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Hidden in the bark: the unexpected presence of the leaf-toed gecko, *Euleptes europaea* (Gené, 1839) (Squamata, Sphaerodactylidae), in Sicily

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SUMMARY

We report the first observations regarding the presence of the leaf-toed gecko, *Euleptes europaea*, in Sicily. During field activities for environmental impact assessment several leaf-toed gecko individuals were found in a restricted coastal area in the north-west of the island, near the city of Palermo. Further surveys were then carried out to better assess the presence of the species. A total of 21 *E. europaea* individuals were observed in a small area of approximately 4.4 hectares, consisting of mixed eucalyptus and pine reforestation. Out of the 21 individuals, there were 14 males, 5 females, and 2 whose sex could not be determined. Additionally, at least two pregnant females were observed. Leaf-toed geckos were found exclusively under eucalyptus bark, syntopic with two other Gekkota species (*Tarentola mauritanica* and *Hemidactylus turcicus*). The presence of such a breeding population of *E. europaea* is probably limited to a small area. However, our results do not allow us to clearly assess either its origin or its actual distribution and demography, therefore new field investigations are necessary.

INTRODUCTION

Mediterranean islands are known for a biogeographically composite herpetofauna (Bonardi et al., 2022), modulated by both natural (Poulakakis et al., 2013; Faraone et al., 2020a) and human-driven dispersal (Salvi et al., 2014; Faraone et al., 2020b). Natural colonization in amphibians and reptiles is usually linked to passive spreading, such as over-sea rafting (Stöck et al., 2016; Sherpa et al., 2023), and active movements via land bridges (Stöck et al., 2008; Faraone et al., 2022). Man-mediated dispersal is instead linked to intentional introductions (Vamberger et al., 2011; Lillo et al., 2013) or unintentionally related to the transport of goods (Silva-Rocha et al., 2015; Faraone et al., 2019).

Some European species of Gekkota have reached an almost cosmopolitan distribution, following various dispersal patterns, even overseas, making them a paradigmatic example of colonizers (Rödder and Lötters, 2009; Rato et al., 2023). This is also true for the leaf-toed gecko, *Euleptes europaea* (Gené, 1839), the only species belonging to the Sphaerodactylidae family in Europe. *Euleptes europaea* is the smallest European gecko, reaching a maximum SVL (snout to vent length) of 47.9 mm (Salvidio et al., 2011 and references therein). It is a nocturnal and secretive species that is usually found in habitats rich in rocky outcrops and sparse vegetation, where it seeks shelter inside rocky crevices or under tree bark (Salvidio et al., 2011 and references therein). Although it is less synanthropic than other European geckos, it also colonizes microhabitats linked to human activities, such as dry stone walls and building ruins, and can also be found in extreme environments such as some rocks and islets with almost no vegetation (Delaugerre and Cheylan, 1992; Salvidio et al., 2011). Its geographic range includes: Corsica, Sardinia and their satellite islets; Tuscan archipelago; small mainland spots and several coastal islets of Provence (France), Liguria, Tuscany and Campania (Italy) (see Salvidio et al., 2011 and reference therein; Delaugerre et al., 2011; Delaugerre and Corti, 2020; Di Nicola et al., 2022 for a more exhaustive list) (Fig. 1). In addition, there are some isolated observations from northern Italy that need confirmation (Iversen in Di Nicola et al., 2022).

The phylogeography of *E. europaea* populations is still unresolved, due to the lack of specific studies, but it is known that its Corsican population may have originated from the northward expansion from Sardinia during the last glacial events (Salvi et al., 2019). However, the overall distribution of the species is considered relict (Delaugerre et al., 2011; Delaugerre and Corti, 2020), although for populations outside the Sardinian-Corsican system and the Tuscan Archipelago, a man-mediated origin is not excluded (Salvidio and Delaugerre, 2003).

Here we describe the presence of a population of European leaf-toed gecko in Sicily, and report preliminary data on its distribution and habitat.

MATERIALS AND METHODS

The area where the population was reported for the first time is a mixed eucalyptus and pine reforestation (Fig. 2a), rich in undergrowth and rocky outcrops, upstream of the coastal village ‘Addaura’ (38.186 N, 13.347 E), north of the city of Palermo (Sicily) (Fig. 3). This area is delimited by the north-facing rock walls of Monte Pellegrino, a limestone promontory (606 m asl) surrounded by the urban fabric of Palermo. The reforested area is intermingled with patches of Mediterranean scrub with a prevalence of holm oak (*Quercus ilex* Linnaeus, 1753), which dominates the surrounding rocky slopes.

A population of *Euleptes europaea* was found during field activities (involving transects of 300 m to survey the reptiles) for the environmental impact assessment preceding the installation of landslide protection system. After the discovery of the first nucleus, six active daytime research sessions were carried out, from

13 to 21 May 2024, both along random paths and within scattered spots of approximately 20 m radius in which geckos were searched under rocks or by inspecting trees. Care was taken to only partially remove the detached bark from the ground up to about 150 cm in height. Each spot was georeferenced with a GPS device and was checked only once.

The sampling sessions took place within the main reforestation and also in neighbouring areas, including the plateau just above rocky walls, characterized by garrigue with scattered reforested patches. Records were taken of every Gekkota found inside the random spots.

Figure 1. Geographic range of the leaf-toed gecko, *Euleptes europaea* (green) with the new Sicilian population (red).

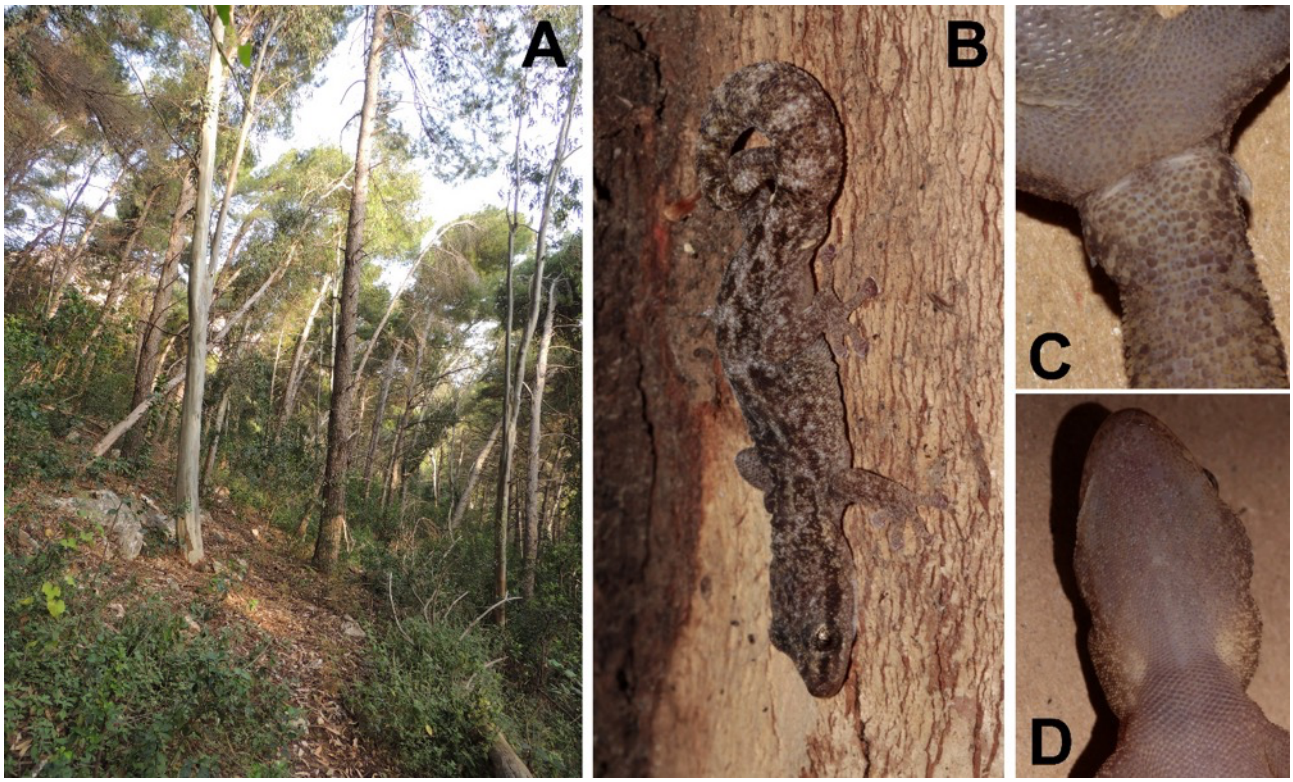

Figure 2. Habitat and habitus of *Euleptes europaea* in the study site. A) mixed reforestation, habitat of *Euleptes europaea* in Monte Pellegrino discovery site (Sicily); B) subadult male *in situ*; C) enlarged base of the tail and post-cloacal spurs (male); D) enlarged neck glands (female).

For every leaf-toed gecko found, the sex was determined by verifying the enlarged base of the tail, prominence of the post-cloacal spurs in males, and absence of spurs and presence of bumped neck glands in females (see Salvidio et al., 2011, Fig. 2c, b).

Descriptive statistics [mean ± standard deviation and min-max range] were calculated on frequencies and altitude (m a.s.l.) of the observations. To estimate the extent of the distribution of *E. europaea* in Sicily, on the basis of our preliminary observations, we used the Minimum Convex Polygon (MCP) method, as implemented in the QGIS software.

RESULTS

The first three leaf-toed geckos were found on 13 May 2024, along the reptiles-targeted transects. After further active research, a total of 21 individuals (14 males, 5 females, and 2 whose sex could not be determined) were detected. *Euleptes europaea* was found exclusively under the bark of eucalyptus trees, in an area of approximately 4.4 hectares (MCP) with an average altitude of 79.7 ± 12.4 (52-105) meters (Fig. 3). This area extends just outside the northern margin of the Natural Reserve and the Site of Community Importance "Monte Pellegrino" (ITA020014, Directive 92/43/EEC of 21 May 1992). No leaf-toed geckos were found on the plateau overlooking the reforestation (Fig. 3). On average, 1.3 ± 0.6 (1-3) individuals were found in each inhabited tree.

Of the five females observed, at least two appeared to be pregnant, as evidenced by their noticeably swollen neck glands and the distinct bulges of two eggs visible on the sides of their bellies.

The other two species of Gekkota present in Sicily *sensu stricto* were also found during the sampling, in close syntopy with *E. europaea*. Out of 138 sampled trees we found 26 *Tarentola mauritanica* (Linnaeus, 1758) (1 gecko/5.3 trees) and 12 *Hemidactylus turcicus* (Linnaeus, 1758) (1 gecko/11.5 trees). For the leaf-toed gecko we estimated, within the area where it was found, approximately 1 gecko/6 trees. In two cases *E. europaea* was found on the same tree with other geckos, once with *T. mauritanica* and once with *H. turcicus*.

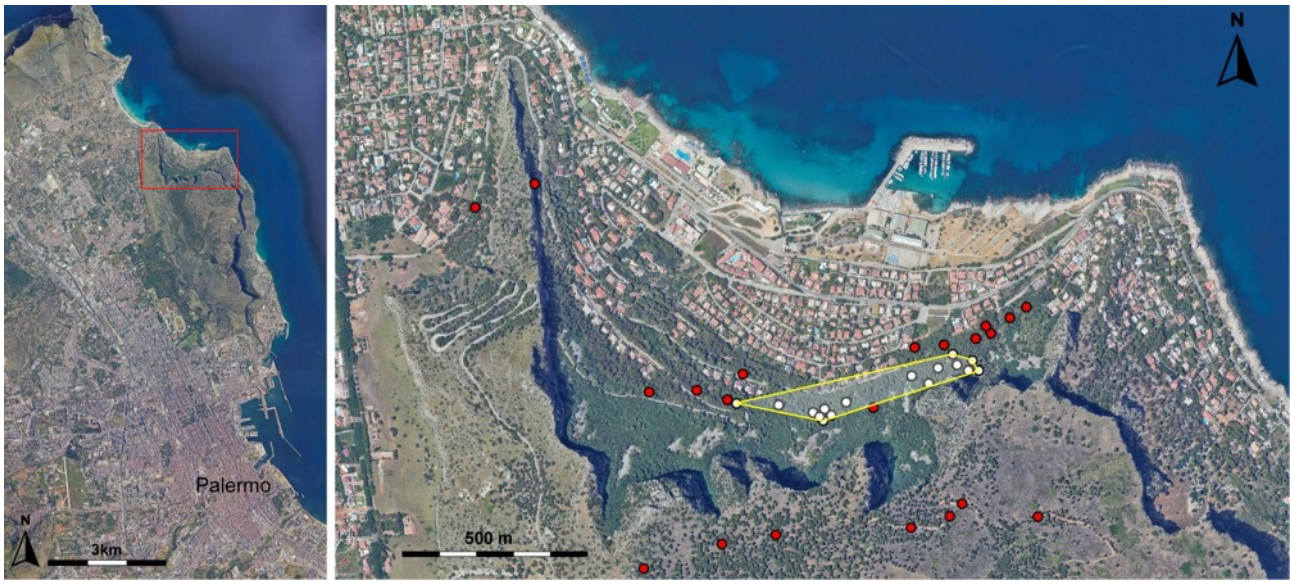

Figure 3. Detailed distribution of the inspected spots. White dots = spots where *E. europaea* was observed; red dots = spots without *E. europaea* findings; yellow line = Minimum Convex Polygon calculated on the *E. europaea* observations.

DISCUSSION

We report the first observations regarding the presence of the leaf-toed gecko in Sicily. Our data (number and distribution of observations, finding of pregnant females, etc.) suggest the presence of a breeding population of *E. europaea*, probably limited to a small area. The apparent narrowness of its distribution and the secretive habits of the species could be the reasons why this population has remained unnoticed in this area, which was the subject of several studies in the past (Lo Valvo, 1986).

Our field observations confirm the coexistence of *E. europaea* in close syntopy with the other two geckos, *Tarentola mauritanica* and *Hemidactylus turcicus* (Radi and Zuffi, 2022; Deso et al., in press), whose relationships in this study area deserve to be explored in depth. Furthermore, we have confirmed the arboreal habits of this lizard and a strong adaptation to eucalyptus woods which, despite their non-native status, seems to constitute a structurally ideal habitat for the *E. europaea* life cycle (Deso et al., in press; Salvi et al., 2023).

The dispersal processes that have determined the fragmented distribution of *E. europaea* are still unclear, due to the lack of in-depth studies. This species is overall considered to have a relict distribution (Salvidio et al., 2011), although human influence on the origin of its peripheral populations cannot be excluded (Salvidio and Delaugerre, 2003). Part of the Sicilian and Sardinian herpetofauna is the result of man-mediated dispersal following the last glacial events (Fritz et al., 2009; Stöck et al., 2016; Faraone et al., 2020b), in this context fauna exchanges occurred between the two islands (Giacalone et al., 2009; Senczuk et al., 2017), which were also sources of further dispersions towards the Italian peninsula (Mori

et al., 2022). The human-driven origin of this *E. europaea* population is plausible, since it is located about 400 m from an ancient port, which was created for fishing and trading activities in the 16th century (Lo Cascio, 1995). Subsequently, during the first half of the 20th century, the port was also a shipyard, initially intended for the construction of wooden boats (Cancila, 1999). As documented, maritime landings and wood trade can facilitate the dispersal of non-native reptile species (D'Amico et al., 2018; Mori et al., 2022). Although the scenario of introduction appears likely, given the absence of genetic data and the strong overseas dispersal capacity of geckos (Carranza et al., 2000; Hawlitschek et al., 2016), it is currently not possible to definitively assess the origin of this population.

The conservation status of the leaf-toed gecko is characterized by two different trends. Populations of small island and islets appear very fragile, as evidenced by local extinctions in recent decades in Provence (Salvidio and Delaugerre, 2003) and Tunisia (Delaugerre et al., 2011). On the other hand, on the large islands and mainland, it could be widespread as recent studies have pointed out a less fragmented distribution than expected (Salvidio et al., 2011; De Pous et al., 2012). The overall conservation status of this lizard has been assessed as Near Threatened (NT) with unknown population trend by the IUCN global red list (Corti et al., 2009) and Least Concern (LC) with declining populations by the IUCN Italian red lists (Rondini et al., 2013, 2022). *Euleptes europaea* is protected throughout Europe, as it is currently listed on Appendix II of the Bern Convention and Annex II and IV of the EU Habitats. This latest directive prescribes the establishment of special protection areas and local conservation measures, as already undertaken in some areas (Deso and Reynier, 2024). Based on available information, the Sicilian population of *E. europaea*, due to its apparent extreme localization and unknown origin, deserves further investigation to quickly undertake management or conservation measures.

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AUTHOR CONTRIBUTIONS

GG: Conceptualization, organization, manuscript preparation. FPF: Dataset curation, analysis, manuscript preparation. MP: Dataset curation, manuscript review. MS: Organization, conceptualization, manuscript preparation. All authors contributed equally to sampling.

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