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Origins of an introduced *Teira dugesii* (Squamata: Lacertidae) population in Porto, Portugal

A. Isabel Ferreira[1,2], Diana S Vasconcelos[1,2], and D. James Harris[1*]

Invasive species are one of the major causes of biodiversity loss. The majority of introductions of non-native species are associated with human activities (Pyšek et al., 2010; Zimmermann et al., 2014), resulting in extensive economic and ecological negative impacts (Pimentel et al., 2000). They can threaten native species by affecting their development or transmitting diseases (Lymbery et al., 2014; Carmo et al., 2018), through predation or parasitism (e.g., Pintor et al., 2009; Lymbery et al., 2014), or competition for resources (e.g., Short and Petren, 2008; Pintor and Sih, 2009).

Teira dugesii (Milne-Edwards, 1829), the Madeiran wall lizard, is a member of the family Lacertidae, subfamily Lacertinae, tribe Lacertini (Arnold et al., 2007), endemic to the Madeira archipelago including Porto Santo, Ilhas Desertas, and Ilhas Selvagens (Jesus, 2008). It occurs throughout the Madeira Archipelago, where it is abundant and inhabits practically all types of terrestrial habitats of the archipelago, extending from the coast to the highest mountains, including urban and rural areas, gardens, and beaches (Davenport and Dellinger, 1995). Four sub-species are recognised, *Teira dugesii dugesii* (Milne-Edwards, 1829), in Madeira, *Teira dugesii jogeri* (Bischoff, Osenegg & Mayer, 1989) in Porto Santo, *Teira dugesii mauli* (Mertens, 1938) on Desertas islands and *Teira dugesii selvagensis* (Bischoff, Osenegg & Mayer, 1989) on the Selvagens islands, which are readily distinguishable based on mitochondrial DNA sequences (Brehm et al., 2003). There are known introduced populations in the Azores islands since the 19th century, possibly due to accidental introduction by ships (Ulfstrand, 1961; Silva-Rocha et al., 2016). It has also been reported as introduced in Lisbon (Sá-Sousa, 1995) and, more recently, in Gran Canaria in the Canary Islands (Mateo et al., 2011; Santos et al., 2013). In the Canary Islands, this species was also recorded in La Orotava, Tenerife, in the early 20th century (Boulenger, 1920), although this population is considered extinct. The Lisbon population was first observed in 1992 (Sá-Sousa, 1995), near Alcântara, and appears to be stable (pers. obs. in May 2021). The site is near the port area of Lisbon, close to the railway line, and the population was potentially carried on transport ships. Analyses of mtDNA indicate that all the populations from the Azores, Lisbon and Canary Islands appear to have their origin in Madeira Island (Silva-Rocha et al., 2016).

In 2022, individuals of this species were sighted on some walls in the city of Porto (Fig. 1). On 24 March, we observed many active individuals, including adults and juveniles, as well as females with clear copulatory bite-marks, basking on walls covered with some vegetation (Fig. 1). This potentially indicates a large and viable population in the historic centre of Porto (41.1431ºN, -8.6160ºE; elevation 82 m). They were observed in strict syntopy with *Podarcis lusitanicus*. To compare this population with both native and other introduced ones, we took tail tips for genetic analyses from four individuals. DNA from these was extracted from tail tissue using the saline method protocol (Sambrook et al., 1989), and two mtDNA gene fragments were amplified, 12S rRNA and Cytochrome *b* following previous protocols (Kim et al., 2006; Kocher et al., 1989; Palumbi et al., 1991). Sequences were submitted to GenBank (accession numbers OP358447 and OP358448).

The sequences obtained in this work were compared to others present in NCBI using the BLAST algorithm. Both 12S rRNA and Cytochrome *b* sequences showed a closest affinity with specimens of *Teira d. dugesii* either from Madeira Island, or the populations introduced from there (1 or 2 base pairs difference for each gene).

[1] BIOPOLIS Program in Genomics, Biodiversity and Land Planning, Centro de Investigação em Biodiversidade e Recursos Genéticos, Laboratório Associado Universidade do Porto, Campus agrário Vairão- rua Padre Armando Quintas nº7, Porto 4485-661, Portugal.

[2] Departamento de Biologia, Universidade do Porto, Porto 4169-007, Portugal.

[*] Corresponding author: james@cibio.up.pt

Figure 1. Capture site of *Teira d. dugesii* in the historic centre of Porto, surrounded by a yellow rectangle (A). Image of the habitats where individuals were sighted and captured (B) and dorsal photos of a captured *Teira d. dugesii* individual (C). Photographs by Diana Vasconcelos.

However, the haplotypes recovered were unique, showing at least one difference from any published sequence. It seems unlikely that the small, introduced populations in Lisbon or the Azores would include extensive genetic variation with these markers, while this is much more likely in Madeira Island. Therefore, rather than being introduced from Lisbon or the Azores, we hypothesise that the Porto population was introduced directly from Madeira Island. The locality is only around 500 m from a customs port, and where small private boats dock. It seems probable that this is the source of the introduction.

Blood smears were also performed with the blood released from the tail tip cuttings to determine if common blood protozoan parasites could be observed, following standard procedures (e.g., Maia et al., 2012). However, no parasites of this type were visualised in any of the seven individuals examined.

The introduction of *Teira d. dugesii* in Lisbon so far does not seem to prejudice the endemic lizard species. Monitoring the places where this species is found however is essential to check if the species may spread, as well as the impact on invertebrates, and further assessments of the potential introduction of parasites. It is also important to conduct further studies in Porto to see if there are more populations of *Teira dugesii* in surrounding areas.

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