

## On the role of plant nurseries introducing *Indotyphlops braminus* (DAUDIN, 1803), in Spain

A key step in the management of human-induced introduction of organisms is release interception or, at least, control (PERRINGS et al. 2005), as introductions are easier to manage when the potential sources of propagules are identified (HULME 2006). In the case of the typhlopid Flowerpot Blindsnake *Indotyphlops braminus* (DAUDIN, 1803), nurseries are widely considered the main (if not the only) propagule reservoir and potential vector for introductions (e. g., KRAUS 2003; YOKOYAMA 2012; JESUS et al. 2013). This small parthenogenetic snake species, of mostly less than 175 mm of snout-vent length and 5 mm of maximum body diameter, is strictly subterranean where it inhabits self-burrowed galleries (MATEO 2013). These snakes inadvertently migrate, hiding between the roots of plants transported with agricultural or ornamental purposes.

After a long-term process of passive introductions, this snake inhabits relatively moist and temperate habitats worldwide (OTA et al. 1991; WALLACH 2008), being one of the most widespread reptiles on Earth (UETZ et al. 2012). It is allegedly native to some areas of the Indo-Malayan region, but its extensive distribution (UETZ et al. 2012) makes it difficult to reliably determine where it is native and where introduced, particularly in early colonized areas (MATEO 2013). In Spain, it was first detected in Fuerteventura (Canary Islands) in 1998 (LÓPEZ-JURADO et al. 2006). By 2010, its presence had also been described in La Gomera, Tenerife, Gran Canaria, and Lanzarote, in the same archipelago (URIOSTE & MATEO 2010), and in Mallorca (Balearic Islands) (MATEO 2013). One more population was found in the Province of Almería (Southeastern Iberian Peninsula) in 2011 (MATEO 2013; RATO et al. 2015). In the present paper, the author assesses the frequency of observations of *I. braminus* individuals in plant nurseries in Spain, by surveying nursery managers statewide for *I. braminus* detection, in order to infer propagule pressure.

In June 2015, publicly available professional e-mail addresses from 403 nursery managers from most provinces of Spain were compiled; no e-mail address was found from the nursery managers of the Autonomous Cities of Ceuta and Melilla, and the Province of Zamora. To facilitate identification by non-experts, a description of the species was sent to the managers, with emphasis on easily distinguishable diagnostic characters, as well as two photographs and one video, along with a questionnaire including four questions: (1) Was the Flowerpot Blindsnake seen in your nursery? (2) If yes, how many individuals? (3) When were they seen and (4) were they seen in flowerpots or freely living in the soil? The nursery managers were asked to forward the questionnaire to their employees and include their observations in the email responses. The questionnaire was not tested prior to the study, but questions were closed, clear and straightforward. The nursery managers were informed that their responses were to be used in a scientific publication. Since these professionals devote much time to transplanting plants, turning over the soil, or rearranging flowerpots, which represent intromissions in *I. braminus* habitats, detection probabilities were high. However, whether or not negative responses corresponded with actual absences must remain unclear, given that disclosure of positive information may have been found to be risky. Geographical location of each nursery surveyed and the answers to questions 1-4 were recorded in a spreadsheet used to calculate percentages of the different types of answers.

Answers were returned from 95 out of 403 (23.57 %) nursery managers polled (Table 1). Among those, only three nursery managers (3.16 %) declared to have seen this snake in their nurseries (Table 1; Fig. 1): one in western Granada province (southeastern Spain), where two specimens were seen living freely on the soil in 2013, another in central Granada province, where several individuals were seen, last observation occurring in 2012, and another in Girona province (northeastern Spain), where three individuals were seen since 2012, the last one in May, 2015. Thus, only three nurseries (3.16 %) evidenced a possible current

Table 1: Number of plant nurseries polled for observations of *Indotyphlops braminus* (DAUDIN, 1803), negative, and positive answers received by province or autonomous city in Spain. A - Plant nurseries polled, B - Negative answers, C - Positive answers.

Province or autonomous city	A	B	C
Araba/Álava	6	3	0
A Coruña	7	1	0
Alacant/Alicante	12	2	0
Albacete	4	0	0
Almería	7	1	0
Asturias	11	3	0
Ávila	4	1	0
Badajoz	6	2	0
Barcelona	12	4	0
Bizkaia	10	3	0
Burgos	3	1	0
Cáceres	6	2	0
Cádiz	8	0	0
Cantabria	8	0	0
Castelló/Castellón	6	1	0
Ceuta	0	0	0
Ciudad Real	5	2	0
Córdoba	12	2	0
Cuenca	1	0	0
Gipuzkoa	8	4	0
Girona	14	1	1
Granada	11	2	2
Guadalajara	3	1	0
Huelva	3	1	0
Huesca	6	3	0
Illes Balears	17	3	0
Jaén	6	1	0
La Rioja	11	3	0
Las Palmas	13	3	0
León	9	2	0
Lleida	6	1	0
Lugo	7	2	0
Madrid	22	4	0
Málaga	17	3	0
Melilla	0	0	0
Murcia	12	2	0
Nafarroa/Navarra	10	4	0
Ourense	3	1	0
Palencia	1	0	0
Pontevedra	10	1	0
Salamanca	8	3	0
Santa Cruz de Tenerife	8	1	0
Segovia	6	1	0
Sevilla	11	3	0
Soria	1	0	0
Tarragona	8	1	0
Teruel	2	0	0
Toledo	4	1	0
València/Valencia	16	5	0
Valladolid	9	3	0
Zamora	0	0	0
Zaragoza	13	4	0
Total	403	92	3

population of *I. braminus*, with potential delivery of individuals to new habitats through plant trade.

This survey does not permit to draw final conclusions on the role of plant nurseries as reservoirs and potential vectors of *I. braminus* introductions in Spain. However, at least it shows a reduced number of plant nurseries detecting this snake throughout Spain. Moreover, recent detection has been reported only in one out of 95 nurseries, which indicates that some introductions fail, although they could have spread individuals before failure. As nurseries were positively identified as vectors for *I. braminus* introductions (KRAUS 2003; KORNILIOS et al. 2013), propagule pressure seems moderate for this species in Spanish territories. Strange enough, the author received no notice of detection in nurseries from the aforementioned areas where the species has established.

Dispersal capacity of this snake is very limited, probably because of its reduced mobility and underground customs, which require loose soils for gallery burrowing (MATEO 2013). Moreover, this tropical and subtropical species thrives in warm, relatively wet habitats (OTA et al. 1991). In Spain, habitats with year-round sufficient humidity and stable warm temperature appear very locally, or in artificial ecosystems such as gardens or agrosystems. In fact, most Spanish populations of *I. braminus* are found in such altered habitats (URIOSTE & MATEO 2011), and not far from the sea, which increases humidity and temperature stability (MATEO 2013). In fact, the nursery holding a potentially stable population described here is also by the coast. These factors altogether, along with low propagule pressure found in this survey, suggest a moderate invasive capacity of *I. braminus* in Spain.

Nevertheless, this is a triploid, all-female reptile that reproduces partenogenetically (NUSSBAUM 1980), producing up to 8 eggs or young a year, which gives each individual the potential to found a population in few years (OTA et al. 1991; KAMOSAWA & OTA 1996). Moreover, these snakes prey on extremely abundant termites and ants (FIELDS & HORROCKS 2011; MIZUNO & KOJIMA 2015). Prey abundance may facilitate establishment and expansion of introduced populations (WHITE et al. 2006). Furthermore, competition with native pred-

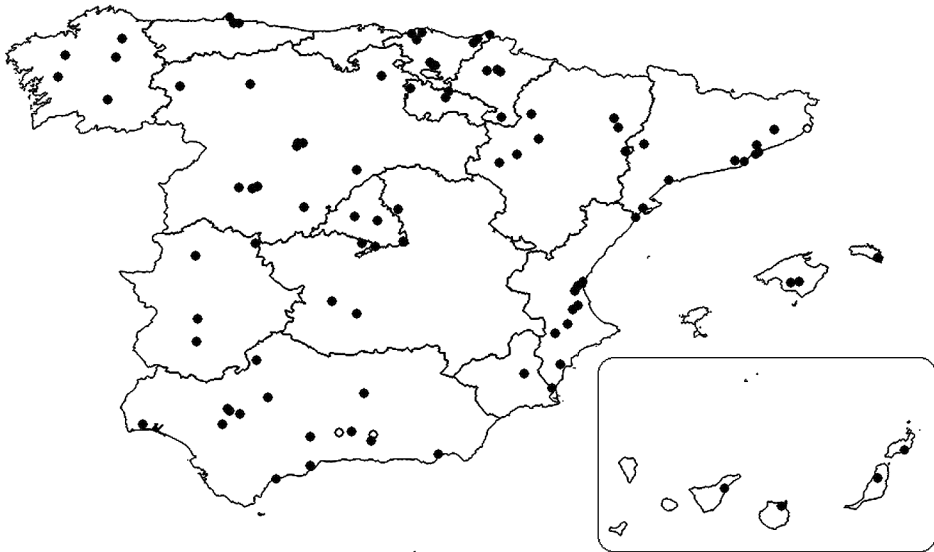


Fig. 1: Map showing the geographic location of participating nurseries. Black dots represent nurseries where *Indotyphlops braminus* (DAUDIN, 1803) was not reported. White circles represent nurseries where *I. braminus* was detected. Canary Islands appear misplaced in the inset. Map was created with software QGIS (v 2.18.7).

ators of the same prey could be mild where prey is abundant (MIRANDE et al. 2015). Negative effects of competition for prey on native fauna are thus expected to be low, but this situation could also benefit the introduced species. Particularly, in the Iberian Peninsula and North Africa Spanish territories, *I. braminus* could compete with native Blanidae and Trogonophidae worm lizards, which are similar in size, ecological requirements, and diet (MARTÍN et al. 2013; SALVADOR 2014; LÓPEZ 2015). In the Balearic and the Canary Islands, no native reptile or amphibian is known to have habitat and diet requirements similar to this introduced snake, so competition with local herpetofauna is not expected.

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