Bonn zoological Bulletin 72 (1): 133–144
2023 László M. et al.
https://doi.org/10.20363/BZB-2023.72.1.133

ISSN 2190–7307
http://www.zoologicalbulletin.de

Research article

urn:lsid:zoobank.org:pub:4529EE38-9C96-4DB1-9DE2-96743A37ED09

Spread of the invasive Giant Asian Mantis *Hierodula tenuidentata* Saussure, 1869 (Mantodea: Mantidae) in Europe with new Hungarian data

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Abstract. The Giant Asian Mantis (*Hierodula tenuidentata*) has a rapid spread in Europe that is considerably helped by global trade and transportation. Following the expansion of this species is crucial to understand the factors facilitating its success. In this paper, we present the first 103 Hungarian observations (42 sites) of *H. tenuidentata i*ncluding its currently known northernmost established population in Central Europe. We also provide its mapped, published and unpublished citizen science-based European data from the 1910s to 2022 highlighting the main dynamics and areas in the spread of this species here. The potential ways of the spread of *H. tenuidentata*, its habitat characteristics and some possible impacts on the native European fauna are also discussed based on previous assumptions and recent experiences.

Key words. Invasion, citizen science, urban heat island, distribution, Hungary, conservation.

INTRODUCTION

Alien species have an increasing number worldwide which largely originates from the growth of global trade and transportation (Hulme 2021). Recently more and more papers are published on this topic (Kühn et al. 2011) even with the use of citizen science data and methods which have an important and growing role in mapping alien species (Encarnação et al. 2021; Wallace et al. 2021)

In Europe this kind of data source is used to capture and map non-native insects, like praying mantises (e.g., Moulin 2020; van der Heyden & Schwarz 2021). The number of alien mantid species and some of their populations in Europe increased recently like in the case of *Sphodromantis viridis* Forskal, 1775, *Hierodula patellifera* Serville, 1839 or even more conspicuously in the case of *Hierodula tenuidentata* Saussure, 1869 (Schwarz & Ehrmann 2018; Battiston et al. 2020). In recent publications, *H. tenuidentata* is sometimes referred to as *H. transcaucasica* Brunner von Wattenwyl, 1878. According to Battiston et al. (2018), the previously used character to separate these two species, the colour of the discoidal spines of the fore femora, proved to be invalid. The comprehensive morphological comparison of their male genitalia also did not bring any appreciable differences (Battiston et al. 2018), however, this approach is widely used in the systematic of insects (Song & Bucheli, 2010) such as mantids (Brannoch & Svenson 2016). Thus, in this article, we follow the statement of Battiston et al. (2018) and account for *H. transcaucasica* as a synonym of the formerly described *H. tenuidentata* as it was previously raised by other authors too (Ehrmann 2011; Ehrmann & Borer 2015).

The Giant Asian Mantis *H. tenuidentata* has a wide distribution from Southeast Asia on the east that extends partly to Europe in the west (Shcherbakov & Battiston 2020), containing some regions of Azerbaijan, Georgia and the southernmost parts of European Russia and Ukraine (Werner 1916; Ramme 1951; Battiston & Massa 2008; Ehrmann 2011). The westernmost known locality of *H. tenuidentata* before the twenty-first century in Europe was in Crimea, Ukraine. After this species was mentioned from there by Werner in 1916, it was not observed there until its rediscovery in the early 2000s (Pushkar &

Received: 12.03.2023
Accepted: 31.05.2023

Corresponding editor: X. Mengual
Published: 10.06.2023

Kavurka 2016). According to the published data arranged by time, this mantid was first observed west of Crimea in Greece in 2007 (Cianferoni et al. 2018) and in the following years it began to spread locally (Schwarz & Ehrmann 2018; van der Heyden 2018a; Romanowski et al. 2019; van der Heyden & Schwarz 2021) such as in Ukraine, mainly near the shoreline of the Black Sea but also towards the interior of the country (Pushkar & Kavurka 2016; Bronskov & Filchakova 2022). In 2016, *H. tenuidentata* was first recorded in another Mediterranean area, the Po Valley, Italy (Battiston et al. 2018), where it successfully established and began a rapid spread (Cianferoni et al. 2018; Di Pietro & Battiston 2021). After 2017, *H. tenuidentata* was observed in other Balkanian countries like Bulgaria (Romanowski et al. 2019; Zlatkov et al. 2020), North Macedonia (Cianferoni et al. 2018), Albania (van der Heyden 2018b; Romanowski et al. 2019), Serbia (Vujić et al. 2021), Slovenia (van der Heyden 2021), Bosnia and Herzegovina (Kulijer et al. 2022), Croatia (Martinović et al. 2022) as well as in Romania (Pintilioaie et al. 2021), Austria (Essl & Zuna-Kratky 2021), France (Moulin & Rouard 2023) and Spain (van der Heyden 2021).

According to the recent spread of *H. tenuidentata* in Europe, it was expected to appear at least in the southern parts of Hungary as well (Vujić & Ivković 2023). In this paper, we provide the available observations from Hungary and the currently known distribution and spread in Europe based on published and new citizen science data with the summarisation of its possible effects on the native fauna and the ways of its spread, containing previous experiences.

MATERIAL AND METHODS

Spread in Europe

To map the spread of *H. tenuidentata* in Europe besides the Hungarian data we used the available observations of the adults, nymphs and oothecae from the website Gbif.org, focusing on the localities west of the 37th meridian east (the eastern border of Crimea). On Gbif.org, *H. tenuidentata* and *H. transcaucasica* belong to two different species pages. Due to their synonymy, we applied the database of *H. tenuidentata* (GBIF 2022a) and also of *H. transcaucasica* (GBIF 2022b). The identifications that were executed by the users of the source website were verified by the authors as well. The published localities of *H. tenuidentata* from the following papers (from 1910s to 2022) were also plotted: Pushkar & Kavurka 2016; Battiston et al. 2018; Cianferoni et al. 2018; Schwarz & Ehrmann 2018; van der Heyden 2018a; van der Heyden 2018b; Romanowski et al. 2019; Zlatkov et al. 2020; Di Pietro & Battiston 2021; Essl & Zuna-Kratky 2021; Pintilioaie et al. 2021; van der Heyden 2021; Vujić et al. 2021; Brosnkov & Filchakova 2022; Kulijer et al. 2022; Martinović et al. 2022; van der Heyden & Schwarz 2021.

Hungarian data

Distributional data of *H. tenuidentata* from Hungary was collected from different sources. Some of the individuals were observed in the field by direct search in previously known or possible locations. We also applied citizen science data from izeltlabuak.hu which is the largest Hungarian website for collecting mainly distributional and phenological data about the arthropod fauna of Hungary. There are several Hungarian Facebook groups where nature and insect lovers can upload their observations to ask for identification or just to share their experiences. These data were also collected. In 2022 there was an appeal of the people of Szeged and Kiskunhalas (Southern Hungary) to share their observations of *H. tenuidentata* via a local news site and a Facebook page. We accepted only those data that were confirmed with at least one photo of the individual from which its identification was possible.

Identification of the individuals was based on the key and figures published by Battiston et al. (2019) and Pintilioaie et al. (2021). Considering these characteristics, the observed *H. tenuidentata* specimens were clearly distinguishable from the congeneric species *H. patellifera* by the lack of the whitish basal plates under its coxal spines on the forelegs, from *S. viridis* by its shorter pronotum with less prominent supracoxal dilatation, and by the whitish stigma on its forewing from other similar mantid species in Europe just like from *Mantis religiosa* (Linnaeus, 1758), the only native praying mantis species in Hungary. In those two cases where male individuals were captured (from Budapest and Zákányszék), the morphology of the genital structures was also examined and compared to the figures published in Battiston & Massa (2008), Battiston et al. (2020) and Liu et al. (2021). The photos of the genital structures were taken with Euromex C-MEX 10 Pro camera and were stacked with Image Focus Alpha software. The collected male and female individuals were preserved and placed in the collection of the Hungarian Natural History Museum.

RESULTS

Spread in Europe

For mapping the spread of *H. tenuidentata* in Europe, 180 published and 1331 other unpublished data were collected, including Hungarian records. The number of observations of individuals and oothecae is showing a significant increase year by year throughout Europe, particularly in areas where this species probably had its earliest established populations: along the northern part of the Black

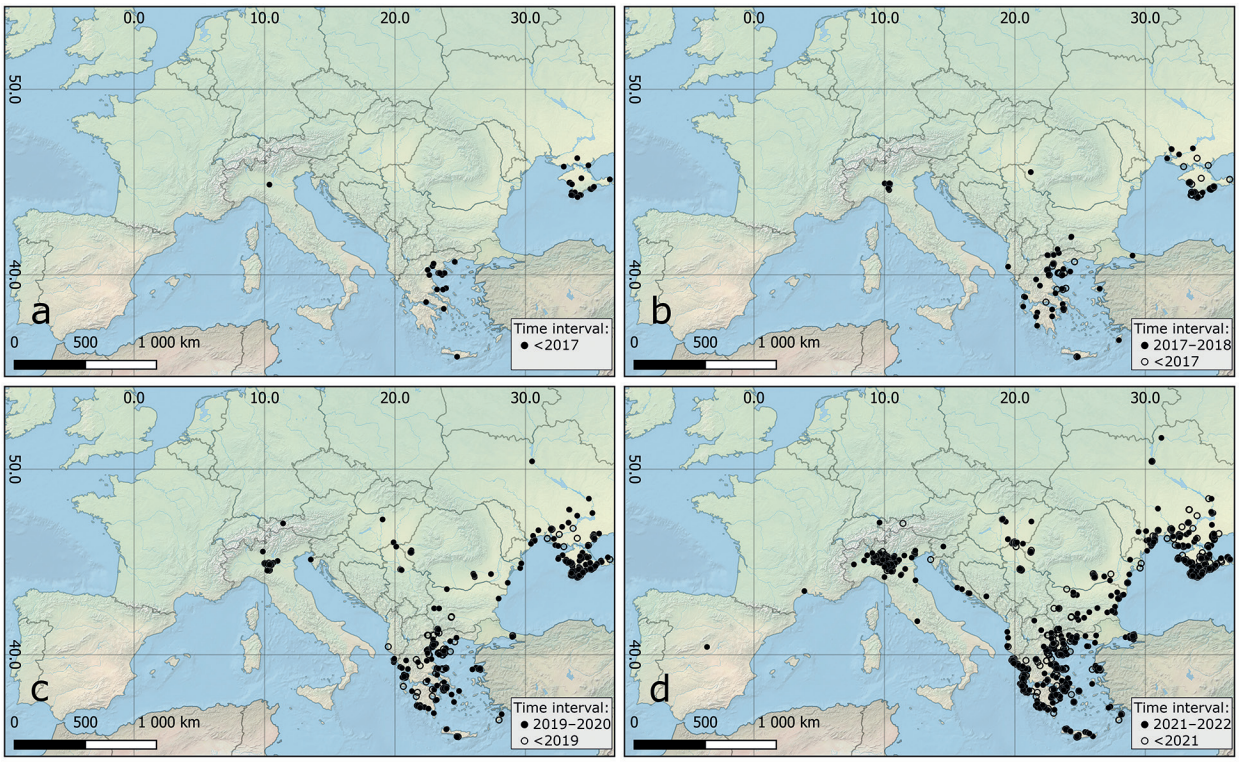

Fig. 1. Spread of the invasive mantid *Hierodula tenuidentata* in Europe, west of the 37th meridian east. Maps are based on its published observations, and new citizen science based records from Hungary and Gbif.org. Solid circles: observations from the plotted time interval. Empty circles: former observations with no data from the plotted time interval.

Sea coast, in the Southern parts of the Balkan Peninsula and in the Po Valley in Italy (Fig. 1).

Hungarian observations

The first observation of *H. tenuidentata* from Hungary was in 2019 in Zákányszék (South Hungary) in a garden. In the following years, larvae, adult individuals and hatched oothecae were also found here. Similar records were reported from several other settlements nearby Szeged (South Hungary), from Kiskunhalas (South Hungary, Fig. 2) and from Budapest (Central Hungary). A few single observations are also known from Hungary without evidence of local establishment there.

Until the end of 2022, altogether 103 observations (88 adult individuals, 8 larvae and 7 oothecae) of *H. tenuidentata* were confirmed in Hungary which are presented here (Fig. 3; Appendix I: Table 1). Altogether, the Hungarian observations came from 42 different localities, mostly gardens or other residential areas (79%; n = 33), less industrial parks (7%), garden centres and cemeteries (5% each), park and goose farm (each 1%). The collected and examined male individuals were also identified as *H. tenuidentata* which was confirmed by the morphology of their genital structures besides other characteristics (Fig. 4).

DISCUSSION

Distribution in Hungary and Europe

Along with other countries in Europe, *H. tenuidentata* has been recorded also in Hungary where it was first observed in 2019 (Zákányszék, South Hungary). In the following years, more and more individuals appeared in two main sites: in Budapest (Central Hungary) which is currently known to be the northernmost stable occurrence of *H. tenuidentata* in Central Europe, and in Szeged (South Hungary) with the nearby settlements (e.g., Zákányszék). Not only adult individuals were found in the same localities in consecutive years but larvae and hatched oothecae as well, from which we can conclude established populations in some Central and Southern Hungarian areas (Fig. 3).

The case is similar in many other parts of Europe where this species was introduced and successfully established (Fig. 1). Its rapid expansion in the Po Valley, Italy (Di Pietro & Battiston 2021) and in the Balkan Peninsula (Kulijer et al. 2022) is remarkable, however, there are grey spots in the latter one without any records, like the area of Kosovo and Montenegro but according to the current range of *H. tenuidentata*, it is probable that this species occurs here as well. There are also many single observations in Europe with no data from the certain

Fig. 2. Adult female of *Hierodula tenuidentata* (Kiskunhalas; 46.4482° N, 19.4817° E; South Hungary; 1 Sep. 2022). Photo by Tamás Kiss.

locality from different years (e.g., Essl & Zuna-Kratky 2021) which can be due to introductions without establishments or even the unnoticed low number of individuals in the initial phases of establishments (Kulijer et al. 2022).

For alien insect species, mainly if they are adapted to a warmer climate, cold winter temperatures seem to be one of the most important abiotic limiting factors regarding their establishment (Bale 2002). In Europe, it can primarily determine their northern range edges (Orlova-Bienkowskaja et al. 2020), which is visible in the case of *H. tenuidentata* as well. So far, the northernmost known single observation of this species in Europe, has been recorded in Chernihiv [51.5°N, 31.2°E], Ukraine (Fig. 1). The cold winters here can make the establishment of this species a challenging issue, however, it is already surviving in some Hungarian and Serbian settlements inside the Pannonian Basin where the winters can also be severe (Gavrilov et al. 2020; Vujić et al. 2021). The urban heat island effect in these populated areas definitely can help the survival of *H. tenuidentata* similar to other alien species (Gaertner et al. 2016). Most of the individuals of *H. tenuidentata* in Europe were observed in settlements mainly in lower latitudes with moderate climates. However, the effects of climate change and the strengthening potential source populations in the south can support the northward spread of this species (Chen et al. 2011; Rimšaitė et al. 2022).

It is important to consider that in the case of citizen science-based species distribution data like this, there is always a bias: highly populated areas are usually overrepresented and other sites with fewer people are underrepresented (Boakes et al. 2010; Wallace et al. 2021). However, the settlement close observations of *H. tenuidentata* in Europe could probably form a valid pattern explained by the possible climatic needs of this species and the dense transport linkages that could facilitate its introductions here (Gaertner et al. 2016).

Ways of spread

Behind the rapid spread of *H. tenuidentata* in Europe, climate change and human activities like transportation and trade can be the two main driving forces. The reappearance of *H. tenuidentata* in Crimea in the early 2000s can possibly be due to an active range expansion from the Caucasus, which could be favoured by climate change such as the northward spread of this species in Ukraine from the eastern coast of the Black Sea (Pushkar & Kavurka 2016). However, its appearance in several different

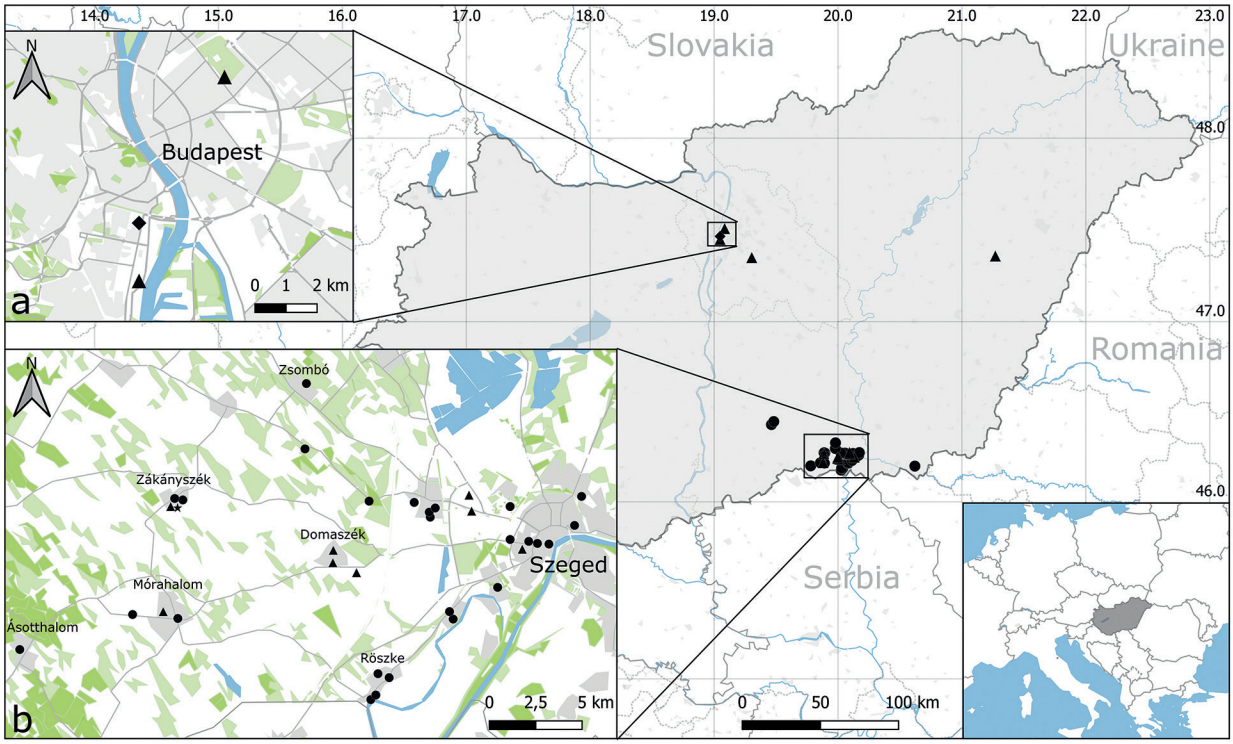

Fig. 3. Localities of the observed *Hierodula tenuidentata* individuals and oothecae in Hungary. Enlarged observation sites in a, Budapest b, Szeged with nearby settlements. The year of the first record from a specific locality is presented as a star (2019), rectangle (2020), triangle (2021) or circle (2022). Basemap: OpenStreetMap (https://openstreetmap.org/copyright).

settlements hundreds of kilometres apart from each other within a short time interval cannot be explained only by active expansion, but by human introductions (Pintilioaie et al. 2021).

There are several possibilities for introducing a non-native species intentionally or unintentionally. Deliberate release or escape of exotic pets is one of them (Hulme 2015). However, some praying mantis species became popular pets and have a general trade in Europe (Battiston et al. 2022), *H. tenuidentata* is not a commonly reared species here, thus its origin from captive breedings seems unlikely (Battiston et al. 2018, Halász 2022). The arrival of *H. tenuidentata* in several parts of Europe could probably happen through mercantile channels by multiple introductions as stowaways (Hulme 2015; Battiston et al. 2018; Cianferoni et al. 2018; Pintilioaie et al. 2021).

Oothecae laid on manufactured goods, ornamental plants, vehicles, timber or other material can easily be transferred by human trade and transportation far from its origin (Pushkar & Kavurka 2016; Cianferoni et al. 2018). Potentially around a hundred larvae can hatch from one ootheca, but in nature, this number can be reduced to a few tens of hatched individuals due to parasitoids or suboptimal microclimatic conditions (Mirzaee et al. 2021; Mirzaee et al. 2022). Long-lived females of this species usually lay five oothecae (Mirzaee et al. 2021) thus both introduced fertile females and oothecae can be considered as high propagule pressure that is very likely to have an important role in the rapid spread of *H. tenuidentata* in Europe (Lockwood et al. 2005). Records of this species in garden centres (e.g., Martinović et al. 2022), sites with newly planted shrubs and trees (e.g., Budai Wlazer residential park and Városliget, Budapest, Hungary), industrial parks with timber and other material trade (e.g., Délép Industrial Park Kft., Szeged, Hungary) support the importance of these pathways in the spread of *H. tenuidentata* such as its early appearance far from the East, in the Po Valley, Italy which is known to be one of the biggest ornamental plant transporter countries in Europe (Eurostat 2017).

It is also notable that the adults of this species are capable of flight, sometimes overcoming large distances (Pushkar & Kavurka 2016) which provides other opportunities in their spread even naturally (e.g., by wind, Cianferoni et al. 2018) or mediated by humans. Specimens attracted by the lights of transport vehicles like ships could be transferred to other ports crossing a stretch of the sea (Cianferoni et al. 2018). It possibly helped the spread of *H. tenuidentata* around the Black Sea coast (Moulin 2020; Pintilioaie et al. 2021).

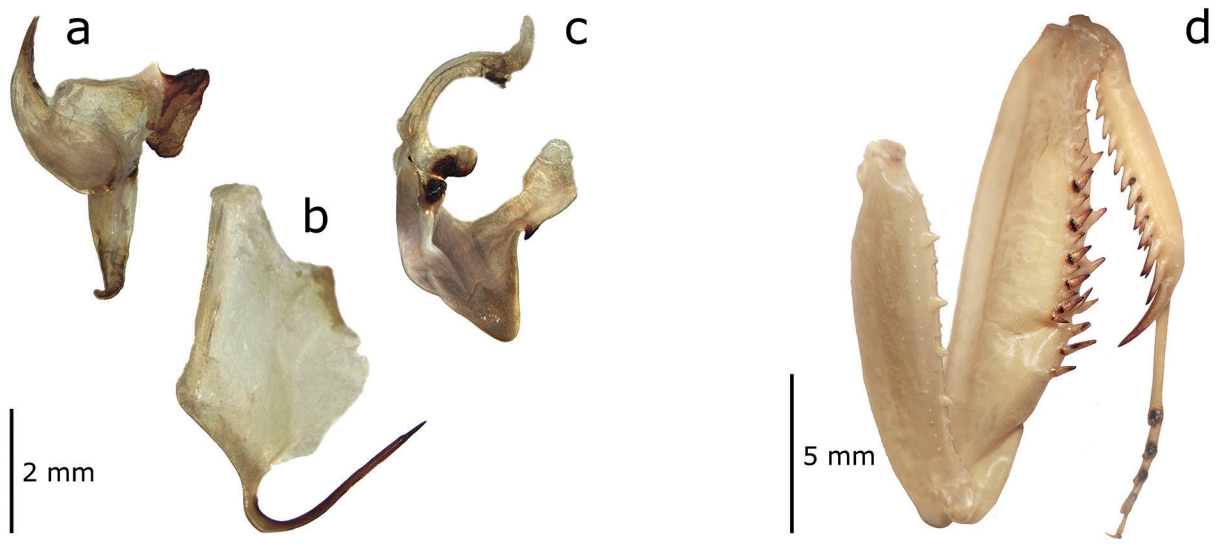

Fig. 4. Morphological characters of a male *Hierodula tenuidentata* collected in Zákányszék [46.27° N, 19.89° E], South Hungary, 30 Sep. 2022. **a**. Left phallomere. **b**. Ventral phallomere. **c**. Right phallomere. **d**. Left foreleg.

Habitat use

The Giant Asian Mantis is known to be a primarily arboreal mantid species which is usually found in forests and shrub vegetations in its original distribution from Southeast Europe to Southeast Asia (Pushkar & Kavurka 2016; Shcherbakov & Battiston 2020). Introduced individuals in Europe within settlements were found on tree canopies, trunks, shrubs and walls or other vertical surfaces that represent their original habitats (Romanowski et al. 2019; Kulijer et al.2021; Pintilioaie et al. 2021). Despite the large size of *H. tenuidentata*, its mainly arboreal life strategy could make it harder to detect its newly established populations with a small number of individuals. It seems that imago females are easier to observe than imago males or nymphs which can be due to their longer lifespan (Mirzaee et al. 2022) or even due to their oothecae laying habits when they possibly climb down to deposit their egg cases at lower heights where they can be captured easier (Pintilioaie et al. 2021). Hungarian data also support this as most of the observed individuals were adult females (80%, n = 77) less males (12%) and nymphs (8%).

As mentioned by Pintilioaie et al. (2021), females of *H. tenuidentata* probably prefer smoother surfaces for laying oothecae. According to their observations, the number of egg cases found in Romania on *Platanus* sp. trunks and twigs was overrepresented compared to other plant species with more rough trunks. In the Budapest park Városliget [47.5097° N, 19.0851° E], our observations also support this assumption. However, no oothecae were found yet in Városliget, most of the adult females were recorded here on the trunks of *Platanus* sp. It is important to note that plane trees are a more abundant species here than in the observation sites in Romania according to Pintilioaie et al. (2021).

Possible impacts and heterospecific patterns of such alien species

Invasive species are capable of causing environmental or economic harm (Iannone et al. 2021), however, forecasting these impacts is a great challenge (Dick et al. 2013). In the case of *H. tenuidentata*, its recent arrival and the low number of ecological studies in Europe (e.g., Pintilioaie et al. 2022) make it even harder to make valid predictions about the possible effects of this predatory species on the native fauna.

The survival of *H. tenuidentata* in Europe seems to be facilitated by the urban heat island effect and the occurrences of this species here are mainly restricted to settlements or their close surroundings and only a few of them occur in natural habitats (Pintilioaie et al. 2020). This distributional pattern can moderate the potential effects of *H. tenuidentata* on the native fauna, partly on other mantis species. However, in Europe, the widespread *Mantis religiosa* also has well-established populations in urban areas (Battiston 2016). The predatory behaviour of these two species and their overlapping range and life cycle can lead to possible interference between them (Battiston et al. 2018). *H. tenuidentata* is known to be an arboreal species living in higher layers of vegetation, while *M. religiosa* usually inhabits mainly grasslands (Battiston 2016) which possibly lowers the chance of competition or predation between them. However, it is known that *M. religiosa* males can be attracted by the sexual pheromones of other mantid species (Lelito & Brown 2008). Due to this phenomenon, *H. tenuidentata*

Fig. 5. Mating behaviour of a male *Mantis religiosa* with a female *Hierodula tenuidentata* (Zákányszék; 46.27° N, 19.89° E; South Hungary). Photo by Balázs Torma.

females can potentially lower the reproduction success of *M. religiosa* males in their close habitats by attracting them and being a threat to the native species due to the sexually cannibalistic behaviour of *H. tenuidentata* (Fea et al. 2013; Battiston et al. 2018). This assumption is supported by a documented Hungarian observation in Zákányszék (South Hungarian) as well, where a male *M. religiosa* tried to copulate with a female *H. tenuidentata* from a well-settled population of the latter (Fig. 5).

Besides this example, there are several other possible opportunities for this invasive mantid to affect some of the native species negatively (Crowder & Snyder 2010) or even positively (Mirzaee et al. 2021; Rădac & Háva 2021). The exact impacts of *H. tenuidentata* on European ecosystems are still not known (Battiston et al. 2018), but further ecological studies and the essential help of citizen scientists can lead us closer to effective conservational steps against biological invasions (Encarnação et al. 2021; Pintilioaie et al. 2022).

Acknowledgements. The authors would like to thank Kurszán Gál, Gábor Janzsó and his family, Balázs Torma and Barna Bálint Tőkés for their help in collecting individuals and everybody else for supporting this study with their data. We are grateful to László Garai Szakács, Attila Vörös, Viktor Greguss and Tamás Kiss for the public appeal and to Gellért Puskás for his help in the data collection. We thank to the anonymous reviewers for their careful reading and their suggestions to improve our manuscript, and to Vivienne and Roger Boreham for the English proofreading.

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APPENDIX I

(*electronic supplement, available at www.zoologicalbulletin.de*)

Table 1 (continued next two pages)**.** Hungarian observations of Hierodula tenuidentata until the end of 2022. For each record, the following pieces of information are given after the settlement name: geographical coordinates in decimal degrees with two digits (if only the name of the settlement is known) or with four digits (if at least the name of the road is known), observation date, number, sex and life stage of the individual(s) (O = ootheca; L = larvae; none = adult; collector or photographer, source: FB = Facebook groups; IL = izeltlabuak.hu; PA = public appeal; none = other). The records are arranged in alphabetical order of the settlements. Individuals that were preserved and placed in the collection of the Hungarian Natural History Museum are marked (*).

Locality	Observations
Apátfalva [46.2002° N, 20.6204° E]	9.X.2022, 5 ♀♀, János Dombi, PA
Ásotthalom [46.2017° N, 19.7798° E]	6.X.2022, 1 ♀, ”kved98”, IL
Bordány [46.2985° N, 19.9790° E]	17.X.2022, 1 ♀, Tata Papp, PA
Budapest [47.4676° N, 19.0486° E]	5.X.2020, 1 ♀*, Kurszán Gál, FB
	23.IX.2021, 1♀, Kurszán Gál
	5.XI.2021, 2 ♀♀, Kurszán Gál, FB
	8.VIII.2022, 1 ♀L, Kurszán Gál, FB
	4.X.2022, 1 ♀, Kurszán Gál, FB
Budapest [47.4509° N, 19.0461° E]	30.IX.2021, 1 ♂*, Kurszán Gál, FB
Budapest [47.5097° N, 19.0851° E]	2.IX.2021, 1 ♀L, Eduardo Balogh, FB
	8.IX.2021, 1 ♀, Klári Adrienn Szitási, FB
	31.X.2021, 6 ♀♀ [2 ♀♀*], Attila László Péntek
	1.XI.2021, 2 ♀♀, Kurszán Gál, IL
	24.IX.2022, 1 ♀, Eduardo Balogh, FB
Domaszék [46.2496° N, 19.9988° E]	9.IX.2021, 1 ♀, Erzsébet Mészáros, PA
Domaszék [46.2436° N, 19.9985° E]	28.X.2021, 1 ♀, Gábor Janzsó, FB
	1.X.2022, 1 ♂, 1 O, Gábor Janzsó
	12.XI.2022, 1 ♂, Bálint Janzsó
Domaszék [46.2388° N, 20.0150° E]	30.X.2021, 1 ♀, Lili Lajtár, IL
	15.VI.2022, 1 ♀L, Lili Lajtár, IL
	16.VII.2022, 1 ♀L, Lili Lajtár, IL
	7.VIII.2022, 1 ♀, Lili Lajtár, IL
	15.VIII.2022, 1 ♀, Lili Lajtár, IL
	18.VIII.2022, 1 ♂, 1 ♀, Lili Lajtár, IL
	19.VIII.2022, 1 ♂, Lili Lajtár, IL
	25.VIII.2022, 1 ♂, Lili Lajtár, IL
	29.VIII.2022, 1 ♂, Lili Lajtár, IL
	31.VIII.2022, 1 ♂, Lili Lajtár, IL

Table 1 (continued).

Locality	Observations
	1.IX.2022, 1 ♀, Lili Lajtár, IL
	27.IX.2022, 1 ♀, Lili Lajtár, IL
Kaba [47.36° N, 21.27° E]	19.07.2021, 1L, Annamária Dámóczi, FB
Kiskunhalas [46.4482° N, 19.4817° E]	1.IX.2022, 1♀, Tamás Kiss, IL
	23.X.2022, 3 ♀♀, Viktor Greguss
	29.X.2022, 1 O, Viktor Greguss
Kiskunhalas [46.4314° N, 19.4631° E]	27.X.2022., 1 ♀, Regina Fejes, PA
Mórahalom [46.22°N, 19.88°E]	31.VII.2021, 1 ♀L, Orsolya Nagy, FB
Mórahalom [46.2167°N, 19.8902°E]	7.X.2022, 1 ♀*, Attila László Péntek
	8.X.2022, 1 ♀, Attila László Péntek
Röszke [46.19° N, 20.03° E]	VIII.2022., 1 ♀, Gergely Bérdi, FB
Röszke [46.1775° N, 20.0250° E]	8.X.2022, 1 ♀, Barbara Vörös, PA
Röszke [46.1881° N, 20.0378° E]	8.X.2022, 2 ♀♀ [1 ♀*], Attila László Péntek
Röszke [46.1797° N, 20.0285° E]	24.X.2022, 1 ♀, ”BHD-91”, IL
Szeged [46.2501° N, 20.1308° E]	1.X.2021, 1 ♀, Izabella Zombori-Benczur, FB
Szeged [46.2685° N, 20.0954° E]	27.X.2021, 1♀, Tibor Csende, FB
	12.VII.2022, 1 ♀L, Tibor Csende, FB
Szeged [46.2548° N, 20.1223° E]	7.X.2022, 1 ♀, Lénárd Biacs, PA
	25.X.2022, 1 ♀, Áron Kovács, FB
Szeged [46.2529° N, 20.1414° E]	12.X.2022, 1 ♀, László Garai Szakács, IL
Szeged [46.2526° N, 20.1494° E]	15.X.2022, 1 ♀, Andrea Péntek, PA
Szeged [46.2756° N, 20.1722° E]	15.X.2022, 1 ♀, Gábor Szabó, PA
Szeged [46.2539° N, 20.1353° E]	16.X.2022, 1 ♀, Zsuzsanna Hangai, FB
Szeged [46.2707° N, 20.1223° E]	17.X.2022, 1 ♀, ”Brigitta90”, IL
Szeged [46.2317° N, 20.1136° E]	20.X.2022, 1 ♀, Imréné Szabó, PA
Szeged [46.2616° N, 20.1673° E]	22.XI.2022, 1 ♀, Ábel Torma
Szeged-Kiskundorozsma [46.27° N, 20.07° E]	3.XI.2022, 1 ♀, Katalin Harnóczi
Szeged-Kiskundorozsma [46.2762° N, 20.0936° E]	11.X.2021, 1 ♀, Barna Bálint Tőkés , FB
	12.VIII.2022, 1♀, Barna Bálint Tőkés
	9.X.2022, 2 ♀♀ [1♀*], Barna Bálint Tőkés
Szeged-Kiskundorozsma [46.2727° N, 20.0553° E]	13.VIII.2022, 1 ♂, Attila Ungi, PA
Szeged-Kiskundorozsma [46.2680° N, 20.0658° E]	8.X.2022, 1 ♀, Beáta Milankovicné Mészáros, PA

Table 1 (continued).

Locality	Observations
Szeged-Kiskundorozsma [46.2733° N, 20.0238° E]	16.X.2022, 1 ♀, Marietta Ábel, IL
Szeged-Kiskundorozsma [46.2656° N, 20.0665° E]	17.X.2022, 1 ♀, Tamás Ungi, PA
Szeged-Szentmihály [46.22° N, 20.08° E]	11.X.2022, 1 ♀, Katalin Harnóczi
	16.X.2022, 1 ♀, Erika Csatlósné Tóth, PA
Szeged-Szentmihály [46.2164° N, 20.0825° E]	17.X.2022, 1 ♀, Zoltán Szűcs, PA
Üllő-Pusztalöb [47.3515° N, 19.3041° E]	28.IX.2021, 1 ♀, Kristóf Teszárs, FB
Zákányszék [46.27° N, 19.89° E]	28.XI.2019, 1 ♀, Balázs Torma, PA
	11.IX.2020, 1 ♂, 1 ♀, Balázs Torma
	13.VII.2021, 3 O, Balázs Torma
	14.VII.2021, 2 O, Balázs Torma
	4.IX.2021, 1 ♀, Balázs Torma
	9.IX.2021, 1 ♀, Balázs Torma;
	19.IX.2021, 1 ♀, Balázs Torma
	29.IX.2022, 2 ♀♀, Balázs Torma
	30.IX.2022, 1 ♂, Balázs Torma
	9.X.2022, 1 ♀, Balázs Torma
Zákányszék [46.2707° N, 19.8852° E]	31.X.2021, 1 ♀, Károly Ábrahám, FB
Zákányszék [46.2746° N, 19.8880° E]	8.X.2022, 1 ♀*, Attila László Péntek
Zákányszék [46.2739° N, 19.8937° E]	16.X.2022, 1 ♀, István Agócs, PA
Zsombó [46.33° N, 19.98° E]	1.VIII.2022, 1 ♀, Tamás Győri