relatively inaccurate. Similarly, the essential lack of *S. curvatum* records from Bosnia & Herzegovina, Albania, FYR Macedonia, Turkey, most of mainland Croatia and Greece, most of Romania, eastern and northern Bulgaria, southern Serbia, southern Italy, etc. are merely a consequence of a spatially uneven collecting effort (i.e. not the genuine gaps in spreading); particularly curious is that it was not yet detected in the Asiatic part of Turkey, despite the extensive available data (cf. LJUBOMIROV & YILDIRIM, 2008).

The recent record of *S. curvatum* from Astrakhan (S Russia, 2010), apart from being easternmost in Europe, suggests that the species will probably continue to spread eastwards using both northern and southern routes around the Caspian Sea. With this most recently documented spreading, *S. curvatum* has reduced the distance from its nearest known natural occurrence in southwest Asia (Iraq: Baghdad) to only about 1,100 km (from Georgia/Abkhazia) and the distance from the easternmost European locality in Russia to the closest record in central Asia is about 1,700 km (Uzbekistan) – as shown in Fig. 3.

Remarks on the western range limits of *S. deforme* and *S. curvatum* in Asia

With the ongoing extension of the allochtonous ranges of both species eastwards, it is of interest to reconsider the knowledge of their respective westernmost and/or northernmost native distribution limits in Asia. As established above, native ranges of the two species are nearly parapatric (i.e. vicariant): *S. curvatum* encompasses parts of southwestern to central and southern Asia, while *S. deforme* inhabits large areas of central, eastern and south to southeastern Asia. On a coarse scale, and based on the available, relatively sparse records, there are two wider areas where the two species appear as possibly sympatric: parts of central Asia (Fig. 3) and northern India to Nepal (not shown).

For many decades after KOHL's (1918) synonymisation of *S. deforme* and *S. curvatum*, authors failed to recognise that the second species might actually be present in central and southwestern Asia (e.g. KAZENAS, 1978, 2001, 2002), hampering the understanding of their real distribution. Following BOHART & MENKE's (1976) and VAN DER VECHT's (1984) re-establishment of *S. curvatum*, HENSEN (1987) finally provided the appropriate discrimination characters for this taxon. HENSEN (1987) and SCHMID-EGGER (2005) examined several specimens of *S. curvatum* from Uzbekistan, Tajikistan, Kyrgyzstan and Afghanistan, while HENSEN (1987) and PULAWSKI (2011) tentatively interpreted several earlier published records of *S. deforme* as *S. curvatum*, based on distribution (from Iraq, Afghanistan, Tajikistan, Uzbekistan, etc.). These actions have effectively limited the westernmost range of *S. deforme* to eastern and southeastern Kazakhstan. On the other hand, some recent authors from Asia continued to list Tajikistan (NEMKOV, 2009), or even also Uzbekistan (KAZENAS, 2002) and Kyrgyzstan (DANILOV, 2011) in the general distribution of this species. One of us (AĆ, 2011; see in the list of material) recently studied 4 specimens from Uzbekistan and 1 from Kyrgyzstan, all identified as *S. deforme* by Kazenas (labelled in 2000; not published so far), but which agree perfectly with HENSEN's concept of *S. curvatum*. Therefore, judging from the more complete distribution data (Fig. 3), it is possible that all earlier published records of *S. deforme* from Kyrgyzstan, Tajikistan and Uzbekistan, and even the records from southeastern Kazakhstan (KAZENAS, 2002) might in fact represent *S. curvatum* (for now, we have retained all Kazakhstan records as *S. deforme*, both in the list and the map). The indisputable westernmost records of *S. deforme* in Asia are from northeastern Kazakhstan (type area of ssp. *atripes*) and the northernmost is the recent record from Krasnoyarskiy Kray in Russian central Siberia (AKULOV, 2009; DANILOV, 2011). The northernmost positive records of *S. curvatum* are from Kyrgyzstan and Uzbekistan, and the remote, isolated record from Iraq is the westernmost range point (SCHMIDD-EGGER, 2005; PULAWSKI, 2011; also this paper).

Therefore, in central Asia, where the northernmost range limit of one species seemingly coincides with the westernmost area of another, the genuine coexistence of *S. deforme* and *S. curvatum* is possible, but not positively established. With parallel (or even combined) advancing of their respective allochtonous populations eastwards, it may be expected that their eventual amalgamation with the native ones could take place along the wide front from central to southwest Asia. Particularly interesting from the biogeographical and ecological perspective is the question if *S. curvatum* will be able to continue spreading along the northern route, and conversely, if *S. deforme* will be able to spread further southeastwards, where they would eventually enter into the respective native ranges of the opposite species. This would create an unprecedented biogeographical context for their inter- and intraspecific relationships. Therefore, it would be of great scientific interest to track this process accurately, based on reliable identification of all future data (ĆETKOVIĆ *et al.*, unpublished).

Diverse ecological notes

Recorded parasitoids

So far, we have recorded 3 species of parasitoids on alien *Hensenia* species, from 3 different families of Hymenoptera, only on *S. curvatum* in Serbia. In the course of rearing a relatively small sample of *S. curvatum* nest-cells from Lipovička šuma (Belgrade env.; collected under cover of honeybee hives) during 2003 and 2004, we established a remarkable parasitisation rate from a eulophid *Melittobia acasta* (Walker): 9 out of 15 larvae were attacked (a number of additional larvae died in earlier stages, so that their parasitisation rate could not be detected). From the nests collected in Rakovica Village (Belgrade env.; also found under cover of honeybee hives) in 2004, we reared one cleptoparasitoid species (Chrysididae: *Chrysis* sp.). Finally, from

the two nest-cells collected near Trstenik in 2010, an Ichneumonidae parasitoids emerged in May 2011 (1 sp., not yet identified).
Melittobia acasta was already recorded from *S. curvatum* in Austria (MADL & VIDLAR, 2005) and northern Italy (HELLRIGL, 2006). It is well known as an extremely polyphagous parasitoid, attacking more than 55 host genera from as many as 4 insect orders (Hymenoptera, Diptera, Lepidoptera, Coleoptera) worldwide, including records from two *Sceliphron* species – Palaearctic *S. destillatorium* and Neotropical *S. asiaticum* (L.) [listed as *figulus* (=syn.)] (UNIVERSAL CHALCIDOIDEA DATABASE, 2010). The effects of the pressure these parasitoids on the population trends of this rapidly spreading sphecid are difficult to evaluate from just a few records in Serbia, but there apparently is an ongoing process of its integration with the local biota.

Sex ratio

The ratio we established for *S. deforme* based on material collected in European Russia is nearly balanced (45:43; other available samples being too small to be compared). In contrast, females largely outnumber males in our material of *S. curvatum* from the focal areas (from Slovenia to central Asia; a pooled number of specimens is 84:16), and an even more strongly skewed ratio is recorded in the published sources for Greece and Russia (24:0). On the other hand, the ratio of *S. curvatum* specimens published for Ukraine is balanced (19:19), as is the ratio calculated only for the available reared material from Serbia (6:6; but this sample is obviously too small to be meaningful). The skewed sex ratio may be largely due to the bias in collecting pattern: females are probably more frequently encountered (while they actively search for spiders and for nesting places in/around human settlements, likewise when they gather in large numbers collecting mud). Hence, the unbiased ratio in *S. deforme* may be related to the less markedly synanthropic behaviour (as observed for the central European Russia). However, it is also possible that a biased sex ratio is partly attributable to a flexible reproductive strategy of the invading species, with a potential to affect its colonisation success (as established for some other alien species in diverse groups).

Notes on phenology

GEPP & BREGANT (1986) and GEPP (1995) summarised for Austria, SCHMIDD-EGGER (2005) for the wider area north of the Alps, and BOGUSCH *et al*. (2005) for the Czech Republic and Slovakia, that the majority of recorded specimens are from mid-June to late July/early August; although there are also a few records from May and early June, and very few late ones, from mid-August to early September (a few records as early as January through mid-April apparently represent prematurely emerged specimens in enclosed warm spaces). GEPP & BREGANT (1986) and GEPP (1995) speculated that at least a part of the population might have two generations, but they could not prove it through rearing. BITSCH & BARBIER (2006) suggested that one generation normally develops in “central Europe”, but with “some populations undoubtedly being bivoltine”; also, they suggested that two or even three generations are possible in Mediterranean areas of France.

Most of the recorded *S. curvatum* specimens in the Balkan area, including those published so far (GUSENLEITNER, 1996; ĆETKOVIĆ *et al*., 2004; STRAKA *et al*., 2004; JACOBS, 2005; SCHMID-EGGER, 2005; STANDFUSS & STANDFUSS, 2006; LJUBOMIROV, 2006; GUÉORGUIEV & LJUBOMIROV, 2009; JÓZAN, 2009), are from the period between early July to the late August, and somewhat fewer records are from early June to early July; the few latest specimens has been noticed by mid-September to early October and the two earliest records are from May (Athens, S. Greece – the southernmost locality within the Balkans) and late April (Fruška Gora Mt, N Serbia); the latter is most probably the case of premature emergence. It should be stressed, however, that the collecting effort was partially biased with respect to the seasonal coverage of the entire flight period. As early as late June (Lipovička šuma, Belgrade env.), closed nest-cells have been collected, with fresh content of spider prey and wasp larvae in various stages of development. From the same locality during 2003 and 2004, we collected nests on several occasions in the second half of July, and

we reared adults (both males and females) in August of the same year. Therefore, the period of adult activity seems to be distinctly longer in southeastern than in central Europe (as expected), and at least two generations certainly develop in northern Serbia.

The great majority of *S. deforme* specimens from central European Russia, published herewith, were collected between late June and early August, just two records being from the first half of June, and the other two from the second half of August. Hence, only one generation may develop in these areas, the most northerly situated in the whole range of the subgenus *Hensenia*.

Note on invasiveness

Like other introduced Sphecidae, both *Hensenia* species were automatically considered as invasive in Europe (GEPP, 2003; BITSCH & BARBIER, 2006; DAISIE, 2008a, 2008b, 2009; RASPLUS, 2010; RASPLUS *et al*., 2010; CABI, 2011a, 2011b; etc), which might be arguable depending on the concept of the term 'invasive' as applied by various authors (i.e. RICHARDSON *et al*., 2000; FALK-PETERSEN *et al*., 2006; PYŠEK *et al*., 2009; *vs.* MCNEELY *et al*., 2001; DAVIS, 2009; SHINE *et al*., 2010; etc.); hence their (eventual) status of invasiveness, and in particular the potentially adverse ecological impacts thereof, are yet to be documented and evaluated (cf. ĆETKOVIĆ *et al*., unpublished).

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СТАТУС ПОТЕНЦИЈАЛНО ИНВАЗИВНЕ АЗИЈСКЕ ВРСТЕ *SCELIPHRON DEFORME* У ЕВРОПИ, И ПРЕГЛЕД ДИСТРИБУЦИЈЕ ВРСТЕ *S. CURVATUM* (HYMENOPTERA: SPHECIDAE)

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Извод

У раду је дат преглед садашњег познавања дистрибуције две азијске врсте рода *Sceliphron* Klug, које су интродуковане у Европу у периоду од касних 1970-их до раних 1980-их: *S. (Hensenia) curvatum* (Smith) и *S. (Hensenia) deforme* (Smith). Обе врсте су рутински означаване као инвазивне, али статус и ефекте њихове (евентуалне) инвазивности тек треба документовати и евалуирати. Наша студија је фокусирана на два шира географска подручја: Балканско полуострво и европски део Русије, и заснива се на материјалу сакупљеном на овим просторима током последњих 15 година, али смо такође дали и екстензиван преглед публиковане грађе (укључујући неке веома важне налазе преузете са интернет-форума), а за врсту *S. curvatum* дат је и кратак преглед целог европског ареала. Студијом смо потврдили да је друго-забележена врста, *S. deforme*, била интродукована у Европу бар два пута, прво у централно подручје европског дела Русије, а затим у југозападни део Балкана, а утврдили смо да интродуковане популације потичу из две географски удаљене азијске подврсте. На основу најновијих података, потврдили смо да је врста успешно успостављена у оба подручја, а документовали смо и њено скорашње ширење: из централног дела европске Русије према југу/југоистоку, и највероватније са Балкана према истоку. Кориговали смо низ погрешних навода врсте *S. deforme* за поједине европске земље/подручја (Француска, Италија, Бугарска, Грчка, "централна Европа"), који су се више пута појавили у низу значајних публикација о инвазивним врстама Европе током последње три године (*n.b.* – за Грчку смо тек сада поуздано документовали њено присуство). За алохтони ареал врсте *S. curvatum*, забележили смо једну нову земљу (Грузија/Абхазија), и додали неке значајне ране налазе са Балкана (из Србије, Грчке, Хрватске и Бугарске), који померају време претходно публикованих "првих појављивања" на овом подручју (за две године у северној Србији и средњој Грчкој), или на други начин модофикују сазнање о историјату ширења алохтоног ареала. Како најскорији налази сугеришу рапидно напредовање обе интродуковане врсте на исток, чиме се приближавају крајњим западним и/или северним границама њихових нативних ареала (на потезу од западне до централне Азије), сматрали смо за битно да укратко размотримо и расположива сазнања о њиховом могућем коегзистирању на том ширем подручју. Такође, у раду дајемо детаљне мапе њихових алохтоних ареала у Европи (који се тренутно протежу на простору од преко 4.000 км географске дужине) као и најзападнијег дела њихових природних ареала у Азији. Најзад, укратко смо размотрили неке еколошке аспекте њиховог јављања на обрађеном подручју (паразитираност, однос полова, фенологија).

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