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## New evidence on blind snake presence in Sicily stress the need for targeted monitoring

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### SUMMARY

The Brahminy blind snake, *Indotyphlops braminus*, is the most widely introduced reptile globally. Its spread has been facilitated by the international plant trade, owing to its ability to inhabit plant pots. In Europe, *I. braminus* is found in Spain (mainland Spain and Canary Islands: Tenerife, Lanzarote, Gran Canaria, Fuerteventura and La Gomera), Portugal (Madeira Island), Malta and Italy (Ischia and Sicily Islands). This study presents data on the long-term persistence of *I. braminus* at the first occurrence site in Sicily (Paceco, western Sicily) and new records of the species in this region. Observations in Paceco from 2017 to 2023 suggest the possible survival of a population. Furthermore, individuals attributable to this species were observed in two additional sites, both in urban contexts: the island of Pantelleria (Sicily channel) where two specimens were found in the same site in 2023 and 2024 and Valderice (western Sicily). Our findings indicates that *I. braminus* may be significantly more widespread in Sicily than previously known. Therefore, further surveys in this area are necessary, and monitoring these sites could be crucial in assessing the survival of this species in Mediterranean climates.

## INTRODUCTION

In Europe, there are 57 species of snakes, the vast majority of which are native, while some others have both native and introduced populations (e.g., Silva-Rocha et al., 2015; Faraone et al., 2020; Meier et al., 2022). Additionally, four species are non-native taxa with reproductive populations in Europe (Di Nicola et al., 2022a). Among the latest, the Brahminy blind snake, *Indotyphlops braminus* (Daudin, 1803), is one of the most emblematic introduced reptiles worldwide. This small fossorial snake, usually not exceeding 17 cm in total length (Mateo, 2013), is probably native to the Indo-Malayan region (Mateo et al., 2011). However, it now has a subcosmopolitan distribution, mostly in tropical and subtropical countries (Global Invasive Species Database, 2018).

The introduction of several reptiles in the Mediterranean basin occurred through passive dispersal mediated by transport of goods (Silva-Rocha et al., 2015; Mori et al., 2022). Similarly, the remarkable diffusion of *I. braminus* is linked to the international plant trade (Kraus, 2003), due to its ability to live inside plant pots, and was likely facilitated by its unisexuality and parthenogenetic reproduction (Cagle, 1946; Kamosawa and Ota, 1996). In Europe, *I. braminus* is known to occur in Madeira (Jesus et al., 2013), the Canary Islands (Mateo et al., 2011; Urioste and Mateo, 2011), the Balearic Islands (Mateo et al., 2011), mainland Spain (Mateo, 2013; Zamora-Camacho, 2017), Malta (Vella et al., 2020), and Italy, where two small populations are known on the islands of Ischia (Paolino et al., 2019) and Sicily (Faraone et al., 2019).

To better define the presence of this species in Italy, we report an update on further records at its first detection site in Sicily (Faraone et al., 2019) and additional observations of this species in novel localities.

## MATERIALS AND METHODS

To monitor the persistence of the first reported population of Brahminy blind snake in Sicily (Faraone et al., 2019), we maintained the collaboration with the owner of the garden in Paceco, western Sicily, where the initial observations occurred. The owner recorded each subsequent observation details of the species after 2019, promptly notifying the authors to allow the collection of each observed specimen.

A Citizen Science approach, currently regarded as valid source of reliable distributional datasets (see Haklay et al., 2021), was also employed to collect additional records: monitoring online naturalistic Facebook groups such as ‘*Fauna Siciliana*’ (<https://www.facebook.com/groups/280292208752800>; 21.079 members on 25 July 2024) and ‘*IDENTIFICAZIONE ANFIBI E RETTILI*’ (<https://www.facebook.com/groups/283231695476830>; 53.944 members on 25 June 2024), which have been valuable resources for other observations (e.g. Faraone et al., 2017; Di Nicola et al., 2022b; Dentici et al., 2024). Additionally, focused inquiries were made by the authors to colleagues and nature enthusiasts by providing material to identify the species and asking for personal observations

All the live *I. braminus* were housed following Kamosawa and Ota (1996).

Dedicated sampling sessions were carried out between 2020 and 2023 in two sites: 1) a plant nursery in the town of Palermo (38.190° N; 13.318° E; 23 m a.s.l.) and 2) the Botanical Garden of Palermo (38.113° N; 13.373° E; 15 m a.s.l.). These locations were considered highly suitable for the frequent and consistent inputs of non-native plants, a common feature of European sites where the species is present (Faraone et al., 2019). At each site, active searches were performed under potential shelters (e.g., rocks, wooden boards, bituminous sheets, plant pots) along random paths.

## RESULTS

At the published site of Paceco, two additional live Brahminy blind snakes were found, supplementing the four individuals observed between 2017 and 2019 (Faraone et al., 2019): 1) a juvenile, 69 mm in total length, found on 28 September 2020, and 2) an adult, 116 mm in total length, found on 17 July 2023. Both individuals were examined by the authors and identified as *I. braminus* following Di Nicola et al. (2022a) (Fig. 1). The Brahminy blind snakes, died for unknown reasons shortly after capture, were preserved in 96% alcohol, and deposited at the Zoology Museum 'Pietro Doderlein' University of Palermo (accession numbers MZPA R-978 and R-979).

Two further observations were documented on the island of Pantelleria (Sicily

channel, province of Trapani) (Table 1, Fig. 2). The first Brahminy blind snake was filmed with a smartphone on 28 August 2023 (<https://youtube.com/shorts/03zp69W1G8U>) (G. Pavia, pers. comm.). The second Brahminy blind snake, measuring 64 mm total length (Fig. 1 D), was collected on 27 August 2024, identified as *Indotyphlops braminus* by the authors and deposited at the Zoology Museum 'Pietro Doderlein' University of Palermo (accession numbers MZPA R-980). Based on its small size, we consider the collected individual as immature (see Kamosawa and Ota, 1996), most likely yearling (see Mateo, 2013). Both snakes were found in the same backyard in the suburb of the main town of the island, far from plant nurseries, and no flower pots or soil had recently been introduced into the backyard in both cases (G. Pavia, pers. comm.).

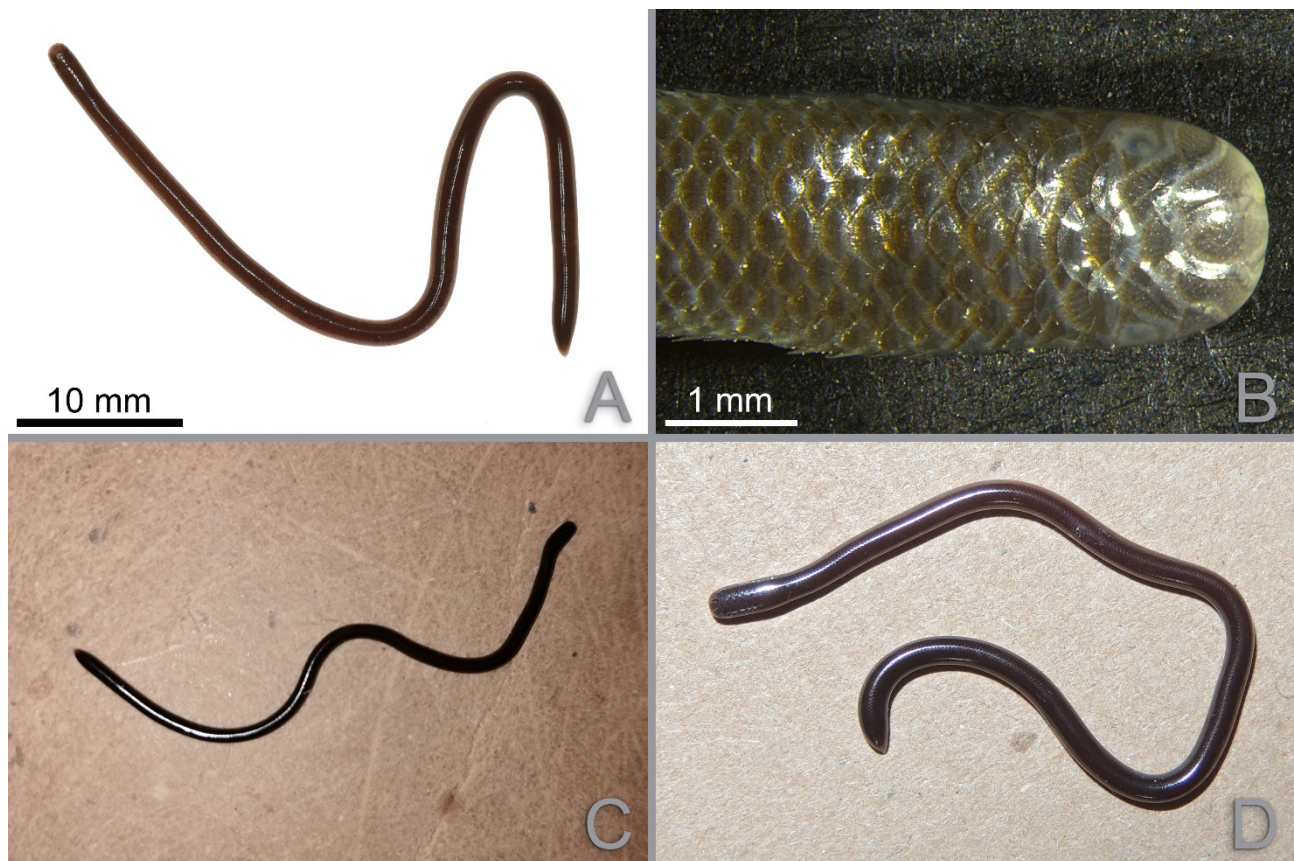


Figure 1. Blind snake specimens observed in Sicily. A) *Indotyphlops braminus* from Paceco B) Head detail of the specimen depicted in A C) Blind snake from Valderice (photo R. Giacalone) D) Live *Indotyphlops braminus* collected in Pantelleria in August 2024.



Table 1. Details on locations where Brahminy blind snakes were observed. "obs. ind." refers to the number of individuals observed per location, "FS" indicates that the record was collected via the citizen science approach on the Facebook group 'Fauna Siciliana'. All observations were collected in the province of Trapani (western Sicily).

obs. ind.	Date	Locality	Latitude	Longitude	Altitude	Habitat	Source
6	2017-2023	Paceco	37.989°	12.560°	10	Urban area, backyard	Faraone et al. (2019)
1	17 Aug 2021	Valderice	38.071°	12.630°	5	Urban area, flowerbed	R. Giacalone (FS)
2	2023-2024	Pantelleria	36.830°	11.951°	50	Urban area, backyard	G. Pavia

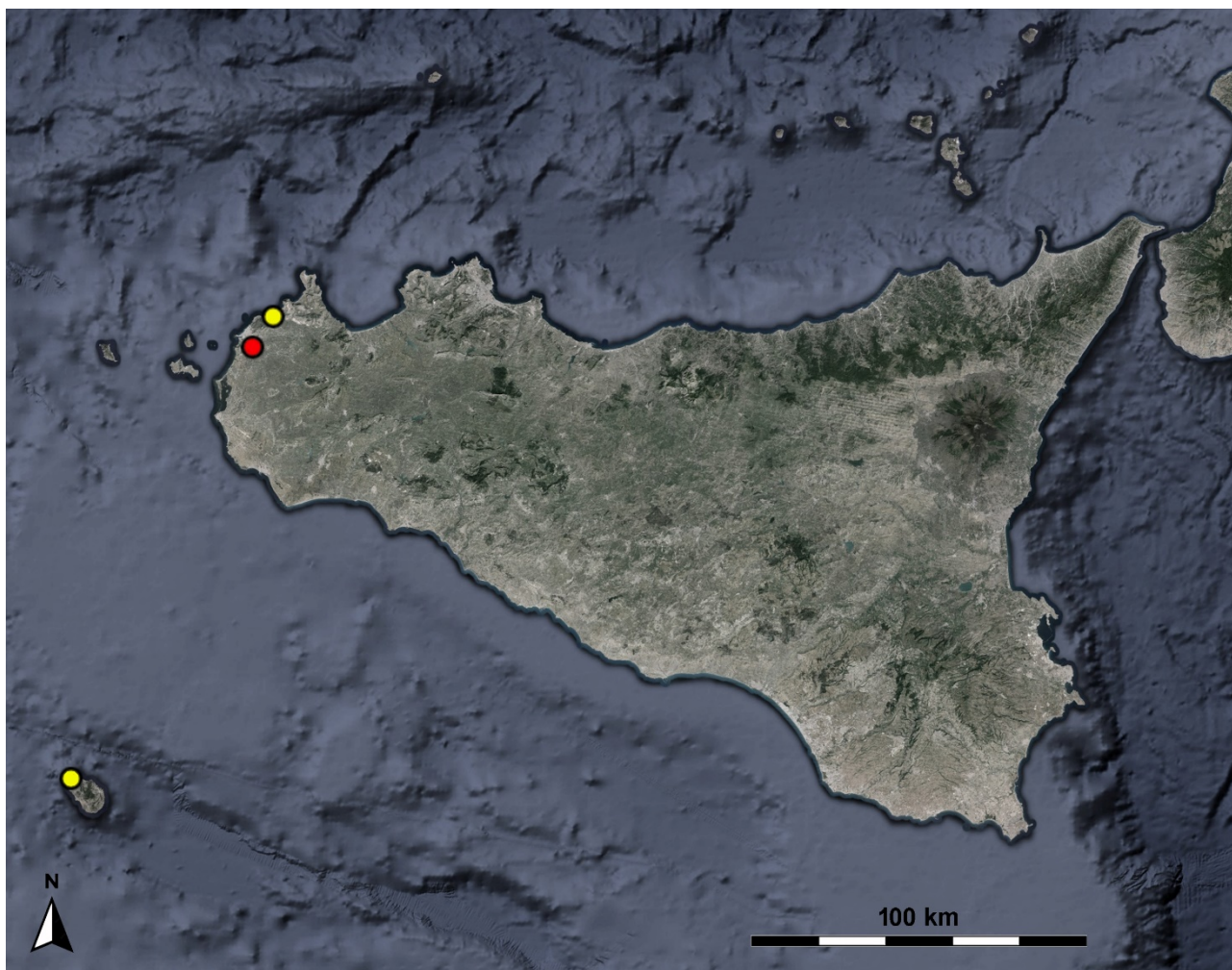


Figure 2. Distribution of the Brahminy blind snake, *Indotyphlops braminus* (green), records in Sicily (Italy). Red dot = previously published record by Faraone et al. (2019); Yellow dots = novel records.

Another observation was recorded from the social media monitoring, via 'Fauna Siciliana'. A typhlopoid snake was found on 17 August 2021 near Valderice (province of Trapani) (Table 1; Figs. 1, 2), on a sidewalk next

to a recently installed flowerbed, during the night (R. Giacalone, pers. obs.) (<https://youtube.com/shorts/WtGRnLpvCnA>).

The last locality of occurrence is based on a record not supported by direct identification of the collected specimen, but only documented through videos and photos; therefore, its specific identity cannot be determined with absolute certainty. However, based on its general appearance and the absence of other blind snakes in Sicily, we believe it is very likely that it was *Indotyphlops braminus*. For this reason, this site deserves further investigations.

No observations emerged from the targeted surveys carried out at the plant nursery and the botanical garden, nor from the interviews of the staff working in the two study areas.

## DISCUSSION

Our results support the possible persistence of a population of *I. braminus* in Italy over time. At the site reported by Faraone et al. (2019), we collected a total of six records over a six-year period, between 6 May 2017 and 17 July 2023. As previously indicated, this site is adjacent to a disused plant nursery, which is likely the source of the introduction of Brahminy blind snakes. The lack of recent inputs of soil and plants into the plant nursery suggests that the repeated observations of Brahminy blind snakes over the years, which only concerned juveniles between 2017 and 2020, could result from an acclimatised population rather than from repeated introduction events. The detectability of the Brahminy blind snake in this area appears rather low compared to other European sites (Urioste and Mateo, 2011; Paolino et al., 2019). However, our records do not derive from targeted sampling but from occasional observations by the garden owner, implying a possible underestimation and not providing sound information on the local density of the species.

The individuals observed in Pantelleria could also indicate the persistence of a population, but further evidence is needed. Their origin is more enigmatic, given the absence of plant nurseries nearby and recent

inputs of soil and plants to the backyard. However, it cannot be ruled out that the Brahminy blind snakes came from neighbouring gardens. Pantelleria maintains regular naval contacts, both touristic and commercial, with the city of Trapani, which is close to the other two sites where *I. braminus* is present. Therefore, it is possible that the observed Brahminy blind snake originates from the same source. Furthermore, it is likely that the plant nurseries on the island receive goods from sites already colonized in the province of Trapani and act as secondary sources for local gardens and backyards. It is interesting to note that the majority of the European observations derive from small islands such as Malta (Vella et al., 2020), the Balearic Islands (Mateo et al., 2011), the Canary Islands (Urioste and Mateo, 2011), and Madeira Island (Jesus et al., 2013), which possibly present better conditions for the survival of this species or, perhaps, for its detectability.

Regarding the record from Valderice, the probable source was the adjacent public flowerbed, although the origin of the soil and newly placed plants is unknown. This observation occurred approximately 11 km northeast of the site reported by Faraone et al. (2019). Given the territorial proximity between these records, it cannot be excluded that both could be secondary introductions from a single source present in the same province, but this is currently impossible to reliably assess.

The observations reported here indicate that the actual presence of the Brahminy blind snake in Sicily could be significantly more widespread than currently known. Therefore, this area warrants further exploration, especially at sites that likely represent primary sources of diffusion, such as plant nurseries (Zamora-Camacho, 2017). Furthermore, from a management perspective, monitoring known sites will be fundamental to better understand the survival and persistence capability of *I. braminus* populations in Mediterranean environments, particularly in the context of current global warming phenomena.

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## AUTHOR CONTRIBUTIONS

FPF: Conceptualization, dataset curation, manuscript preparation. MRDN: manuscript preparation, dataset curation, figure design. LB: Dataset curation, manuscript review. FL: Conceptualization, manuscript preparation. All authors contributed equally to sampling.

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