Acta Entomologica Serbica, 2021, 26(2): xx-xx

UDC:
DOI: 10.5281/zenodo.5537059

FURTHER RANGE EXPANSION OF THE SCULPTURED RESIN BEE (*MEGACHILE SCULPTURALIS*) IN SERBIA AND BOSNIA & HERZEGOVINA

JOVANA BILA DUBAIĆ[1*], JOVANA RAIČEVIĆ[1], MILAN PLEĆAŠ[1], JULIA LANNER[2], PETAR NIKOLIĆ[3], VLADIMIR ŽIKIĆ[4], LJUBIŠA STANISAVLJEVIĆ[1] and ALEKSANDAR ĆETKOVIĆ[1]

1 Faculty of Biology, University of Belgrade, Studentski trg 16, 11000 Belgrade, Serbia
*E-mail: jovanabila@bio.bg.ac.rs (corresponding author)
2 Institute for Integrative Nature Conservation Research,
University of Natural Resources and Life Sciences, Vienna, Austria
3 Faculty of Agriculture, University of Banja Luka, Bulevar vojvode Petra Bojovića 1A,
78000 Banja Luka, Republic of Srpska, Bosnia & Herzegovina
4 Faculty of Sciences and Mathematics, University of Niš, Višegradska 33, 18000 Niš, Serbia

Abstract

Megachile sculpturalis is the first non-native bee species established in Europe, originating from E-Asia. Since early detections in SW-Europe (2008–2010) its spreading resulted in a range currently spanning nearly 2,800 km x 1,100 km across the southern and central Europe. In SE-Europe establishment was confirmed since 2015 in NE-Hungary, followed by detection in N-Serbia (2017), and wider spreading across the eastern Pannonian Plain (2018–2019); eventually it was detected in NW-Bosnia & Herzegovina (2020). Accordingly, the repeated calls for monitoring of *M. sculpturalis* spread were voiced, aiming to address its potential invasiveness, but mostly lacking a more specific assessment protocol. A 'working concept' for a comprehensive monitoring of *M. sculpturalis* was proposed within the survey conducted in Belgrade (Serbia) during 2017–2019, based on quantitative assessment of bee population trends in relation to focal plant resources. There was a need to improve and broaden this initial framework, e.g., to allow for different spatio-temporal scales and various potential usage requirements. Therefore, in 2020 we considerably extended the research scope, defined at two spatial scales: LOCAL, for the Belgrade area – the continuation of protocol development, through a high-intensity assessment of *M. sculpturalis* abundance, bionomics, and distribution, in parallel with assessment of extended set of relevant plants (and potential bee-plant interactions); REGIONAL, a survey covering the bee spreading across Serbia and Bosnia & Herzegovina, aiming to provide a reference time-section in expanding SE-European front, while also extending the knowledge of its environmental affinities. The study included the launching of a pioneering citizen science project, which enabled a remarkable geographic coverage despite modest return of positive reports.

The Belgrade-scale survey yielded a modest increase in recorded locations, relative to 2019, but the recording efficiency was decreased, despite a much intensified surveying efforts and extended coverage. This corroborated the importance of inter-seasonal variation of key food resources, which affects both the population dynamics and detectability of this bee, through alternating concentration and dilution effects. We confirmed the strong association of detection success with availability and variability of blooming *Styphnolobium*, at both scales, indicating the highest relevance of inclusion of this plant into monitoring assessment protocols. The established phenological extent of *M. sculpturalis* activity (>70 days) also closely corresponded with the phenology of *Styphnolobium* blooming; yet it does not represent the entire phenological span for the region. Almost no record came from surveying other plants. The regional expansion of *M. sculpturalis* during 2017–2020 is documented from 19 wider locations (16 added in 2020). It is particularly well established in the Pannonian, and to a lesser extent in peri-Pannonian area of Serbia and B&H, while the approximated range extent was likely doubled during 2019–2020. Further south records were scarce, indicating the slower expansion across the hilly-mountainous part of the Balkans. Records largely came from urban or other settlements, only about a third from semi-natural or agricultural environments.

KEY WORDS: invasive alien bees; introduced pollinators; southeastern Europe; monitoring; citizen science

Introduction

Sculptured resin bee (Hymenoptera: Anthophila: Megachilidae: *Megachile sculpturalis* Smith, 1853) is one of the very few non-native bee species in Europe (Russo, 2016; Rasmont *et al*., 2017; Bortolotti *et al*., 2018). It was the first one established, and so far the only one widely distributed across the continent, while also continuously spreading at remarkable rates (Bila Dubaić & Lanner, 2021; Le Féon *et al*., 2021). This solitary bee typically nests in pre-existing cavities in dead wood, various hollow plant stems (e.g., large reed internodes), but also in diverse man-made structures and materials, with an univoltine life cycle (Maeta et al., 2008; Quaranta et al., 2014; Aguado *et al*., 2018; Ivanov & Fateryga, 2019). The mode of above-ground cavity-nesting likely facilitated its accidental introductions, both overseas and within newly colonized continents, through inadvertent transport of brood concealed within wood/timber and other suitable goods (Mangum & Brooks, 1997; Quaranta et al., 2014; Westrich *et al*., 2015; Russo, 2016; Le Féon et al., 2018; Lanner et al., 2020a). Accordingly, its chances for further passive dispersal (secondary introductions) are related to the topology and frequency of 'vectoring goods' transportation, providing that sufficient local population build-up was attained (Bertelsmeier & Keller, 2018). Regardless of accidental human vectoring, it is expected that *M. sculpturalis* possesses a remarkable capacity to spread actively across newly colonized areas (Quaranta et al., 2014; Westrich *et al*., 2015), within regions with adequate resources and basic environmental conditions.

Sculptured resin bee is native to eastern Asia, where it is relatively widespread and moderately common in eastern China, Korea and Japan (Batra, 1998; Wu, 2006; Ascher & Pickering, 2020). In the early 1990s it was first successfully introduced into North America (Mangum & Brooks, 1997), followed by rapid range expansion across eastern half of the continent (Mangum & Sumner, 2003; Hinojosa-Diaz *et al*., 2005; Parys *et al*., 2015). Its second non-native range establishment took place in south-western Europe: starting from restricted areas in SW-France, NW-Italy and S-Switzerland (2008/2009/2010), its initially slow continuous expansion remained mostly confined to wider neighbouring regions of France and Italy (Vereecken & Barbier, 2009; Amiet, 2012; Quaranta *et al*., 2014; Westrich *et al*., 2015; Le Féon *et al*., 2018; Ruzzier *et al*., 2020). The more rapid spreading was documented since 2014–2015, resulting in a remarkable range extension: throughout southern half of France, through northern Switzerland and southern Germany to western Austria, throughout most of Italy, eastwards to Slovenia and south-westwards into NE-Spain (Aguado *et al*., 2018; Gogala & Zadravec, 2018; Le Féon *et al*., 2018, 2021; Ortiz-Sánchez *et al*., 2018; Lanner *et al*., 2020; Ruzzier *et al*., 2020; Westrich, 2020). In contrast with this largely continuous, i.e., diffusive mode of spread, several relatively isolated establishments took place mostly across central and eastern/south-eastern Europe during 2015–2020: to NE-Hungary (Kovács, 2015), NE-Austria (Westrich, 2017), N-Serbia (Ćetković & Plećaš, 2017), W&S-Croatia (Resl, 2018; 'pitrusque', 2019), Crimean Peninsula (Ivanov & Fateryga, 2019), and NW-Bosnia & Herzegovina (Nikolić, 2020). Some of these cases appear as genuine long-distance 'jumps' (of uncertain origin – cf. Lanner *et al*., 2021), other being arguably the combination of both dispersal mechanisms, yet to be clarified. The capacity of *M. sculpturalis* for remarkable jump-dispersals was most recently (2020) demonstrated through introduction into Mallorca Islands, across the W-Mediterranean Sea (Ribas Marquès & Díaz Calafat, 2021). On the other hand, a study comparing the early-phase colonisation in the Belgrade area (N-Serbia) with early spreading of *M. sculpturalis* across the eastern Pannonian Plain during 2015–2019 (Bila Dubaić *et al*., 2021 [in rev.]) suggested the likely mixed mode: long-distance jump into NE-Hungary, followed by continuous diffusive spreading southwards into Serbia. Comprehensive phase-mapping compilations of the colonisation history in Europe (Ćetković *et al*., 2020; Le Féon *et al*., 2021), show that it is currently spanning nearly 2,800 km W-E, and more than 1,100 km N-S.

There is a growing worldwide concern about the current extent and trends in alien bee introductions, regarding their potential to become invasive, i.e., to cause various negative environmental impacts (Goulson, 2003; Stout & Morales, 2009; Aizen *et al*., 2014, 2020; Russo, 2016; Morales *et al*., 2017; Vanbergen *et al*., 2018). Unlike many other alien insects, introduction of bees may represent a controversial subject, because of possible overlap of various negative impacts (either documented or assumed) and seemingly positive net contributions to pollination services (Russo, 2016). The very term invasive (also: invasiveness, invading, etc.) in case of *M. sculpturalis* was often used inconsistently and/or loosely, with respect to the 'conceptual issue of impact' in invasion biology (Bila Dubaić *et al*., 2021 [in rev.]). Nevertheless, it is of prime importance to evaluate if *M. sculpturalis* may cause significant adverse effects on native bee populations (principally through competition for floral and nesting resources), native and exotic flora, and intricate pollination interactions across diverse ecosystems and habitat types (Russo, 2016; IUCN, 2020; Ribas Marquès & Díaz Calafat, 2021).

Megachile sculpturalis excessively visits several widely available mass blooming plants (Quaranta *et al*., 2014; Parys *et al*., 2015; Le Féon *et al*., 2018; Ruzzier *et al*., 2020), hence, a substantial usage overlap with some common generalist bee taxa is obvious, yet no evidence exists of effective competition (in terms of measurable impacts). As for the interactions at nesting sites, evidence was accumulated across both sections of its non-native range (North America and Europe), about unusually aggressive and/or destructive habits of *M. sculpturalis*, affecting adults and/or larvae of native solitary bees (*Xylocopa*, *Osmia*, *Megachile*, *Heriades*) or other co-occurring Hymenoptera (most recent summaries in: Le Féon *et al*., 2018, 2021; Lanner *et al*., 2020a,b; Straffon Díaz *et al*., 2021). Additionally, negative correlation has been found between the abundance of *M. sculpturalis* and the presence of native bees, in a study based on bee hotels in urban setting of SE-France (Geslin *et al*., 2020). However, we still lack the exact approach to estimating extended impacts on affected taxa, e.g., through causative effects on population trends. Further specific concerns are expressed about the risks that *M. sculpturalis* could enhance propagation of invasive plants (Mangum & Sumner, 2003; Aguado *et al*., 2018); although not yet adequately evaluated, concerns seem particularly justified with regard to some exotic Fabaceae, e.g., genera *Pueraria* and *Lespedeza* (Batra, 1998; Lindgren *et al*., 2013; European Commission, 2020). Therefore, following the precautionary principle, *M. sculpturalis* should be regarded as potentially invasive (i.e., possibly harmful alien species), regardless of the current lack of decisive proof of measurable impacts (cf. Stout & Morales, 2009).

Sculptured resin bee is often referred to as polylectic, with remarkably high incidence of visitations to exotic ornamental taxa, but also with very strong preference for the pollen of large-flowered Fabaceae; the ornamental Japanese pagoda tree (*Styphnolobium japonicum* (L.) Schott) is well established as the single most frequently used pollen source in Europe (Mangum & Brooks, 1997; Mangum & Sumner, 2003; Maeta *et al*., 2008; Quaranta *et al*., 2014; Parys *et al*., 2015; Westrich *et al*., 2015; Aguado *et al*., 2018; Le Féon & Geslin, 2018; Le Féon *et al*., 2018; Guariento *et al*., 2019; Ruzzier *et al*., 2020). Arguably, some of the interpretations of the plant usage pattern might prove as biased and/or even inaccurate, but *M. sculpturalis* undoubtedly visits rather wide range of plants, with varying frequencies in different regional settings (cf. Ćetković *et al*., 2020; and ongoing study). Hence, it is of great practical importance to further clarify and to rank genuine bee's preferences and visitation patterns in the context of varying phenology and local availability of different floral resources – i.e., to evaluate them also as the potential 'monitoring plots'.

Since the introduction, it was repeatedly proposed that the monitoring of *M. sculpturalis* spread in Europe needs to be established (Quaranta *et al*., 2014; Aguado *et al*., 2018; Le Féon *et al*., 2018; IUCN, 2020; Ruzzier *et al*., 2020; Ribas Marquès & Díaz Calafat, 2021). The monitoring efforts should have the goal to provide a timely evaluation of bee invasiveness, and in turn, to inform actions for timely preventing possible negative consequences. Current ongoing efforts, however, mostly represent an opportunistic documenting of its spread, through compiling new occurrence data from a variety of sources. Hence, we are lacking more specific protocols for assessing the impacts or other relevant parameters. Based on outcomes from the Belgrade survey 2017–2019, Bila Dubaić *et al*. (2021 [in rev.]) established the explicit spatio-temporal framework for quantitative assessment of bee population trends in relation to focal plant resources, as a 'working concept' for building a more comprehensive monitoring of *M. sculpturalis*. This initial 2019 framework needs to be rigorously tested and 'calibrated' for different spatio-temporal scales and specific purposes. To enable the broad array of current and future requirements, we are currently working towards the following operative targets: (i) to refine and standardize tailored protocols for quantitative assessments, in order to provide comparable population estimates across spatial scales and phases in different colonisation timelines, (ii) to extend the protocols to account for varying combinations of target-plants, across regions and environment types (from urban to natural) and in variable phenological regimes, (iii) to outline options for flexible monitoring intensity (i.e. various extent of engagement, research or management interests/priorities, etc.). Furthermore, the assessment approach based on recording bee's activities on flowers should be integrated with the nesting-based monitoring, which is particularly important to complement the evaluation of bee's potential invasiveness (cf. experiences from: Geslin *et al*., 2020; Lanner *et al*., 2020a,b; Straffon Díaz *et al*., 2021; see also: MacIvor & Packer, 2015).

Accordingly, in the season of 2020 we considerably extended the research programme on *M. sculpturalis* spread in the area, building on previous surveying experiences (in Serbia), as well as on advancement of respective Europe-wide research (Le Féon *et al*., 2018, 2021; Lanner *et al*., 2020a, 2021; Ruzzier *et al*., 2020). In this phase it is still an exploratory endeavour with an 'open-ended' timeline regarding the outlined targets. We defined a two scale approach: LOCAL, for the Belgrade area – the continuation of protocol development, through a high-intensity assessment of sculptured resin bee abundance, bionomics, and distribution across the main urbanistic-landscape zones, with parallel assessment of most relevant plants (distribution, phenology, quantification of floral resources), as well as all aspects of bee-plant interactions; REGIONAL, the extension of the survey on entire distribution across Serbia – aiming to track the bee spreading in 'real-time', and to extend the evidence of its wider environmental affinities; the survey coverage eventually happened to be extended to the neighbouring Bosnia & Herzegovina, following the first detection there in August 2020. Herewith we provide a reference time-section in the *M. sculpturalis* expansion across the SE-Europe, by documenting presences/absences and abundance trends (i.e., an updated state of the expansion front). As such, this contribution represents a 'progress-report' aimed to provide a timely evidence-base for diverse planned or ongoing monitoring efforts.

Material and Methods

The survey of Belgrade: a local scale approach

The Belgrade-level survey included a wide array of activities (conducted by JBD, JR, MP and AĆ): **(a)** checking for *M. sculpturalis* presence at all locations with suitable plants, taking particular care that all target plants within a single location are surveyed simultaneously (wherever two or more plant taxa were available in proximity); **(b)** wherever *M. sculpturalis* was found, we assessed its activity density; this included testing of the improved 2019 protocol (a better defined bee-counting procedures, allowing for highly variable dynamics of bee activity on site, etc.); **(c)** an extensive assessment of 'resource units' of selected plant genera across Belgrade urbanistic zones, aiming to detect and assess as many plant sites as feasible (at known locations or through search for new ones; followed with high-accuracy georeferencing); **(d)** recording details of plants blooming status (phenology, quantity), building on experiences from *ad hoc* protocol for *Styphnolobium* in 2019, with substantial efforts on protocol refinement (particularly regarding different types of plants).

The city of Belgrade was the core study area for our 2017–2019 survey of *M. sculpturalis* establishment in Serbia (Bila Dubaić *et al*., 2021 [in rev.]); therein we elaborated on its most relevant biogeographical, ecological and urbanistic features (available in extensive form on-line: https://srbee.bio.bg.ac.rs/english/belgrade-general-features). In particular, we introduced the operative concept of wider 'urbanistic-landscape zones' suited for this taxon-specific study, based on elements generally relevant for wild bee studies in urban setting. The approach provided a simplified 'summary account' of multiple key factors and resources (of importance for bees) across environmental gradients of a large, heterogeneous and dynamic urban area (https://srbee.bio.bg.ac.rs/english/m-sculpturalis-2019-survey). The studied portion of Belgrade municipalities was principally delimited by the availability of sites with suitable plants of interest.

In 2020 we largely maintained the same study area and the conceptual framework: the principal focus was on *Styphnolobium*, as the key food-plant resource, while we broadened the survey to assessing suitability and relevance of other attractive plant taxa. In this phase of protocol development, we considered all plants known as frequently visited (anywhere, but principally based on European evidence; cf. Ćetković *et al*., 2020: an ongoing study) while also being locally available and phenologically suitable for this bee species (and accessible to observers). Generally, the relevance for monitoring should be tested regardless of the mode of usage (whether foraged for pollen or only for nectar), or plant nativeness (noteworthy: this trait may differ at continental *vs*. regional or local scale for some genera). For the season of 2020, we selected seven prospective genera, representing different plant families, for suitability-testing: *Buddleja* (Scrophulariaceae), *Catalpa* (Bignoniaceae), *Koelreuteria* (Sapindaceae), *Lavandula* (Lamiaceae), *Ligustrum* (Oleaceae), *Lythrum* (Lythraceae), and *Wisteria* (Fabaceae). Within the Belgrade area (and Serbia generally), majority of selected taxa are exotic (except *Lythrum* and *Ligustrum*), and mostly available through ornamental planting (except *Lythrum*), principally in public spaces.

For the spatial quantification of *Styphnolobium* resources, we started from the framework based on circular 'landscape sectors' (r=250 m), as defined within the 2019 survey (https://srbee.bio.bg.ac.rs/english/m-sculpturalis-2019-survey). In 2020 we aimed to improve the completeness of spatial coverage and resource quantification (Fig. 1a); in particular, we verified and/or complemented estimates of floral resources from 2019. Furthermore, we performed extensive and meticulous assessment of the phenology pattern of *Styphnolobium* blooming across the study area. For other selected plants, we focused on assessing their phenological suitability and attractiveness, particularly considering the comparative availability of *Styphnolobium* resources nearby. Due to various limitations (see in Results), only the subset of these additional genera was feasible to cover with thorough assessment in 2020 (Fig. 1b).

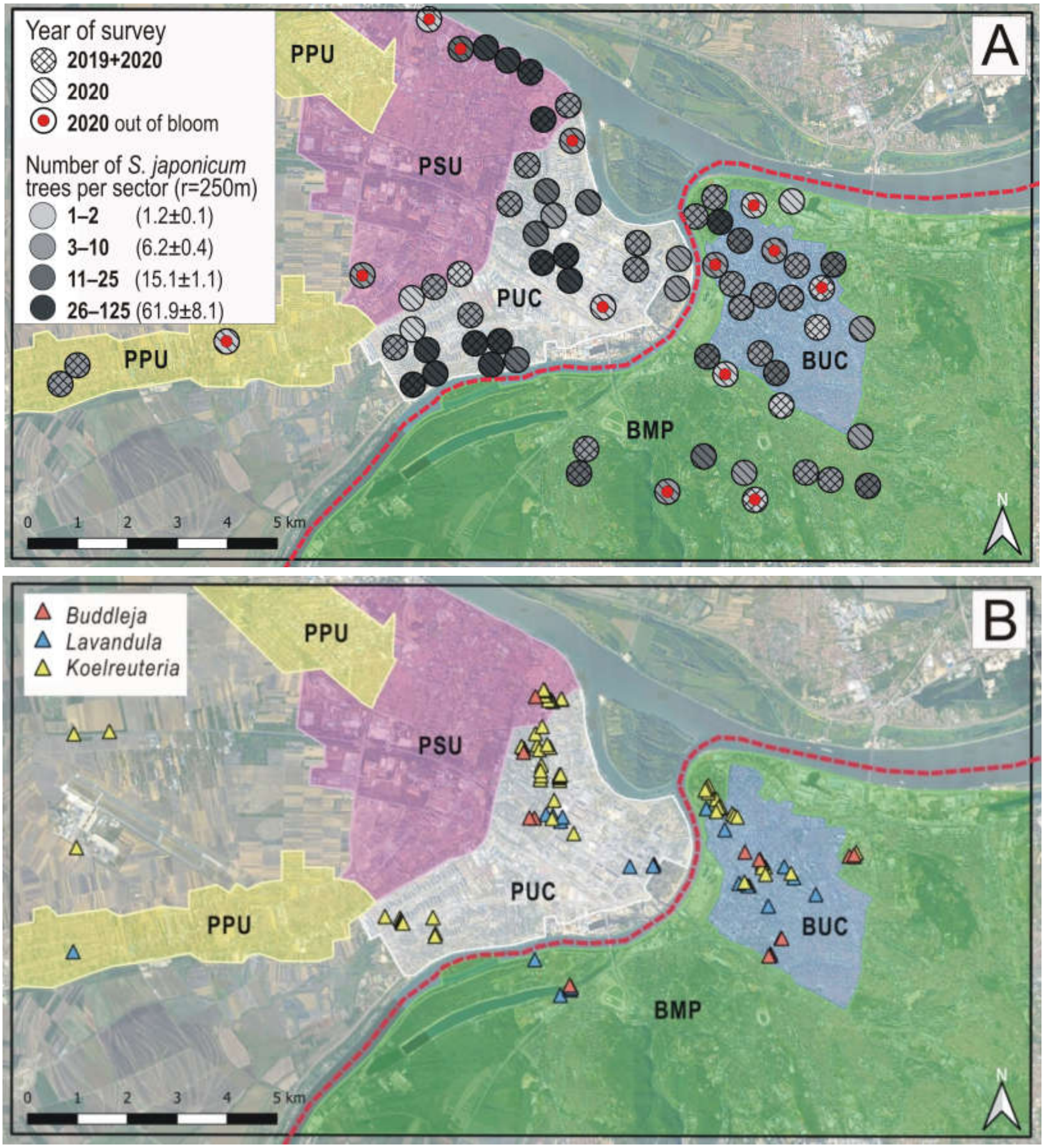

Figure 1. The studied area of Belgrade, showing distribution of principal focal plants included in the 2020 survey. A – Distribution of all detected *Styphnolobium* trees (*S. japonicum*): the main floral resource for *M. sculpturalis* is treated also as most relevant 'unit-plot' for monitoring; numbers of recorded trees are aggregated within r=250 m circular sectors framework (in four abundance classes), in accordance with the approach designed for the 2019 survey (Bila Dubaić *et al*., 2021 [in rev.]); 13 sectors assessed only outside the blooming period are marked with red dot. B – Distribution of some other focal plants surveyed in 2020, as prospective complementary resources and detection plots (symbols show actual locations of plant units, i.e. without aggregated quantification). The base-map is satellite imagery from Google Satellite™; coloured map overlays represent the customised landscape/urbanistic zonation concept, as elaborated at https://srbee.bio.bg.ac.rs/english/m-sculpturalis-2019-survey: BUC – Balkan Urban Core; BMP – Balkan Mixed Periphery; PUC – Pannonian Urban Core; PSU – Pannonian Semi-Urban; PPU – Pannonian Peri-Urban.

For accurate recording of bees in higher trees crowns, the use of binoculars was proved necessary (Fig. 2b). For each 'unit-point' survey for bee presence, we recorded the time spent in effective personal engagement, typically in focused observations; if both collecting and observation were conducted, effort-time was recorded separately for each activity. A targeted standard duration of observations per 'unit-point' was ≥10 minutes, although shorter (e.g., casual/accidental) observations were also considered eligible for the effort-time estimates. In some occasions where no bee activity could be noted during the 10' period (despite ample blooming of *Styphnolobium*), the observation time was opportunistically extended.

Longer time should emphasize the difference between states of very low bee abundance/activity and effective absence (to be interpreted at relevant landscape scale). According to the previous Belgrade study (of 2019), all detections could be interpreted also as timed counts, and converted into appropriate abundance estimates (per unit-time). Even within a highly variable and uneven surveying regime, reference effort-time should enable comparisons both for detection efficiency and for population dynamics parameters.

We effectively conducted surveys of plants in suitable phase from the end of May (30th), until early September (04th), with variable intensity and coverage. This period preceded for four weeks the first actual detection of *M. sculpturalis* in 2020, while lasting more than two weeks after the last actual detection in the area (see in Results). Due to complicated phenology of different plants at landscape scale, our field work regime was flexibly adjusted throughout the blooming season, varying in intensity/frequency, spatial coverage and floral focus (i.e., optimized within logistical limitations). On a whole-season basis, our field-engagement spanned 60 calendar days, with highly variable per-day personal efforts and per-location time spent; 37 days were within the period of confirmed *M. sculpturalis* activity in the Belgrade area in 2020.

As a trial attempt, in early July 2020 we installed a series of nesting facilities – 'trap-nests' (by LjS, JBD, MP, JR, AĆ) across the wider Belgrade area (16 locations), and at one location 60 km to the northeast of Belgrade (with earlier confirmed activity of *M. sculpturalis*: Sremski Karlovci). Nests were prepared as bundles of common reed (*Phragmites*), each with about 16–17 reed internodes of suitable diameter (9–11 mm). Nests were collected in mid-September, after we evidenced that activity of *M. sculpturalis* ceased all over the area. We preliminary inspected all reeds and separated the inhabited ones, to be reared under suitable laboratory conditions with controlled temperature regime (simulating respective seasonal conditions before the expected period of emergence).

Beyond the Belgrade area: CSP and a regional scale survey

To extend the territorial coverage of *M. sculpturalis* distribution across Serbia, from the season of 2020 we initiated a comprehensive long-term collaborative research (Ćetković *et al*., 2020). This included launching of a pioneering citizen science project (CSP), an approach proved as highly effective in providing respectable biodiversity data coverage for large areas (Theobald *et al*., 2015; Soroye *et al*., 2018). Launching was largely facilitated through experience-exchange and coordination of activities with the ongoing CSPs established earlier for the Alpine countries (Lanner, 2018–2019; www.beeradar.info). We created a thematic web page (https://srbee.bio.bg.ac.rs/azijska-pcela-smolarica/azijska-pcela-projekat-ucesce) with all relevant information about the sculptured resin bee, our research, and specifically about CSP approach; also, we prepared poster-calls with standardized information (by JBD, JL, AĆ, MP, JR and LjS): where, when and how to search for sculptured resin bee, how to recognize it, how to submit a report, etc. Posters were distributed via several social media channels and nature platforms, through various other internet sites with relevant focus, while several national and local media took part in dissemination and promotion. We also used all other means of electronic communication to circulate the calls through academic and/or professional networks in Serbia (principally the relevant university departments, scientific societies, beekeepers' associations, etc.), but also through personal contacts of the authors (LjS, JBD, MP, VŽ).

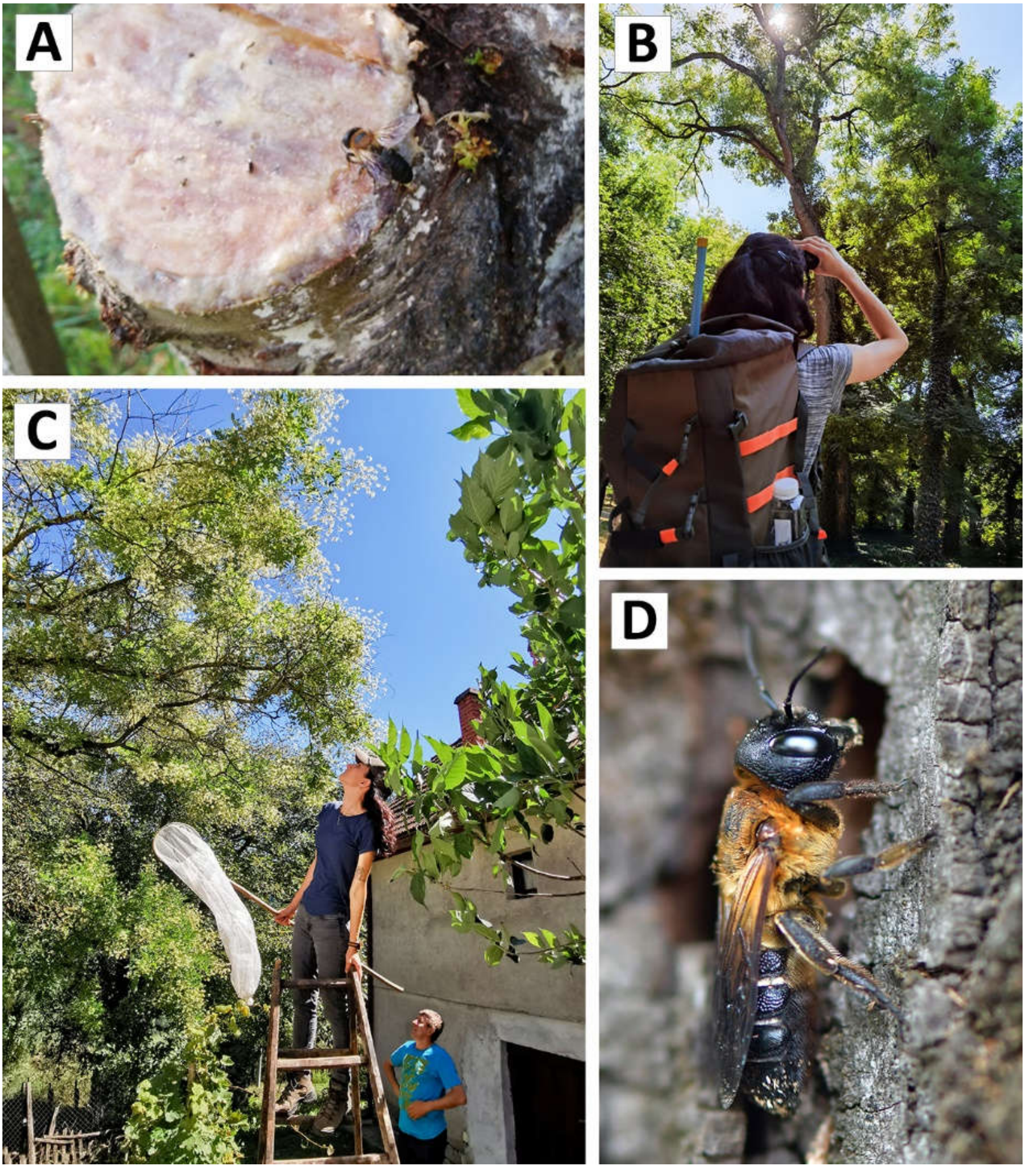

Figure 2. Facets from the 2020 survey: A – *M. sculpturalis* female collecting fresh grafting wax from a cherry tree: Pučile near Bijeljina (CSP report, rec_#44); B – the use of binocular is essential for assessing the presence/activity density of *M. sculpturalis* in a high crown of *Styphnolobium* trees: surveying in Temerin, rec_#34; C – sampling of *M. sculpturalis* on the very late-blooming *Styphnolobium* trees (Sept 05, rec_#64) in a small and remote rural setting of Skržuti, within a semi-natural surrounding: the southernmost record and the 'wildest' of all landscapes we surveyed in 2020 (following the CSP report: rec_#63); D – *M. sculpturalis* nesting in a tree trunk of the semi-withered *Tilia* tree (holes by wood-boring beetles): churchyard in the centre of Ada (CSP report, rec_#42). Photo credits: (A) Nikola Simanić, (B, C) Đorđe Dubaić, (D) Gergely József.

The CSP officially started in early July, after we confirmed the first appearance of *M. sculpturalis* in 2020, and lasted until the end of the summer (https://srbee.bio.bg.ac.rs/azijska-pcela-smolarica/azijska-pcela-projekat-ucesce/gra%C4%91ani-koji-su-dali-svoj-doprinos-na%C5%A1em-projektu). For each report of observed specimen(s), we asked participants to provide relevant accompanying information. Photo- or video-evidence was strictly required, along with the date of observation and detailed location descriptors (if possible, with accurate coordinates). Other details we asked were not obligatory (site features/circumstances, nesting, foraging on a plant, etc.), but presented as highly valuable and desirable.

For each report, we established direct communication with CSP-participants, to provide feedback, but also to seek additional rewarding details (communication mostly by JBD). The verification of identity of reported specimens was based on thorough examinations of provided photos/videos, and often included repeated communication with participants (coordinated mostly by JBD, double-checked where necessary by AĆ); occasionally, participants also provided collected specimens. Upon verification, we have personally visited eight locations of confirmed reports (by JBD and JR), to further explore relevant details of bee occurrences in different environments of Serbia (abundance, host-plants or nesting details, habitat/landscape features, etc.). We also used the opportunity to verify the reported location accuracy, and to promote closer communication with citizens for future participation in prospective monitoring networking (but also to sample bee specimens – see more details below).

In addition to visiting the CSP-reported sites, we managed to extend the survey to several other locations in Serbia (by JBD and JR), principally in Vojvodina province (N-Serbia): in the period July 05 – Sept 04 we visited 29 sites (within 12 wider settlements), and at 27 of them we located and observed *Styphnolobium* trees (mostly in blooming phase). A small-scale but important search for *M. sculpturalis* presence was conducted in SE-Serbia (by VŽ), within the wider municipality of Niš, as our southernmost-positioned research sites in 2020. Search was conducted by extensive and repeated observations in July-August, at two sites with numerous *Styphnolobium* trees in full bloom (similarly to routine used in the Belgrade survey).

Eventually, owing to the communication within CSP-networking, but also to prior cooperation (LjS – PN), a detection of *M. sculpturalis* was eventually made possible in the neighbouring country: Bosnia & Herzegovina (Nikolić & Bila Dubaić, 2021). In addition to our surveying (throughout the city of Banja Luka), one more B&H recording location was reported through CSP, hence extending our initial study scope to a wider SE-European expansion front.

In addition to our field surveys and CSP reports, we continually searched main international (e.g., GBIF; iNaturalist.org; Observation.org), regional, and national internet platforms (including naturalists' online forums and social media-groups), for new or previously unrecognized records of *M. sculpturalis* in Serbia, B&H, or other neighbouring Balkan countries. Furthermore, the routine scrutiny of recent publications on bee faunistics, invasive bee species, and pollination ecology yielded a single additional record from Serbia.

Other research activities

At various visited locations – wherever possible – we collected the bee specimens for population-genetic studies and collected pollen samples for the study of trophic interactions (JBD, MP, JR, PN). We collected bees mostly while foraging at *Styphnolobium* inflorescences, rarely at nesting places. Typically, we used standard entomological hand-net, which limited collecting to lower, reachable tree branches, except when additional facilities were available (as in Fig. 2c; foraging sculptured resin bees often concentrate in upper crown portions). Pollen samples were mostly taken from female scopal loads, collected while foraging, few from nesting settings or from nest cells. All samples were sent to the Institute for Integrative Nature Conservation Research, University of Natural Resources and Life Sciences Vienna, Austria (Austria), for further processing (by JL).

Data processing and presentation

As explained above, this contribution is focused on presenting the occurrence data gained through all our activities during 2020, based on their quality, relevance and merits for understanding the current state of *M. sculpturalis* expansion in SE-Europe. Various other results and outcomes were withheld, although sparingly referred to in the text. Specifically, the in-depth elaboration of assessment protocol advances, and ensuing analyses of outcomes, will be dealt with in separate studies, pending the sufficient surveillance coverage and ample testing performed over the adequate time-span (i.e., several seasons). We report herewith on selected survey outcomes and relevant experiences, without going further into methodological details or far-reaching evaluation of the survey results (e.g., abundance assessments, work effort *vs*. recording efficiency estimates, full floral surveillance and resource estimates, etc.). Similarly, we refrain from in-depth analysis of CSP outcomes and experiences, or of more general aspects of the approach suitability for this study topic (e.g., its comparative strengths and weaknesses in Serbian/Balkans context), pending the sufficient duration of the endeavour.

For various types of research activities on *M. sculpturalis* conducted during 2017–2021, we established separate (but coordinated) thematic databases (by AĆ, JBD, JL). Therein we store and maintain most extensive sets of data and metadata, comprising detailed primary inputs from all sources, and various kinds of data-processing (e.g., diverse calculations and interpretations; for CSP-inputs especially relevant are means of verification of data accuracy, i.e., of species identification and location precision). For the purpose of this paper, we integrated records from 2020 into a summary database, with selected subset of faunistic and ecological data-types: source of record and recorders' details, recording locality/site info (with varying details), altitude and coordinates (with source and accuracy info), date and time of recording, method of recording (with relevant details: in particular, effort-time of performed assessments), habitats/landscape types, nesting (type, context, etc.), visited plants, with type of recorded interaction (particularly the pollen-gathering), various abundance indices for bees and for plants (including blooming status). In line with restricted scope of this contribution, herewith we presented a selection of most essential evidence (summarized in Supplementary material: Table S1), i.e., basic faunistics and detection context data.

Expansion dynamics for the period 2017–2020 is compiled from all available sources, and presented in summary maps at two studied scales: (i) aggregated local occurrences and yearly pattern of detections within the Belgrade area (Fig. 3) are contrasted with distribution and coarse abundance indices of key floral resources, as assessed in 2020 (Fig. 1); (ii) at regional scale, we have shown all records from Serbia and B&H (aggregated as necessary), complemented with few most adjacent records from neighbouring countries: S-Hungary and SE-Croatia (Fig. 4). Records from Hungary were particularly added to enable inference of likely regional range extension attained during the seasons of 2019 and 2020, respectively.

We used Google Earth Pro (Google Inc., 2020) for various mapping routines, from primary georeferencing of our research data (or other data acquired without coordinates), to verification of location accuracy/consistency from CSP-reports. Furthermore, we used the 'Polygon' tool in Google Earth Pro to define convex hulls of approximate *M. sculpturalis* range, and to estimate its hypothetical expansion. Also, we used Google Earth™ Terrain layer to extract the altitude of each documented location. Georeferenced datasets were then imported into QGIS (QGIS Development Team, 2018) for further map processing. Depending on the context and scale, maps depict either exact locations (Fig. 1b, most of Fig. 4), or variously aggregated data; within the Belgrade area (Fig. 1a, Fig. 3) it follows 'landscape framework' approach from Bila Dubaić et al. (2021 [in rev.]; also at: https://srbee.bio.bg.ac.rs/english/m-sculpturalis-2019-survey). Final maps were customized for publication with various picture-editing software.

Results

During the season of 2020 we established the presence of *M. sculpturalis* at numerous locations in Serbia (mostly in the northern part) and at two locations in Bosnia & Herzegovina. Herewith we present all available records for the two countries since 2017 (from all sources), and we review most relevant aspects of *M. sculpturalis* spreading, at two scales: through a detailed survey for the Belgrade area (Fig. 3), and through a summarizing coverage of the current SE-European range (Fig. 4). In both cases, we aggregated the primary point-data into operative 'locations' (more strictly standardized for the Belgrade survey), while providing sufficient level of detail for the newly presented data in the Supplementary material: Table S1. Records prior to 2020 are included from the respective primary sources: Ćetković & Plećaš (2017), Insekti Srbije (2018), Mudri-Stojnić *et al*. (2021), and Bila Dubaić *et al*. (2021 [in rev.]).

Local scale: a survey of the Belgrade patterns

In 2020 we recorded *M. sculpturalis* at 22 locations across all landscape/urbanistic zones within the core Belgrade area (ca. 19x9 km): 19 as a result of our field survey, and three from CSP-reports (Supplementary material: Table S1, Fig. 3; all Belgrade locations are presented as r=250 m circular sectors). At eight of these recording locations *M. sculpturalis* was found also in 2019, while at seven other locations from 2017–2019 we could not repeat the finding. Most of the records were made on plant inflorescences (almost all on *Styphnolobium*; the single male-based record on *Buddleja*: #3 in Supplementary material: Table S1), three records were associated with nesting activities (two of them in proximity to blooming *Styphnolobium* trees) and one represents the female collecting resin (on a coniferous tree). The few earliest finds (June 29, July 09) coincided with very early phase of *Styphnolobium* blooming at just few sites (typically ≤20% of the respective crowns); the last find coincided with nearly finished blooming of great majority of *Styphnolobium* trees. Positive recordings spanned the period of 50 days (June 29 – August 17), but were effectively accomplished in only 14 days (out of total engagement of 37 days). Active females were present throughout that period, while males were observed only until July 24 (effectively on five days, at six locations). Generally, the number of recorded specimens was relatively low at most places, rarely exceeding 1–2 per observational unit-time.

Due to uneven distribution of visited *Styphnolobium* sites (Fig. 1a), different landscape-urbanistic zones were covered with variable surveying effort, and consequently, recording locations are distributed unevenly (2–6 per zone). We recorded *M. sculpturalis* at about 35% of all locations visited during the blooming period; the share of locations with confirmed occurrences varied between zones (26–100%). Despite various logistic constrains, we have covered as many as 58 locations within the blooming period, with variable intensity of visitation (frequency and duration per site). Out of total 159 unique site-visits, 45 were very short (≤2') and/or conducted on trees with relatively few active flowers, hence, with reduced capacity for detecting the bees (none yielding any bee record); other visits were fully representative (often >10'). Repeated observation visits were conducted to as many as 37 locations during the blooming season: 27 locations we visited 2–4 times, while 10 locations we visited 5–10 times. Nevertheless, only at three locations we were able to detect bees more than once: twice at a site in the BUC zone (over the 28 days interval) and three times at two sites in the PPU zone (over the 17–18 days interval). Overall, we scored only 24 recording events from 19 locations.

Along with the search for the presence/activity of *M. sculpturalis*, we surveyed and quantified *Styphnolobium* trees within 71 analytical r=250 m sectors, totalling roughly 14 km^2 (Fig. 1a). In comparison with 2019, we complemented the spatial coverage with 31 new sectors (nearly 78% increase), comprising about 550 blooming trees; we also recorded 216 additional trees within the sectors assessed in 2019 (45% increase). In total, we detected more than 1,250 *Styphnolobium* trees within the survey area (ca. 16x10 km). This is certainly far from complete inventory, but likely accounts for >95% of trees actually present within the assessed sectors, and might represent >80% of available trees across several intensively surveyed wider city sections (particularly within BUC and PUC zones). The earliest period when some of the trees entered blooming was June 29 – July 07: we detected it at only three locations (all in PUC zone).

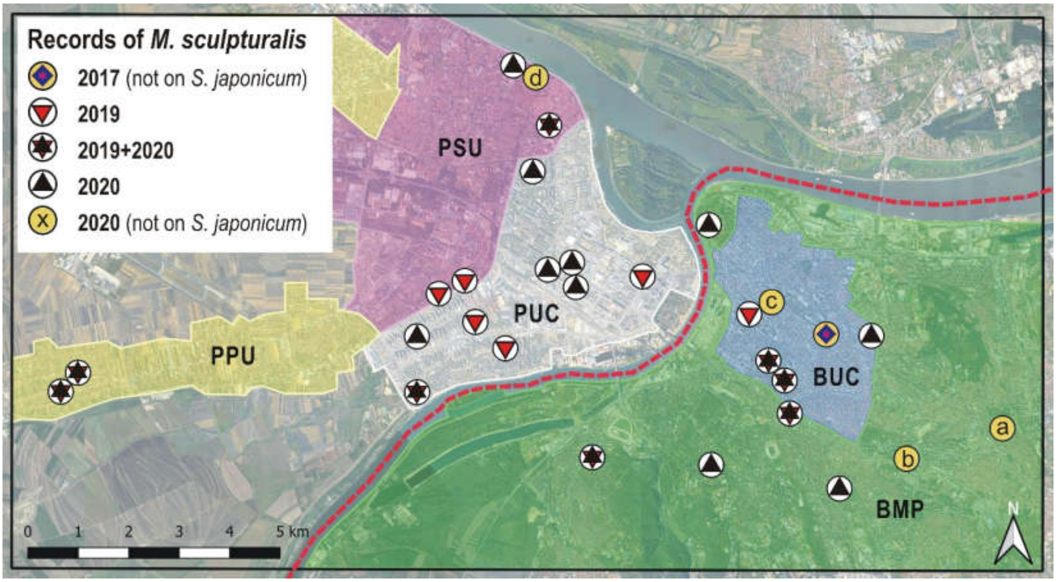

Figure 3. Summary review of documented *M. sculpturalis* occurrences within the Belgrade area in the period 2017–2020. Actual recording localities are aggregated into respective landscape sectors (r=250 m; as explained for Fig. 1). Majority of records represent the bees' foraging activity on blooming *Styphnolobium* trees (*S. japonicum*), exceptions are shown with orange-background circles: 2017 – the first record in Serbia: single male at *Trifolium*; 2020 – "x" in the legend is replaced with respective letter in the map, as follows: a – female collecting resin from a coniferous tree, b – female nesting in a hole in wooden table, c – single male at *Buddleja* blossom, d – female inspecting crevices in a brick pillar (within a line of blooming *Styphnolobium* trees all-around). Locations labelled with a, b, and c represent CSP records. Base map and zonation as in Fig. 1.

Only after July 09–11 blooming became widespread, so many trees within most of the surveyed sectors were suitable for assessing the bee activity. Relatively late-blooming trees (with ≤3% of opened flowers in the period as late as July 16–21), were recorded within at least 11 sectors (19%). Most trees finished blooming soon after August 15–17 (the state when most inflorescences remained with ≤5% active flowers), hence, became effectively unavailable for bees; few trees finished blooming as early as July 27–31. Certain *Styphnolobium* locations we managed to survey only outside the blooming period (13 out of 71 sectors were assessed mostly after the blooming was finished, until late October). These could not be assessed for bee presence/activity in 2020, but were included in the presentation (Fig. 1a) to provide a more complete floral resources overview for the whole-season (as well as for future planning). Distribution of sectors (total *vs*. assessed in bloom: 71/58) by landscape-urbanistic zones was: 15/11 in BUC, 17/14 in BMP, 25/23 in PUC, 11/8 in PSU, 3/2 in PPU.

Regardless of different phenophases in which we assessed various trees and sectors, we could establish that the greatest majority of *Styphnolobium* trees were blooming successfully in the season of 2020. Most of the tree crowns were >95% covered with inflorescences (considering the terminal branches which were in a state that allows blooming), very few had crown coverage of 85–95%, while we recorded only four fully grown trees that were not blooming at all in 2020. Therefore, effective floral resources available to *M. sculpturalis* bees were plentiful and almost evenly distributed all over the studied sectors for about 30–35 days, while being strongly reduced and patchily distributed during early- and late-blooming periods, respectively (each lasting about 10 days, when rare trees with 'outlying phenology' were most important).

Our surveying of other prospective plant genera yielded no record of *M. sculpturalis* in 2020 (the exceptional observation on *Buddleja* was from CSP). Out of seven initially planned genera, we could meaningfully survey only three: *Lavandula, Koelreuteria*, and *Buddleja* (Fig. 1b). Based on our ample long-term experience with assessing bees on *Lavandula* in Belgrade setting, the spatial coverage and surveying intensity in 2020 was reduced in favour of other co-flowering plants (see in Discussion). We surveyed 14 wider locations harbouring *Lavandula* plots (of various sizes and spatial arrangements), and conducted 25 unit-observations in the period June 04 – Sept 03 (on 18 days, but only 12 during favourable blooming conditions; similar with assessment elaborated for *Styphnolobium*, for all other plants we consider as 'unit-observation' any minimal duration of targeted observation per unit-location in a single day). For other two plants we scarcely had prior experience, hence our 2020 survey provided baseline evidence of distribution and phenological suitability. We documented 20 locations harbouring more than 140 *Koelreuteria* trees (variously grouped/clustered, from 1–6 to >50 trees per location), and we conducted 28 unit-observations in the period May 30 – July 15 (on 16 effective days). At most locations, the meaningful phase of blooming was reached only after June 10, while it was largely finished after July 05 (only few late-blooming trees were noted). We surveyed six locations harbouring *Buddleja* bushes (of various sizes, 1–5 separated units per location), and conducted 29 unit-observations in the period June 29 – Sept 04 (on 22 effective days). Throughout this period (and beyond) there were sufficient active *Buddleja* blossoms to justify surveying efforts. Since no bee activity was recorded, we did not provide any more detailed estimate of available floral resources of these plants; accordingly, no aggregated quantification was attempted, comparable to sector-based quantification for *Styphnolobium* (only 'raw' distributions are shown in Fig. 1b). Yet, the overall coverage and surveying efforts enable the meaningful comparisons of contrasting bee recording outcomes.

As for other initially considered plant genera, our 2020 survey has shown various limitations regarding their utility for *M. sculpturalis* assessment/monitoring, at least for the current situation in the Belgrade area, hence, we omitted them from mapping. *Catalpa*: we recorded it at more than 10 locations (many more are available), but we limited observations only to 6, in the period June 12–29; however, all observed trees were already in the final blooming phase by June 20, hence, hardly overlapping with *M. sculpturalis* activity period, at least in 2020. *Wisteria*: we recorded it at >15 locations, but none of the observed plants showed hardly any blooming after early May, hence, not having suitable phenology for bee visitation (possibly related to local cultivars; contradicts the examples documented elsewhere in Europe). *Ligustrum*: none of the numerous locations with various ornamental forms and varieties of this common plant in Belgrade green areas harboured cultivars which blooms in summer; due to logistic reasons, we could not search for wild *Ligustrum* (likely available in parts of wider peripheral zones), and this became even more unrewarding option after we documented too low activity density of *M. sculpturalis* on optimal floral resource. *Lythrum*: for similar reasons, we largely reduced the engagement on checking the suitability for monitoring on this late-blooming native plant – we made just five observations in August, without positive result; wild stands of this plant are common around small running or standing waters throughout Belgrade periphery, usually after mid-July, while we could not locate any site with ornamental *Lythrum* stands (ornamental forms were the basis for many recordings elsewhere in Europe or USA).

As for the installed trap-nests, no nesting of *M. sculpturalis* was detected in any of them, neither by inspection nor by rearing (relatively few other Hymenoptera were reared from the nests, so this is not of interest for the scope of this paper).

Regional scale: surveying in Serbia (beyond Belgrade) and Bosnia & Herzegovina

Apart from the wider Belgrade area, wherefrom we compiled occurrence data from 29 standardized unit-locations since 2017, we have further documented *M. sculpturalis* presence at 16 other 'localities' in Serbia (Fig. 4). Three of them comprise several 'sub-localities' (seven in Novi Sad, four in Bačka Topola, two in Temerin), hence totalling 26 unit-locations (which are mostly comparable in size with unit-locations from the Belgrade survey; closer toponyms and/or differing coordinates available in Supplementary material: Table S1). Only two of these localities represent the occurrences recorded before 2020: Palić (2018) and Bački Maglić (2019). From Bosnia & Herzegovina we documented the presence of *M. sculpturalis* at two wider localities in 2020 (near Bijeljina and in Banja Luka).

Within some more extensive localities we managed to detect the bees at most of the surveyed sub-localities (Banja Luka: 5/5; Bačka Topola: 4/4, Novi Sad: 6/9), while at others recording was less successful (Vršac: 1/5, Pančevo: 1/3, Temerin: 1/2). Generally, significant part of our surveying efforts resulted in 'negative records' – when no activity of *M. sculpturalis* could be detected on blooming *Styphnolobium* trees: we surveyed 19 such sites in Serbia outside Belgrade (in addition to 38 *Styphnolobium* unit-locations in Belgrade). Only two 'negative recordings' were specifically presented in the map: locations in SE-Serbia, in the centre of the city of Niš and in the nearby much smaller settlement of Niška banja, representing our southernmost research area in 2020.

CSP-participants in 2020 provided new records from 15 locations in Serbia (three in Belgrade) and one location in B&H. In two cases, reports were cross-posted both to our CSP-network and to the Facebook group "Insekti Srbije" (https://www.facebook.com/groups/insectserbia/), partially available also through the Alciphron portal (https://alciphron.habiprot.org.rs/) (rec_#4 and #32 in Supplementary material: Table S1). A short summary of CSP-reports is provided in the Table I. Our field work provided unique records from further 16 locations in Serbia (beyond Belgrade) and five locations in B&H (within Banja Luka); in addition, we visited eight locations to confirm CSP-reports. At 11 of these locations (out of 28) we conducted repeated observations on *Styphnolobium* trees (2–5 times), which resulted in repeated recordings of *M. sculpturalis* at six locations (55%). CSP-reports extended over the full two-month period: July 01 – August 31, closely followed by our extended field work outside the Belgrade area: July 05 – Sept 05. Documented phenology of *M. sculpturalis* was generally similar throughout the whole studied area, recording incidence being shifted just for few days outside Belgrade; exception are the records from the southernmost location in W-Serbia (#63–64: Skržuti, August 31 – Sept 05).

Overall, we summarized evidence for 61 unit-locations of confirmed *M. sculpturalis* occurrence from the two countries: one from 2017, one from 2018, 15 from 2019, and 53 from 2020. For practical reasons, we mapped recording sites (Fig. 4) as aggregated into 18 main localities, plus the more complex presentation of the Belgrade area.

First detection in Bosnia & Herzegovina (Nikolić, 2020) was based on the nesting event (three females) in an artificial facility (installed for rearing of *Osmia* orchard bees), in early August 2020 in Banja Luka; it was immediately followed by limited observation survey on *Styphnolobium* trees throughout the city area, generally documenting moderate to high local population abundance. Later on, an additional recording location was reported through CSP (Fig. 4; Nikolić & Bila Dubaić, 2021).

For the two respective blooming seasons, we defined two hypothetical convex hull polygons, to depict the minimal range extent of *M. sculpturalis* within the region south of Hungary. Assuming that it was likely established as continuous within the Pannonian and peri-Pannonian lowland area, the estimated range extension was more than doubled, from about 27,000 km^2 by 2019, to nearly 56,000 km^2 in 2020.

Other research activities

At various visited locations we sampled 88 bee specimens (81 females, seven males) for population-genetic studies, within 21 recording events (i.e., unique locality/date combinations), mostly while foraging on *Styphnolobium* inflorescences (76 specimens; this includes 13 taken by the CSP-participant), rarely from various nesting settings (12 specimens). Also, we gathered 58 pollen samples, within 16 recording events: seven were from the nest cells (one nest), the rest from scopal loads – 10 from females caught at nesting holes (at two sites), all others were foraging on *Styphnolobium* inflorescences. The on-going molecular analyses should provide comprehensive insight into local and regional colonisation history and pattern of population build-up, as well as to fill the knowledge gap on floral preferences of *M. sculpturalis* (Lanner *et al*, 2021; Bila Dubaić & Lanner, 2021).

Table. I. The summary of all reports gained through CSP (more details on *M. sculpturalis* reports in Supplementary material: Table S1). Three nesting situations were: in 'bee-hotel' setting (rec#8), in a wooden table (rec#21), and in a semi-withered tree trunk (rec#42). The most unusual case of nesting material were females observed depleting freshly applied grafting wax from the cherry trees (rec#44; Fig. 2a); to our knowledge, this behaviour has not been reported so far, and may represent potential nuisance for the commercial fruit producers.

		Structure of CSP reports	
Total	**Confirmed as *M. sculpturalis***	**Other insects (bees, wasp, flies)**	**Reports without photo or video**
77	16 (21%)	51	10
		Confirmed reports of *M. sculpturalis* (16)	
		Area	
Belgrade		Serbia (except Belgrade)	Bosnia & Herzegovina
3		12	1
		Sex of reported individuals	
Females		Males	Both (additional reporting)
12		4	1
		Observation context	
Foraging on flowers		**Collecting the nesting material**	
Sohphora	*Buddleja*	Resin (conif. trees)	Grafting wax (in orchard)
4	1	3	1
Nesting		**Other situations**	
	Alive - indoors	Dead - indoors	Dead - outdoors
3	1	1	2

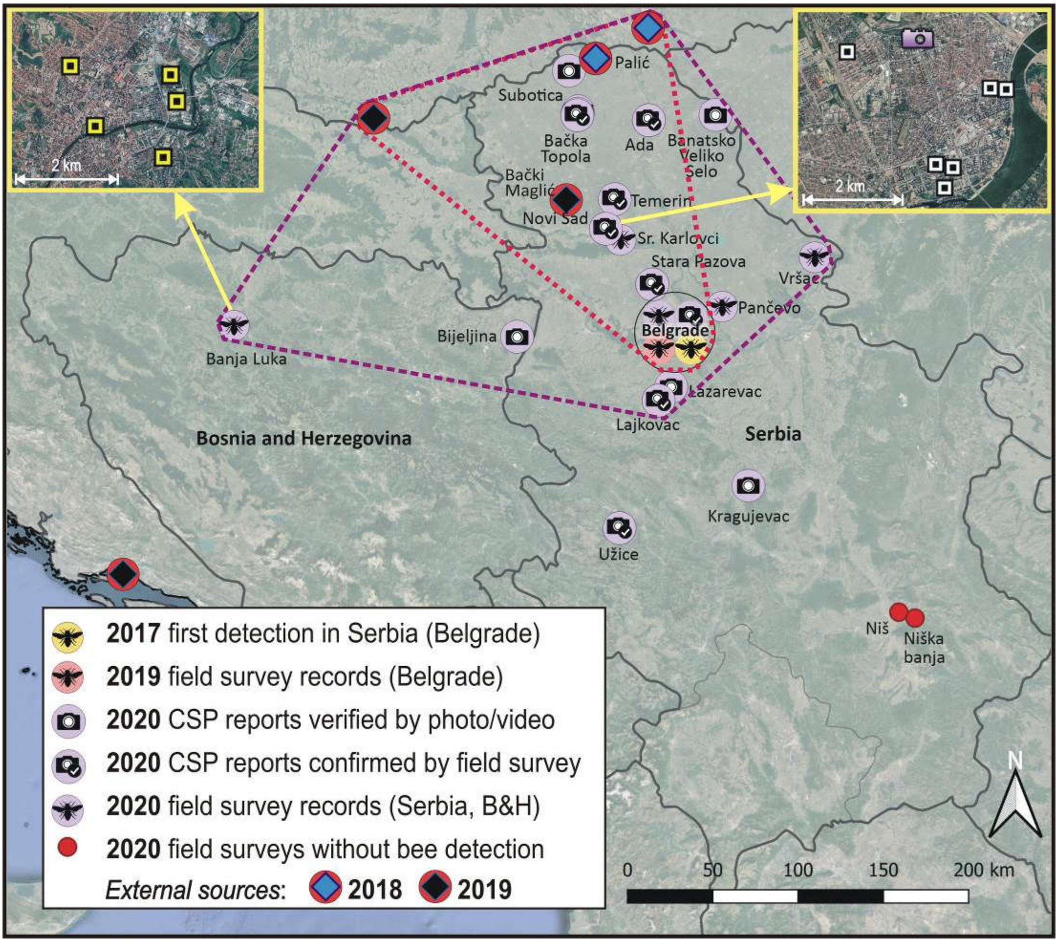

Figure 4. Summary review of documented *M. sculpturalis* occurrences in Serbia and Bosnia & Herzegovina, for the period 2017–2020, by data source and quality. For the Belgrade area, as most intensively surveyed, only the summary of record types is shown (compare with detailed distribution in Fig. 3). Insert-maps show records within the city-areas of Banja Luka and Novi Sad, respectively. The two southernmost of the surveyed locations represent the important outlying 'negative evidence' (bees not detected, despite the effort). From the external sources only two additional records were available from Serbia: Palić in 2018 (Insekti Srbije, 2018), and Bački Maglić in 2019 (Mudri-Stojnić *et al*., 2021). The three most adjacent records to the north and to the southwest depict the documented range extent in the respective countries bordering the survey area: Hungary by 2018–2019 (Rovarok, pókok, 2017–2019; izeltlabuak.hu, 2018) and Croatia by 2019 ('pitrusque', 2019). Two hypothetical convex hulls depict the approximate minimal extent of bee's continuously established range within the area, before the respective blooming seasons: 2019 (dotted/red) and 2020 (dashed/violet). Base-map source: Google Satellite™.

Discussion

Local scale: a survey of the Belgrade patterns

Likewise in the previous season, our Belgrade survey in 2020 confirmed the strong association of successful detections of *M. sculpturalis* with the availability and the adequate assessment of *Styphnolobium* trees in bloom. During the season of 2020 we immensely extended the surveying efforts, not just regarding the spatial coverage of *Styphnolobium* floral resources (+78% of unit-locations, +158% of surveyed trees), but also with inclusion of other prospective plant genera, with ample phenological span and by far more intensive field work. However, we managed to detect *M. sculpturalis* at only 19 locations associated with *Styphnolobium* across Belgrade. Another three records (all from CSP) were not related to *Styphnolobium*. Our results show a modest increase of 36%, compared to the 14 locations which resulted from a quite limited survey in 2019 (Bila Dubaić *et al*., 2021 [in rev.]; Fig. 3). Considering only the phenologically suitable survey period of 50 days of blooming *Styphnolobium*, the recording success was only about 35% in 2020 (19 out of 58 locations), compared to 88% in 2019 (14 out of 16 suitable locations, surveyed only within the last 8 days of scarce *Styphnolobium* blooming). Other parameters of detecting efficiency also indicated very low population level, e.g., number of recording events and recorded specimens, compared with overall intensity of surveying. Low population abundance of *M. sculpturalis* was further corroborated by the lack of nesting in any of the installed nesting facilities across Belgrade.

Bila Dubaić *et al*. (2021 [in rev.]) has shown how strongly reduced blooming of the key food-plant (*Styphnolobium*) in 2019 has promoted strong local concentration of bee activity around scarce resources, enabling easy and mass recording. This was contrasted with a poor detectability across the N-Serbia during 2017–2018 due to 'dilution effect'. The effect is produced when super-abundant floral resources induce very low average activity density of bees per 'unit-resource'. In a strong contrast with the extreme situation in 2019 (blooming reduced to about 6% of the average intensity), the season of 2020 had a highly successful *Styphnolobium* blooming, providing exceedingly abundant and evenly distributed key food resource. The overall poor recording success in 2020 indicates that we have witnessed a repeated dilution effect on the local bee population. It is possible that, at least in the Belgrade area, populations of *M. sculpturalis* were additionally reduced due to diminished reproduction during the food-limited summer of 2019. It is a well-known phenomenon, that the inter-seasonal variation of key food resources may affect both the local bee reproduction and the 'apparent' frequency of occurrences (cf. Tepedino & Stanton, 1981; Crone, 2013). This could create the alternation of concentration and dilution effects, leading to the dynamics of activity density observed for *M. sculpturalis* in Belgrade during 2017–2020. Remarkably, *Styphnolobium* seems to follow the 'alternating' or even markedly 'irregular bearing' pattern, recorded otherwise among numerous tree taxa belonging to widely different plant families (Monselise & Goldschmidt, 1982). It is of great relevance for future monitoring efforts to account for variable blooming pattern of *Styphnolobium*, as the most important food resource in our surveys 2019–2020.

The total of 29 different locations for the period 2017–2020 (Fig. 3) appears as widespread presence seemingly without any notable pattern. Apparently, the current recording score represents still too inadequate evidence-base for revealing possible spatial differences, e.g., effects of varying habitat compositions or wider urban environmental gradients. Comparison of recording success between the landscape-urbanistic zones may indicate some meaningful differences. The highest share (100%) was maintained in the PPU zone, over both seasons (2019–2020). The zone represents an isolated peripheral settlement surrounded with wide areas of inhospitable agricultural land, and with *Styphnolobium* trees restricted to just a few points. Therefore, repeated occurrences of *M. sculpturalis* at both PPU-locations, including high incidence of repeated findings during 2020, further support the idea that localized resource concentration highly improves detectability (Bila Dubaić *et al*., 2021 [in rev.]). The lowest share of recording was in the PUC zone (26%), where we managed to survey the largest number of *Styphnolobium* units with almost 62% of all the trees detected in the Belgrade area. In the remaining three zones, we had almost uniform recording success (36–38%), slightly above the average for the Belgrade area (35%). Despite the seemingly 'averaged state' of these simple metrics, indicating the similar population patterns, the real situation was probably neither uniform nor representative for the straightforward interpretation. In the most heavily urbanized BUC zone we had quite high intensity and spatial density of surveying, which yielded considerably poor outcomes: records were mostly peripheral (near the surrounding BMP zone), hence the repeated records (2019–2020) at two locations may not be regarded as remarkable as in case of PUC. The two remaining zones (BMP and PSU) seem by far insufficiently assessed, regarding the sparse and uneven location coverage (hence, obviously with undersampled resources).

Yet, on a coarser scale, recording success within Pannonian *vs*. Balkan section (Fig. 3; but see details at: https://srbee.bio.bg.ac.rs/english/m-sculpturalis-2019-survey), appears as 'stabilized' around similar average values (33% and 36%, respectively). Further testing is needed to explore the relevance of this tentative measure of 'effort *vs*. coverage index': could the detection success of about 35% (with a suitable coverage) provide a minimal target value, for reaching the meaningful estimates of local activity density of bees at low initial population levels. In parallel, we should test further – what is the representative number of unit-locations over certain wider spatial extent (at various scales), needed to enable the reliable monitoring with minimal/feasible effort. These preliminary indices justify the efforts to provide extended and more accurate quantification of floral resources on a wider scale. So far, our initial r=250 m grid framework appears as a highly practical and operative approach for exploratory field studies. However, coarser scales are probably more suitable for assessing the activity patterns and preferences of such a large and highly vagile bee. It is particularly challenging to deal with the phenological dynamics and variability (both of bees and of target plant taxa) at respective landscape scale, i.e., to 'capture' the realistic bees' activity and interaction indices within the shifting availability of floral resource. Our intensive surveying of exceedingly abundant *Styphnolobium* floral resource with an ample phenological coverage throughout the Belgrade area (Fig. 1a) provided a sound baseline for comprehensive future estimates at a wide range of spatio-temporal scales.

Besides the key floral resource, we extended the survey to other possible foraging plants. However, unlike in various studies across Europe, it is remarkable that we have so very few detections of *M. sculpturalis* foraging on other plants. In only two cases over the period 2017–2020 males were observed feeding on plants other than *Styphnolobium* (Fig. 3). Bila Dubaić *et al*. (2021 [in rev.]) tentatively associated this curiosity with the early phase of colonization in Serbia (Belgrade), characterized with population abundance being too low to support the 'spill-over' effect from the principal pollen-source plant. Accordingly, some of these additional plant genera are expected to serve as important complementary 'monitoring plants', once the local bee abundance reaches the sufficient level.

For example, *Lavandula* is among the most frequently visited plant taxa in the European range, second only to *Styphnolobium* (cf. Ćetković *et al*., 2020: unpublished study); it is even the first ranked in some country accounts: France (Le Féon *et al*., 2018) and Italy (Ruzzier *et al*., 2020). So far, we have no observation of *M. sculpturalis* on this plant, in spite of its widespread presence in Belgrade. In addition to still low bee population levels, some other reasons possibly reduce suitability of *Lavandula* in the Belgrade context: improper management regime on most public floral sites and/or unsuitable cultivar selection. Over the extended period (>8 yrs, unpublished observations) blooming of *Lavandula* in Belgrade was usually much reduced or even finished as early as July 10–15 (when often being completely trimmed), while the meaningful blooming extent recovers only at a few places, sometime in late August. Therefore, in the Belgrade setting *Lavandula* could be considered attractive for *M. sculpturalis* only before mid-July, hence, useful for comparative surveying in the early phase of seasonal activity.

Of other prospective plants, *Koelreuteria* is largely comparable with *Lavandula* in phenological aspect, hence potentially useful for surveying in the same seasonal phase, particularly after the mid-June. It is also a widespread and abundantly planted ornamental tree across Belgrade (Fig. 1b), representing a plant of different life form and geographic origin from *Lavandula*, while similar to *Styphnolobium* in these respects. Finally, our 2020 survey documented that the third compared plant, *Buddleja*, could be useful as alternative or 'control' monitoring unit, since it blooms continuously during the most of seasonal activity of *M. sculpturalis* females, and overlaps with other three plant genera in important period: late June – mid-July. It is currently not so abundant and widespread in Belgrade, but its distribution seems sufficient for comparative analyses.

All four considered plants are of special interest also for studying the relative preferences and possibly altered interactions among some common summer bees (genera *Apis*, *Bombus*, *Anthidium*, *Xylocopa*, native *Megachile*, etc.).

The lack of records from the two out of three compared plants largely corresponds with our still poorly documented early phenology of *M. sculpturalis* in Belgrade. Its activity is expected to begin by mid-June, based on flight period recorded elsewhere in Europe: early June – mid-September in Italy and France (Ruzzier *et al*., 2020; Le Féon *et al*., 2021); mid-June – late August in Hungary (Rovarok, pókok, 2017–2019; izeltlabuak.hu, 2018); hence, at least the two or three earliest weeks are not yet documented. This may also in part explain the unrealistically small share of males in our recordings within Belgrade (it was similar elsewhere across our study area). Activity of males could precede females for about 10–15 days (Kakutani *et al*., 1990) while the effective sex ratio could be as much as 72% male-biased, based on total brood emergence (Sasaki & Maeta, 2018). Extensive worldwide evidence (cf. Ćetković *et al*., 2020: unpublished study) clearly shows predominance of male visitations to all three alternative plant genera from our survey. Therefore, we hypothesize that a more realistic sex ratio will be evidenced when higher abundance of *M. sculpturalis* would allow for observable 'spill-over' effect from the mass-flowering *Styphnolobium*. Similarly, we are also still missing the exact evidence for approximately the final two weeks of female foraging/nesting activity (late August – early Sept).

Regional scale: distribution in Serbia (beyond Belgrade) and Bosnia & Herzegovina

We established that, by the season of 2020, *M. sculpturalis* has colonized more than a third of Serbia and arguably a quite extensive tract of northern Bosnia & Herzegovina; it is recorded within 19 aggregated localities (Fig. 4), only three of them being documented before 2020. A detailed review for the period 2017–2020 is based on the evidenced occurrences within 61 unit-locations. The importance of *Styphnolobium* for the detection of *M. sculpturalis* is further emphasized also at this scale: only at 13 unit-locations the presence of this key food plant was not explicitly documented (Supplementary material: Table S1). Accordingly, the temporal span of all recordings throughout the region was strictly defined by the phenology of blooming *Styphnolobium* trees (June 29–September 05).

Based on the currently documented distribution and the pattern of detection dynamics during 2017–2020, we assume that the Pannonian portion of Serbia (the Province of Vojvodina) has probably been fully colonized well before 2020, despite the initial paucity of records. Such a pattern was first suggested based on findings from the eastern Pannonian Plain that were available in 2019 (Bila Dubaić *et al*., 2021 [in rev.]), and is analogous to documented dynamics of spread in some other countries of Europe (cf. phase maps at: Ćetković *et al*., 2020). *M. sculpturalis* is now fairly well established, frequently encountered and numerous across Vojvodina. The average recording success per visited *Styphnolobium* sites was much higher than in the Belgrade area (ca. 50% *vs*. 35%), despite considerably less intensive surveying. This could be indicative of both the higher population levels (due to earlier local establishments) and/or a more efficient detection due to favorable and spatially restricted situations. We have found it in a range of mostly urban environments, including a few larger cities (Novi Sad, Vršac, Subotica) and several smaller towns, but also in some rural settlements. The region is characterized with a flat terrain, mostly dominated by agricultural land use, hence generally unsuitable for this bee species, regarding the availability of *Styphnolobium* or other proven pollen-source plants. However, the area is interspersed with numerous settlements (often less than 10–15 km apart), and *Styphnolobium* is present in many of them. It was generally widely planted throughout all types of settlements in Serbia, as both ornamental and melliferous species, and this situation could have promoted an easy expansion of *M. sculpturalis*, in a kind of 'stepping stone' fashion. All these results further corroborate the suggested 'sneaking distribution scenario' for the *M. sculpturalis* introduction into Serbia (Bila Dubaić *et al*., 2021 [in rev.]): a continuous southward spreading from NE-Hungary (instead of a long-distance jump into

Belgrade). Future molecular studies on the genetic structure of the Serbian and other E-European populations should provide a clearer picture of possible colonization routes (Lanner *et al*., 2021).

Occurrences across the lowland-to-hilly peri-Pannonian zone, from NW-Bosnia through C-Serbia, are still sporadic, arguably indicating the ongoing widely-frontal expansion, southwards from the Pannonian Plain. This tentative expansion zone is now spanning ca. 250 km W–E, from Banja Luka, through Bijeljina to Lajkovac. The westernmost Bosnian records are about 137 km SW linear distance from the closest known record in the southern Hungary (of 2019; cf. Rovarok, pókok, 2017–2019). The alternative sources could have been populations from Belgrade area and/or Vojvodina (records of 2017–2019), or those from Slovenia (records of 2018–2019), both at about 250 km linear distance (to the east or to the west, respectively). Smaller distances from the two Croatian coastal records (150–180 km to S/W) are probably irrelevant in this context, since no easy dispersal seems likely across the Dinaric Mountains range. Noteworthy, the recording in Banja Luka conducted within a single day was extraordinary successful per visited *Styphnolobium* site (100%), and *M. sculpturalis* was fairly abundant, indicating much earlier local establishment (Nikolić & Bila Dubaić, 2021). Based on assumption that spreading was probably continual and unlimited across the lowlands, including across the NE-Croatia (wherefrom no records are available), the range extension within the lowland area south of Hungary is estimated as likely doubled only during 2019–2020 (i.e., minimal convex hull increase of +107%).

There are only two scattered records more southerly, in the central to western hilly-mountainous areas, indicating that spreading into the core of the Balkan Peninsula is taking place somewhat slower and not continuously: ca. 95–125 km linear distance was reached in at least three seasons (since the first Belgrade find in 2017). Further south, extensive and repeated observations in Niš and in Niška banja during July-August, at two sites with numerous *Styphnolobium* trees in full bloom, yielded no activity of *M. sculpturalis*, hence indicating that bee expansion has not yet reached the area (or the population still being very low for detection)

With respect to the entire temporal span of recorded *M. sculpturalis* activity, the single southernmost location of Skržuti (near Užice; Supplementary material: Table S1: #63–64) represented a notable exception. In this area we evidenced a vivid activity of *M. sculpturalis* as late as August 31–September 05 (and collected 13 females and four males). All individuals were in fairly good condition (hence, recently emerged), and were intensively foraging on a *Styphnolobium* tree in a full bloom. Probably the local bee activity could have lasted for at least 1–2 weeks after our surveying, while in the rest of the region we documented only a much reduced activity after mid-August (the last find was on August 22). This was also the highest (512 m) of all records in SE-Europe (in our dataset *M. sculpturalis* is restricted to the lowlands: 75–232 m, mean 118 m; cf. Supplementary material: Table S1), but the ecological difference of altitude alone may not explain such a remarkable delay in phenology. However, this small rural settlement is situated within the wider mountainous region of SW-Serbia, dominated by the vast nearby plateau of Pešter (around 1,000 m average height), and renowned for extremely low winter temperatures. Hence, we attribute this shift to the extraordinary climatic effects of regional topography, affecting similarly the bee species and its key food-plant. Intensive foraging (and nesting activity) of *M. sculpturalis* so late in September was not documented so far in Europe, but is known from the northern areas within its native range in Japan (Sasaki & Maeta, 1994). Otherwise, the record is remarkable also for its remote position, away from the important traffic routes and from other documented *M. sculpturalis* occurrences. It is situated within wider semi-natural surroundings, probably with only a scattered distribution of relevant floral resources.

During the first three years of its documented presence in Serbia (2017–2019), detections of *M. sculpturalis* were scattered and accidental, hence, a time-intensive field survey across the wide geographical area would not be feasible. Our pioneering CSP was proved fairly effective and suitable for this regional scale, regarding the fact that the majority of the observations of *M. sculpturalis* outside of the Belgrade area were initially made by citizen scientists. Despite the small number of correct reports, it covered the remarkable spatial extent (ca. 250x130 km, encompassing alone the convex polygon of >23,000 km^2). To improve the coverage of *M. sculpturalis* range dynamics and habitat affinities, in future efforts we specifically need to enhance the engagement of people who live in (or visit) rural, semi-natural or natural areas. So far, we compiled the records from only six such locations (from all sources). Another aspect which could be improved is the low accuracy rate of identification by CSP-participants (21%), as compared with e.g., bumblebee surveys in the UK (40–60%) (Falk *et al*., 2019). This clearly emphasizes the need for professional verification of species identifications (Soroye *et al*., 2018; MacPhail *et al*., 2020), even in the case of a bee with such a remarkable habitus (Fig. 2d). Generally, tailored CSPs and other forms of involvement of general public are confirmed approaches for tracking the expansion of *M. sculpturalis* across Europe (Le Féon *et al*., 2018; Lanner, 2018–2019; Lanner *et al*., 2020a; Ruzzier *et al*., 2020; www.beeradar.info). However, these must be accompanied with well designed and focused research by professional bee experts, in order to establish a much needed thorough scientific foundation for future monitoring and management of this potentially troublesome species.

Acknowledgements

We want to thank to all the participants of the CSP (>60) who enthusiastically took part in our on-going research, and in particular, to those who managed to provide exact information on *M. sculpturalis* occurrences, used in this paper: Milica Perić, Matija Zloporubović, Varga Balázs, J.M., Momčilo Adamović, R. Samurović, Dragana Predojević, Ivana Jurić, J.S., Kristina Simić, Snežana Vujković Lamić, Bozsóki Róbert (representing the citizen organisation "Zeleno ostrvo Ada"), Gergely József, Todor Radović, Nikola Simanić, Predrag Kovačević and Mitar Stevanović (showing of some full names withheld upon request); see also at: https://srbee.bio.bg.ac.rs/azijska-pcela-smolarica/azijska-pcela-projekat-ucesce/gra%C4%91ani-koji-su-dali-svoj-doprinos-na%C5%A1em-projektu. Special thanks go to participants who contributed further with extended observations of nesting activities (Samurović family; B. Varga), and to those who contributed also with collecting the bee-samples (M. Stevanović). Contributions of various organisations (including media) and internet-based platforms (soc-media/groups) to promotion and/or dissemination of relevant news about our research were also of great importance. We are grateful to colleagues and friends who participated in installing of nesting facilities around the Belgrade area: Katarina Bjelanović, Katarina Breka, Jelisaveta Čkrkić, Milica Čkrkić Matijević, Maja Dakić, Aleksandra Penezić, Ivan Stojanović, Milja Vuković and Miloš Zdravković.Various research facilities, logistics and consumables were partly provided through the extended funding framework of the Faculty of Biology (University of Belgrade), from the Ministry of Education, Science and Technological Development of the Republic of Serbia (contract: # 451-03-68/2020-14/200178).

References

Aguado, O., Hernández-Castellano, C., Bassols, E., Miralles, M., Navarro, D., Stefanescu, C., & Vicens, N. (2018). *Megachile* (*Callomegachile*) *sculpturalis* Smith, 1853 (Apoidea: Megachilidae): a new exotic species in the Iberian Peninsula, and some notes about its biology. *Butlletí de la Institució Catalana d'Història Natural, 82*, 157-162.

Aizen, M. A., Arbetman, M. P., Chacoff, N. P., Chalcoff, V. R., Feinsinger, P., Garibaldi, L. A., Harder, L. D., Morales, C. L., Sáez, A., & Vanbergen, A. J. (2020). Invasive bees and their impact on agriculture. [Chapter 2] In Bohan, D. A. & Vanbergen, A. J. (Eds.), The future of agricultural landscapes, Part I. *Advances in Ecological Research, 63*, 49-92.

Aizen, M. A., Morales, C. L., Vázquez, D. P., Garibaldi, L. A., Sáez, A., & Harder, L. D. (2014). When mutualism goes bad: density-dependent impacts of introduced bees on plant reproduction. *New Phytologist, 204*(2), 322-328.

Amiet, F. (2012). Kurzbeitrag Die Blattschneiderbiene *Megachile sculpturalis* Smith, 1853 (Hymenoptera, Apidae) nun auch in der Schweiz. *Entomo Helvetica, 5*, 157-159.

Andrieu-Ponel, V., Ponel, P., Le Féon, V., Geslin, B., & Duvallet, G. (2018). À propos du comportement de butinage de *Megachile sculpturalis* Smith, 1853, en France méditerranéenne (Nîmes et Montpellier) (Hymenoptera, Megachilidae). *Bulletin de la Société entomologique de France, 123*(1), 49-54.

Ascher, J. S., & Pickering, J. (2020). *Megachile sculpturalis* Smith, 1853. In: Discover Life bee species guide and world checklist (Hymenoptera: Apoidea: Anthophila). Retrieved from: https://www.discoverlife.org/mp/20q?search=Megachile+sculpturalis#Hosts [Accessed on: April 2021].

Batra, S. W. T. (1998). Biology of the giant resin bee, *Megachile sculpturalis* Smith, a conspicuous new immigrant in Maryland. *Maryland Naturalist, 42*(1-2), 1-3.

Bertelsmeier, C., & Keller, L. (2018). Bridgehead effects and role of adaptive evolution in invasive populations. *Trends in Ecology & Evolution, 33*(7), 527-534.

Bila Dubaić, J., & Lanner, J. (2021). *Megachile sculpturalis* (Hymenoptera: Megachilidae): a valuable study organism for invasive pollinators and the role of beekeepers in ongoing monitoring programs. *Bee World, 98*(3), 78-82.

Bila Dubaić, J., Plećaš, M., Raičević, J., Lanner, J., & Ćetković, A. (2021 [in rev.]). Early-phase colonization by introduced sculptured resin bee (Hymenoptera: Megachilidae: *Megachile sculpturalis*) revealed by local floral resources variability.

Bortolotti, L., Luthi, F., Flaminio, S., Bogo, G., & Sgolastra, F. (2018). First record of the Asiatic bee *Megachile disjunctiformis* in Europe. *Bulletin of Insectology, 71*(1), 143-149.

Ćetković, A., & Plećaš, M. (2017). *Dalje širenje alohtone azijske pčele u Evropi: prvi nalaz Megachile sculpturalis na Balkanu.* Paper presented at the XI Simpozijum entomologa Srbije 2017, Goč, Zbornik rezimea, 82-83

Ćetković, A., Stanisavljević, L., Plećaš, M., Raičević, J., Žikić, V., Glavendekić, M., & Bila Dubaić, J. (2020). Project: Monitoring the spread of sculptured resin bee (*Megachile sculpturalis*) in Serbia. [English version]. Retrieved from: https://srbee.bio.bg.ac.rs/azijska-pcela-smolarica/azijska-pcela; https://srbee.bio.bg.ac.rs/english [Accessed on: January 2021].

Crone, E. E. (2013). Responses of social and solitary bees to pulsed floral resources. *The American Naturalist, 182*(4), 465-473.

European Commission. (2020). *Invasive Alien Species of Union concern. Version 2020.*: Publications Office of the European Union, Luxembourg.

Falk, S., Foster, G., Comont, R., Conroy, J., Bostock, H., Salisbury, A., Kilbey, D., Bennett, J., & Smith, B. (2019). Evaluating the ability of citizen scientists to identify bumblebee (*Bombus*) species. *PLoS ONE, 14*(6), e0218614.

Geslin, B., Gachet, S., Deschamps-Cottin, M., Flacher, F., Ignace, B., Knoploch, C., Meineri, É., Robles, C., Ropars, L., Schurr, L., & Le Féon, V. (2020). Bee hotels host a high abundance of exotic bees in an urban context. *Acta Oecologica, 105*, 103556.

Gogala, A., & Zadravec, B. (2018). First record of *Megachile sculpturalis* Smith in Slovenia (Hymenoptera: Megachilidae). *Acta Entomologica slovenica, 26*(1), 79-81.

Goulson, D. (2003). Effects of introduced bees on native ecosystems. *Annual Review of Ecology, Evolution, and Systematics, 34*(1), 1-26.

Google Earth Pro ver. 7.3.3.7786. Retrieved from: https://www.google.com/earth [Accessed on: March 2021].

Guariento, E., Lanner, J., Staggl, M. A., & Kranebitter, P. (2019). *Megachile sculpturalis* (Smith, 1853) (Hymenoptera: Megachilidae), the giant resin bee new to South Tyrol with a newly described plant species interaction. *Gredleriana, 19*, 209-215.

HabiProt. (2020). Alciphron - baza podataka o insektima Srbije. Retrieved from: https://alciphron.habiprot.org.rs [Accessed on: August 2021].

Hinojosa-Diaz, I. A., Yanez-Ordonez, O., Chen, G., Peterson, A. T., & Engel, M. S. (2005). The North American invasion of the giant resin bee (Hymenoptera: Megachilidae). *Journal of Hymenoptera Research, 14*(1), 69-77.

Insekti Srbije. (2018). Cvjetićanin, Miloš: Da li je ovo mamutska osa? Park prirode "Palić", 28. jul 2018. [https://youtu.be/Qi_ikI9RjLw]. Retrieved from: https://www.facebook.com/groups/insectserbia/permalink/1052703608266051/ [Accessed on: September 2020].

IUCN (2020). Managing invasive alien species to protect wild pollinators. Technical guidance prepared for the European Commission under contract No 07.0202/2018/795538/SER/ENV.D.2 "Technical support related to the implementation of the EU Pollinators Initiative". (pp. 43 pp): European Commission.

Ivanov, S. P., & Fateryga, A. V. (2019). First record of the invasive giant resin bee *Megachile* (*Callomegachile*) *sculpturalis* Smith, 1853 (Hymenoptera: Megachilidae) in the Crimea. *Far Eastern entomologist, 395*, 7-13.

izeltlabuak.hu. (2018). Forum "Izeltlabuak.hu: segítünk egymásnak megismerni Magyarország ízeltlábú élővilágát". [https://www.izeltlabuak.hu/talalat/33628]. Retrieved from: https://www.izeltlabuak.hu [Accessed on: June 2020].

Kakutani, T., Inoue, T., Kato, M. &, Ichihashi, H. (1990). Insect-flower relationship in the campus of Kyoto University, Kyoto: an overview of the flowering phenology and the seasonal pattern of insect visits. *Contributions from the Biological Laboratory, Kyoto University, 27*, 465-522.

Kovács, T. (2015). *Megachile sculpturalis* Smith, 1853 in Hungary (Hymenoptera, Megachilidae). *Folia Historico-Naturalia Musei Matraensis, 39*, 73-76.

Lanner, J. (2018-2019). Asiatische Mörtelbiene Projekt. Retrieved from: https://www.citizen-science.at/projekte/asiatische-moertelbiene; https://www.schweiz-forscht.ch/de/tiere/item/452-asiatische-moertelbiene [Accessed on: April 2020].

Lanner, J., Huchler, K., Pachinger, B., Sedivy, C., & Meimberg, H. (2020a). Dispersal patterns of an introduced wild bee, *Megachile sculpturalis* Smith, 1853 (Hymenoptera: Megachilidae) in European alpine countries. *PLoS ONE, 15*(7), e0236042.

Lanner, J., Meyer, P., Harmetzky, F., Meimberg, H., & Pachinger, B. (2020b). Die Asiatische Mörtelbiene (Hymenoptera: *Megachile sculpturalis* Smith, 1853) – eine neue Bienenart für Österreich. *Beiträge zur Entomofaunistik, 21*, 87-95.

Lanner, J., Gstöttenmayer, F., Curto, M., Geslin, B., Huchler, K., Orr, M. C., Pachinger, B., Sedivy, C., & Meimberg, H. (2021). Evidence for multiple introductions of an invasive wild bee species currently under rapid range expansion in Europe. *BMC Ecology and Evolution, 21*(1), 17.

Le Féon, V., Aubert, M., Genoud, D., Andrieu-Ponel, V., Westrich, P., & Geslin, B. (2018). Range expansion of the Asian native giant resin bee *Megachile sculpturalis* (Hymenoptera, Apoidea, Megachilidae) in France. *Ecology and Evolution, 8*(3), 1534-1542.

Le Féon, V., Genoud, D., & Geslin, B. (2021). Actualisation des connaissances sur l'abeille *Megachile sculpturalis* Smith, 1853 en France et en Europe (Hymenoptera: Megachilidae). *Osmia, 9*, 25-36.

Le Féon, V., & Geslin, B. (2018). Écologie et distribution de l'abeille originaire d'Asie *Megachile sculpturalis* Smith 1853 (Apoidea – Megachilidae – Megachilini): un état des connaissances dix ans après sa première observation en Europe. *Osmia, 7*, 31-39.

Lindgren, C. J., Castro, K. L., Coiner, H. A., Nurse, R. E., & Darbyshire, S. J. (2013). The biology of invasive alien plants in Canada. 12. *Pueraria montana* var. *lobata* (Willd.) Sanjappa & Predeep. *Canadian Journal of Plant Science, 93*(1), 71-95.

MacIvor, J. S., & Packer, L. (2015). 'Bee hotels' as tools for native pollinator conservation: a premature verdict? *PLoS ONE, 10*(3), e0122126.

MacPhail, V. J., Gibson, S. D., Hatfield, R. G., & Colla, S. R. (2020). Using Bumble Bee Watch to investigate the accuracy and perception of bumble bee (*Bombus* spp.) identification by community scientists. *PeerJ, 8*, e9412.

Maeta, Y., Kitamura, K., Kagino, Y., & Ikegami, N. (2008). In-nest behaviors and labor economy of *Megachile* (*Callomegachile*) *sculpturalis* Smith (Hymenoptera, Megachilidae). *Chugoku Kontyu, 22*, 1-22.

Mangum, W. A., & Brooks, R. W. (1997). First records of *Megachile (Callomegachile) sculpturalis* Smith (Hymenoptera: Megachilidae) in the continental United States. *Journal of the Kansas Entomological Society, 70*(2), 140-142.

Mangum, W. A., & Sumner, S. (2003). A survey of the North American range of *Megachile* (*Callomegachile*) *sculpturalis*, an adventive species in North America. *Journal of the Kansas Entomological Society, 76*(4), 658-662.

Monselise, S. P., & Goldschmidt, E. E. (1982). Alternate bearing in fruit trees. [Chapter 5]. *Horticultural Reviews, 4*, 128-173.

Morales, C. L., Sáez, A., Garibaldi, L. A., & Aizen, M. A. (2017). Disruption of pollination services by invasive pollinator species. [Chapter 13]. In Vilà, M. & Hulme, P. E. (Eds.), *Impact of biological invasions on ecosystem services.* (pp. 203-220). Springer International Publishing, Switzerland.

Mudri-Stojnić, S., Andrić, A., Markov-Ristić, Z., Đukić, A., & Vujić, A. (2021). Contribution to the knowledge of the bee fauna (Hymenoptera, Apoidea, Anthophila) in Serbia. *ZooKeys, 1053*, 43-105.

Nikolić, P. (2020). Sculptured Resin Bee (*Megachile sculpturalis*). Observed on: August 3, 2020: Banja Luka 78000, Bosnia and Herzegovina. Retrieved from: https://www.inaturalist.org/observations/55266322 [Accessed on: August 2020].

Nikolić, P., & Bila Dubaić, J. (2021). *First finding of sculptured resin bee (Megachile sculpturalis Smith) in Bosnia and Herzegovina.* Paper presented at the X International Symposium on Agricultural Sciences – AgroReS 2021. Book of Abstracts, Trebinje.

Ortiz-Sánchez, F. J., Navarro, J. F., & Taeger, U. (2018). *Megachile* (*Callomegachile*) *sculpturalis* Smith, 1853, nueva especie para la fauna Ibérica (Hymenoptera, Megachilidae). *Boletín de la Sociedad Entomológica Aragonesa, 63*, 259-261.

Parys, K., Tripodi, A. D., & Sampson, B. J. (2015). The giant resin bee, *Megachile sculpturalis* Smith: New distributional records for the mid- and gulf-south USA. *Biodiversity Data Journal, 3*, e6733.

'pitrusque'. (2019). Sculptured Resin Bee (*Megachile sculpturalis*). Observed on August 5, 2019: 21000, Split, Croatie. Retrieved from: https://www.inaturalist.org/observations/37059640 [Accessed on: February 2020].

QGIS Development Team. (2018). QGIS Geographic Information System. Open Source Geospatial Foundation.

Quaranta, M., Sommaruga, A., Balzarini, P., & Felicioli, A. (2014). A new species for the bee fauna of Italy: *Megachile sculpturalis* continues its colonization of Europe. *Bulletin of Insectology, 67*(2), 287-293.

Rasmont, P., Devalez, J., Pauly, A., Michez, D., & Radchenko, V. G. (2017). Addition to the checklist of IUCN European wild bees (Hymenoptera: Apoidea). *Annales de la Société entomologique de France (N.S.), 53*(1), 17-32.

Resl, J. (2018). *Megachile* (*Callomegachile*) *sculpturalis* Smith, 1853. In: Scarabaeidae; Aktivity; Zajímavé objevy. Retrieved from: https://www.scarabaeidae.cz/products/megachile-callomegachile-sculpturalis-smith-1853/; http://files.listorozi.webnode.cz/200000105-50fb451f64/Megachilidae%20moje.pdf [Accessed on: January 2021].

Ribas Marquès, E., & Díaz Calafat, J. (2021). The Asian giant resin bee *Megachile sculpturalis* Smith 1853 (Hymenoptera: Apoidea: Megachilidae), a new exotic species for the bee fauna of Mallorca (Balearic Islands, Spain). *Journal of Apicultural Research*. *60*(3), 506-511

Rovarok; pókok. (2017–2019). Facebook group "Rovarok, pókok" [Insects, spiders]. Retrieved from: https://www.facebook.com/groups/rovarokpokok/ [Accessed on: January 2021].

Russo, L. (2016). Positive and negative impacts of non-native bee species around the world. *Insects, 7*(4), 69.

Ruzzier, E., Menchetti, M., Bortolotti, L., Selis, M., Monterastelli, E., & Forbicioni, L. (2020). Updated distribution of the invasive *Megachile sculpturalis* (Hymenoptera: Megachilidae) in Italy and its first record on a Mediterranean island. *Biodiversity Data Journal, 8*, e57783.

Sasaki, Y., & Maeta, Y. (1994). Occurrence of fresh adults of *Chalicodoma sculpturalis* (Smith) in autumn (Hymenoptera: Megachilidae). [In Japanese, English abstract]. *Chugoku Kontyu, 8*, 37-48.

Sasaki, Y., & Maeta, Y. (2018). Diurnal activity and reproduction of *Megachile* (*Callomegachile*) *sculpturalis* Smith (Hymenoptera, Megachilidae). [In Japanese, English abstract]. *Bulletin of the Hoshizaki Green Foundation, 21*, 209-218.

Soroye, P., Ahmed, N., & Kerr, J. T. (2018). Opportunistic citizen science data transform understanding of species distributions, phenology, and diversity gradients for global change research. *Global Change Biology, 24*(11), 5281-5291.

Stout, J. C., & Morales, C. L. (2009). Ecological impacts of invasive alien species on bees. *Apidologie, 40*(3), 388-409.

Straffon Díaz, S., Carisio, L., Manino, A., Biella, P., & Porporato, M. (2021). Nesting, sex ratio and natural enemies of the giant resin bee in relation to native species in Europe. *Insects, 12*, 545.

Tepedino, V. J., & Stanton, N. L. (1981). Diversity and competition in bee-plant communities on short-grass prairie. *Oikos, 36*(1), 35-44.

Theobald, E. J., Ettinger, A. K., Burgess, H. K., DeBey, L. B., Schmidt, N. R., Froehlich, H. E., Wagner, C., Hille Ris Lambers, J., Tewksbury, J., Harsch, M. A., & Parrish, J. K. (2015). Global change and local solutions: Tapping the unrealized potential of citizen science for biodiversity research. *Biological Conservation, 181*, 236-244.

Vanbergen, A. J., Espindola, A., & Aizen, M. A. (2018). Risks to pollinators and pollination from invasive alien species. *Nature Ecology & Evolution, 2*(1), 16-25.

Vereecken, N. J., & Barbier, E. (2009). Premières données sur la présence de l'abeille asiatique *Megachile* (*Callomegachile*) *sculpturalis* Smith (Hymenoptera, Megachilidae) en Europe. *Osmia, 3*, 4-6.

Westrich, P. (2017). Erstnachweis der Asiatischen Mörtelbiene (*Megachile sculpturalis*) in Österreich! [Projekte *Megachile sculpturalis* 7]. Retrieved from: https://www.wildbienen.info/forschung/projekte_17.php [Accessed on: August 2019].

Westrich, P. (2020). Neues zur Ausbreitung der Mörtelbiene *Megachile sculpturalis* Smith 1853 (Hymenoptera: Anthophila) in Deutschland – Stand Oktober 2019. *Eucera, 14*, 12-15.

Westrich, P., Knapp, A., & Berney, I. (2015). *Megachile sculpturalis* Smith 1853 (Hymenoptera, Apidae), a new species for the bee fauna of Germany, now north of the Alps. *Eucera, 9*, 3-10.

Wu, Y. R. (2006). *Hymenoptera, Megachilidae. Fauna Sinica, Insecta. Vol. 44. [In Chinese, English summary].* Science Press, Beijing.

ДАЉА ЕКСПАНЗИЈА АРЕАЛА ВЕЛИКЕ ПЧЕЛЕ СМОЛАРИЦЕ (*MEGACHILE SCULPTURALIS*) У СРБИЈИ И БОСНИ И ХЕРЦЕГОВИНИ

ЈОВАНА БИЛА ДУБАИЋ, ЈОВАНА РАИЧЕВИЋ, МИЛАН ПЛЕЋАШ, ЈУЛИА ЛАНЕР, ПЕТАР НИКОЛИЋ, ВЛАДИМИР ЖИКИЋ, ЉУБИША СТАНИСАВЉЕВИЋ и АЛЕКСАНДАР ЋЕТКОВИЋ[1]

Извод

Велика пчела смоларица (*Megachile sculpturalis*) је прва неаутохтона врста пчеле у Европи, пореклом из источне Азије. Њено континуирано ширење (од кад је откривена у југозападној Европи, 2008–2010) резултирало је дистрибуцијом која тренутно обухвата готово 2.800 x 1.100 км (по географској дужини, односно, географској ширини), у оквиру јужне и средње Европе. У југоисточној Европи је потврђена од 2015. (у североисточној Мађарској), а затим у северној Србији и широм источне Панонске низије (2017–2019); последње је нађена у северозападној Босни и Херцеговини (2020).

У глобалним размерама изражена је све већа забринутост због растућег броја интродукција алохтоних врста пчела. Због тога расте и интерес за бољим разумевањем образаца и процеса који утичу на њихово успешно колонизовање нових простора, посебно због потенцијалне инвазивности. Најважнији негативни ефекти инвазивних алохтоних пчела могу се испољити у односу на популације аутохтоних врста, као и на различите категорије интеракција повезаних са опрашивањем. У литератури о интродукцији *M. sculpturalis* широм Европе, више пута је истицана потреба за праћењем („мониторингом“) ове „инвазије“, али тренутно не постоје никакви протоколи за процену потенцијалних утицаја, као ни других релевантних параметара везаних за успешност колонизовања. На основу наших истраживања спроведених током 2017–2019. године на подручју Београда, предложен је „радни концепт“ за свеобухватно праћење *M. sculpturalis*, заснован на квантитативној процени популационих трендова ове пчеле у односу на ресурсе кључне биљке хранитељке. Овај иницијални концепт сада треба унапредити, проширити и тестирати, у односу на различите просторно-временске скале истраживања или потребе различитих режима будућег праћења. Зато смо током 2020. значајно проширили опсег истраживања, на две просторне скале. На ЛОКАЛНОЈ скали, за подручје Београда, настављено је интензивно праћење и процена бројности, те проучавање биономије и локалне дистрибуције *M. sculpturalis* (у односу на градијенте станишних услова у урбаној средини); паралелно је вршена евалуација ширег сета релевантних биљака и њихових интеракција, као потенцијалних ресурса хране али и „референтних јединица“ за регистровање активности смоларице. На РЕГИОНАЛНОЈ скали проучавана је дистрибуција и динамизам ареала ове врсте широм Србије и Босне и Херцеговине, као референтног „пресека стања“ експанзионог фронта у југоисточној Европи; ово је укључило шири обухват њених еколошких преференција у односу на различите типове станишта и животних услова. Ради ширег и ефикаснијег обухвата студије, покренут је, као пионирски концепт, наменски „пројекат грађанске/волонтерске науке“ (citizen science project), фокусиран на регистровање присуства врсте широм Србије и региона, што је омогућило значајну географску покривеност истраживања (упркос релативно скромном броју тачних дојава).

Током истраживања на подручју Београда врста је забележена на нешто већем броју локација него у 2019. години (+36%), али је значајно смањена ефикасност регистровања (35%, у односу на 88% у 2019), упркос знатно повећаном интензитету и обухвату истраживања. Ово је додатно потврдило

значај феномена алтернирања „ефекта концентрације“ и „ефекта разређивања“ на детектабилност ове пчеле, изазваног међусезонским варирањем кључних извора хране, што значајно утиче и на динамику популације смоларице. Потврдили смо наглашену везу између ефикасности детекције и доступности кључне биљке хранитељке – софоре (*Styphnolobium*), посебно имајући у виду варијабилност њеног цветања између сезона; ове релације, потврђене на обе скале истраживања, од велике су важности за дефинисање концепта праћења. Фенолошки опсег регистроване активности *M. sculpturalis* (>70 дана) блиско се поклапа са фенологијом цветања софоре током 2020; реални опсег активности на нивоу региона је свакако шири, делом условљен и локалним модификацијама климе услед наглашеног рељефа. Са једним изузетком, практично нисмо имали налазе на другим испитиваним биљкама. Регионална експанзија *M. sculpturalis* у периоду 2017–2020. документована је у склопу детекције на 19 ширих локација, од којих је на 16 врста први пут регистрована у 2020. години. *M. sculpturalis* је сада посебно добро заступљена у панонском, а нешто слабије у перипанонском подручју Србије и БиХ, где се приближно процењени опсег ареала вероватно удвостручио између 2019. и 2020. године. Даље на југ смоларица је нађена на свега пар локација, што указује на спорије ширење врсте кроз брдско-планински део Балкана. У целини, налази су претежно били из градских средина или других типова насеља, тек око трећине потиче из полуприродног или претежно пољопривредног окружења.

Received: September 18th, 2021
Accepted: September 28th, 2021

Supplementary material

S1. S1_Supplementary material Table S1
Records of *M. sculpturalis* from Serbia and Bosnia & Herzegovina during 2020.

Table S1. Records of M. sculpturalis from Serbia and Bosnia & Herzegovina during 2020, sorted chronologically. The unit record is defined as unique locality/date combination, hence, some recording sites encompass repeated recording events (being re-visited for various purposes); however, in few cases of extended observation of nesting activity, repeated reports are omitted. Source of data is abbreviated as: OR – Own Research (surveying by co-authors), or CSP – Citizen Science Project reports. Coordinates (Latitude, Longitude) are given in WGS84 system. Locations are given as broader toponyms and/or in combination with smaller units (municipalities, etc.), while coordinates were used to define the basic locality-units. Recorded by: co-authors are shown by initials, full surnames given for CSP contributors (but only initials if withheld by request). Recording context: mostly recorded on blooming Styphnolobium trees (49 out of 64), 7 based on nesting (but #46 includes both the nesting and observation on Styphnolobium within the same site), 9 were other contexts. Sex: F – female, M – males; indicates positively established sex of the observed specimens (some reports likely include both sexes, but undocumented). Sampling: number of collected specimens, followed by "p" if some included pollen.

No	Source	Date	Ctry.	Lat.	Long.	Locations (municipalities)	Alt. (m)	Recorded by	Record. context	Sex	Samp ling
1	OR	29.06.2020	SRB	44.81811	20.41590	Belgrade, Novi Beograd	77	JBD	*Styphnolo bium*	M	-
2	OR	29.06.2020	SRB	44.81399	20.40924	Belgrade, Novi Beograd	75	JBD	*Styphnolo bium*	F, M	2
3	CSP	01.07.2020	SRB	44.81145	20.46370	Belgrade, Stari grad	124	Perić, M.	*Buddleja*	M	-
4	CSP	03.07.2020	SRB	45.26064	19.83133	Novi Sad, Banatić	80	Zloporubović, M.	found dead	M	-
5	OR	05.07.2020	SRB	45.26109	19.81351	Novi Sad, Detelinara	77	JR	*Styphnolo bium*	F	-
6	OR	05.07.2020	SRB	45.25488	19.85042	Novi Sad, Dunavski park	80	JR	*Styphnolo bium*	F	7p
7	OR	09.07.2020	SRB	44.81169	20.41645	Belgrade, Novi Beograd	79	JR	*Styphnolo bium*	F	-
8	CSP	10.07.2020	SRB	45.41092	19.87661	Temerin	78	Varga, B.	nesting	F	-
9	OR	11.07.2020	SRB	44.79601	20.29127	Belgrade, Surčin	92	JR	*Styphnolo bium*	F, M	1
10	OR	13.07.2020	SRB	44.77467	20.48248	Belgrade, Voždovac	119	JBD, MP	*Styphnolo bium*	F	-
11	OR	13.07.2020	SRB	45.25470	19.85452	Novi Sad, Trg Nezn. junaka	81	JR	*Styphnolo bium*	F	-
12	OR	13.07.2020	SRB	45.24095	19.83669	Novi Sad, Liman3	82	JR	*Styphnolo bium*	F	
13	OR	13.07.2020	SRB	45.20551	19.93460	Sremski Karlovci	76	JR	*Styphnolo bium*	F	17p
14	CSP	14.07.2020	SRB	44.98328	20.15795	Stara Pazova	81	Adamović, M.	*Styphnolo bium*	F	-
15	OR	15.07.2020	SRB	44.79445	20.37442	Belgrade, Novi Beograd	74	JBD, MP	*Styphnolo bium*	F	-
16	OR	15.07.2020	SRB	44.79601	20.29127	Belgrade, Surčin	92	JR	*Styphnolo bium*	F	1p
17	OR	15.07.2020	SRB	44.84095	20.40947	Belgrade, Zemun	77	JR	*Styphnolo bium*	F, M	-

Table S1 – continued

No	Source	Date	Ctry.	Lat.	Long.	Locations (municipalities)	Alt. (m)	Recorded by	Record. context	Sex	Samp ling
18	OR	16.07.2020	SRB	44.79527	20.46635	Belgrade, Vračar	120	JBD, JR	*Styphnolo bium*	F	-
19	OR	16.07.2020	SRB	44.79797	20.46364	Belgrade, Savski venac	130	MP	*Styphnolo bium*	F	-
20	OR	16.07.2020	SRB	44.79052	20.46907	Belgrade, Voždovac	93	JBD, JR	*Styphnolo bium*	F	-
21	CSP	16.07.2020	SRB	44.78175	20.49840	Belgrade, Zvezdara	139	Samurović	nesting	F	-
22	CSP	20/28.07.20 20	SRB	45.83426	19.63351	Bačka Topola	93	Jurić, I.	collecting resin	F	-
23	OR	22.07.2020	SRB	45.24041	19.84113	Novi Sad, Limanski park	83	JR	*Styphnolo bium*	F	-
24	CSP	23.07.2020	SRB	45.82298	20.60325	Kikinda, Banat. Vel. selo	76	Predojević, D.	*Styphnolo bium*	M	-
25	OR	23.07.2020	SRB	44.98328	20.15795	Stara Pazova	81	JR	*Styphnolo bium*	F	8p
26	OR	24.07.2020	SRB	44.82164	20.44831	Belgrade, Stari grad	93	AĆ	*Styphnolo bium*	F, M	-
27	OR	26.07.2020	SRB	44.87252	20.64966	Pančevo	78	JBD	*Styphnolo bium*	F	-
28	OR	26.07.2020	SRB	45.11843	21.30196	Vršac	94	JBD	*Styphnolo bium*	F, M	-
29	OR	27.07.2020	SRB	44.79601	20.29127	Belgrade, Surčin	92	JR	*Styphnolo bium*	F	-
30	OR	27.07.2020	SRB	44.79393	20.28740	Belgrade, Surčin	88	JR	*Styphnolo bium*	F	3p
31	OR	27.07.2020	SRB	44.84948	20.40643	Belgrade, Zemun	104	JR	nesting	F	1
32	CSP	28.07.2020	SRB	45.82097	19.62987	Bačka Topola	92	Simić, K.	found dead	F	-
33	CSP	28.07.2020	SRB	44.47047	20.29035	Lazarevac, Veliki Crljeni	108	- (JS)	active indoors	M	-
34	OR	02.08.2020	SRB	45.40677	19.89346	Temerin	83	JBD	*Styphnolo bium*	F	-
35	OR	03.08.2020	BIH	44.77699	17.21097	Banja Luka, Agricult. Faculty	155	PN	nesting	F	6p
36	OR	03.08.2020	BIH	44.77219	17.21263	Banja Luka, Police Academy	154	PN	*Styphnolo bium*	F	-
37	OR	03.08.2020	BIH	44.76213	17.20963	Banja Luka, Starčevica	166	PN	*Styphnolo bium*	F	-
38	OR	03.08.2020	BIH	44.76728	17.19221	Banja Luka, Kastel	156	PN	*Styphnolo bium*	F	-
39	OR	03.08.2020	BIH	44.77787	17.18547	Banja Luka, Borik	165	PN	*Styphnolo bium*	F	-
40	OR	06.08.2020	SRB	44.79393	20.28740	Belgrade, Surčin	88	JR	*Styphnolo bium*	F	-
41	CSP	06.08.2020	SRB	46.03930	19.57128	Subotica, Mala Bosna	115	Vujković Lamić, S.	collecting resin	F	-
42	CSP	07.08.2020	SRB	45.79674	20.13371	Ada	83	Bozsóki, R. Gergely, J.	nesting	F	-

Table S1 – continued

No	Source	Date	Ctry.	Lat.	Long.	Locations (municipalities)	Alt. (m)	Recorded by	Record. context	Sex	Samp ling
43	CSP	07.08.2020	SRB	43.96932	20.83405	Kragujevac, Dragobraća	280	Radović, T.	found dead	F	-
44	CSP	08.08.2020	BIH	44.72187	19.20614	Bijeljina, Pučile	102	Simanić, N.	collecting grafting wax	F	-
45	OR	11.08.2020	SRB	45.23670	19.83906	Novi Sad, Liman3	82	JR	*Styphnolo bium*	F	-
46	OR	12.08.2020	SRB	44.79527	20.46635	Belgrade, Vračar	126	JBD, MP, JR	*Styphnolo bium* + nesting	F	7p
47	OR	12.08.2020	SRB	44.80306	20.49123	Belgrade, Zvezdara	135	JBD, MP, JR	*Styphnolo bium*	F	-
48	CSP	12.08.2020	SRB	44.40123	20.20192	Lajkovac, Jabučje	124	Kovačević, P.	*Styphnolo bium*	F	-
49	OR	13.08.2020	SRB	44.78138	20.41976	Belgrade, Čukarica	122	JBD, MP, JR	*Styphnolo bium*	F	-
50	OR	13.08.2020	SRB	44.78077	20.44716	Belgrade, Savski venac	108	MP	*Styphnolo bium*	F	-
51	OR	13.08.2020	SRB	44.80124	20.37624	Belgrade, Novi Beograd	83	JBD, MP, JR	*Styphnolo bium*	F	-
52	OR	13.08.2020	SRB	44.83395	20.40534	Belgrade, Novi Beograd	79	JBD	*Styphnolo bium*	F	-
53	OR	13.08.2020	SRB	44.79393	20.28740	Belgrade, Surčin	88	JR	*Styphnolo bium*	F	2p
54	OR	15.08.2020	SRB	45.84646	19.63646	Bačka Topola, Zobnatičko jez.	104	JBD	*Styphnolo bium*	F	1p
55	OR	16.08.2020	SRB	45.79674	20.13371	Ada	83	JBD	nesting	F	6p
56	OR	16.08.2020	SRB	45.81640	19.62988	Bačka Topola	97	JBD	*Styphnolo bium*	F	6p
57	CSP	16.08.2020	SRB	44.78733	20.52198	Belgrade, Zvezdara	232	- (JM)	collecting resin	F	-
58	OR	17.08.2020	SRB	45.81640	19.62988	Bačka Topola	97	JBD	*Styphnolo bium*	F	1p
59	OR	17.08.2020	SRB	44.85287	20.39761	Belgrade, Zemun	97	JR	*Styphnolo bium*	F	-
60	OR	18.08.2020	SRB	45.81640	19.62988	Bačka Topola	97	JBD	*Styphnolo bium*	F	1p
61	OR	18.08.2020	SRB	45.83426	19.63351	Bačka Topola, Zobnatičko jez.	100	JBD	*Styphnolo bium*	F	-
62	OR	22.08.2020	SRB	44.40123	20.20192	Lajkovac, Jabučje	124	JBD	*Styphnolo bium*	F	1p
63	CSP	31.08. - 04.09.2020	SRB	43.75295	19.92682	Užice, Skržuti	512	Stevanović, M.	*Styphnolo bium*	F (+M)	13p
64	OR	05.09.2020	SRB	43.75295	19.92682	Užice, Skržuti	512	JBD	*Styphnolo bium*	F, M	4p