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Rapid Communication

First record of the Argentine ant, *Linepithema humile* (Mayr, 1868), in the Tuscan Archipelago (Italy)

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Abstract

We present the first record of the invasive ant *Linepithema humile* (Mayr, 1868) in the Tuscan Archipelago. Due to its importance as a conservation area in the Mediterranean basin, the archipelago is now protected as a national park (Parco Nazionale dell'Arcipelago Toscano-PNAT). *L. humile* colonies were found on three of the seven islands studied: Elba, Giglio and Giannutri. The last two islands host abundant populations, whereas the distribution on Elba, although it is probably underestimated, is sparse and spatially localised. No evidence of presence was found on Montecristo, Gorgona, Pianosa and Capraia. Notably, these are islands where public access is more difficult and restricted. Since this ant has a strong impact on native species, strategic plans for future control are crucial to minimise its effect on the already colonised islands and prevent its spread to the other islands.

Key words: alien species, biological invasion, habitat conservation

Introduction

Invasive ants are well known to negatively affect many native biota (Holway et al. 2002; Simberloff et al. 2013). Native to central South America, the Argentine ant (*Linepithema humile* Mayr, 1868) is one of the most harmful invasive species in many terrestrial ecosystems. In the last century, it spread to at least 15 countries on six continents and many oceanic islands, with a negative impact on native animal and plant communities (Wetterer et al. 2009). In areas it occupies it competes for trophic resources with native ant species and other terrestrial arthropods, often causing their localised extinction (Human and Gordon 1997, 1999; Holway 1998; Liebherr and Krushelnycky 2007; Rowles and O'Dowd 2007). As these include several pollinator insects, their suppression or extirpation may, in turn, affect plant reproductive success (Visser et al. 1996; Blancafort and Gómez 2005; Lach 2008; Hanna et al. 2015; Sidhu and Rankin 2016). Plant reproduction may also be impaired due to the interference of the Argentine ant with myrmecochores that disperse seeds (Quilichini and Debussche 2000; Christian 2001; Carney et al. 2003; Gómez et al. 2003; Gómez and Oliveras 2003; Witt et al. 2004).

L. humile began its spread into southern Europe during the 19th century, arriving probably from Madeira through Portugal (Wetterer et al. 2009). It is now widespread and distributed continuously from Portugal to Italy (Espadaler and Gómez 2003), as well as the Balearic Islands (Gómez and Espadaler 2006) and Corsica (Blight et al. 2010). The first record of this species in Italy dates to 1922 (Silvestri 1922) in Campania. It is now present in other regions like Sicily, Calabria, Liguria and Tuscany, but there is strong evidence that the invaded areas are underreported (Jucker and Lupi 2011). In Tuscany, this species has been recorded in a few areas of the coast around Follonica and Monte Argentario in the Province of Grosseto (http://www.inaturalist.org), and in a few sites in the urban areas between Firenze and Prato (personal observation). However, no systematic investigation has ever been conducted.

The Tuscan Archipelago is a chain of islands between the Ligurian Sea and the Tyrrhenian Sea, off the coast of Tuscany. The archipelago consists of seven islands and a few islets and skerries. The landscape of the region has changed significantly over the last century, as the traditional economy based on agriculture and pastoralism has given way to an economy based mostly on tourism (Papayannis and Sorotou 2008). But despite the long-lasting human impact, the islands have a rich fauna and flora, and host several endemic species (Dapporto and Cini 2007; Coppi et al. 2014; Cini et al. 2018). For example, the flora consists of c. 1,400 taxa of which 1.14% are endemic (Foggi et al. 2015).

All the islands are now protected as part of the Arcipelago Toscano National Park (PNAT). *L. humile* has never been detected on these islands, although unconfirmed sightings have been reported by tourists visiting Giannutri and Giglio islands (Masoni *personal communications*). Due to the ecological relevance of this archipelago, and its proximity to areas invaded by the ant on the Tuscan coast, we decided to perform a preliminary assessment of the presence of the species on the islands.

Materials and methods

We explored all seven islands of the archipelago, although sampling effort varied among them. Due to the high visibility of the species when present (large colonies formed by thousands of workers), we decided to visually sample along pre-determined routes, instead of deploying a more complex baiting or pitfall sampling protocol. Typically, sampling began at 10:00 and ended at 18:00 on sunny days. Each time the species was found, we collected 6–8 workers, and the nest was georeferenced using a X30 GPS receiver (Garmin Ltd., Kansas City, USA) to a spatial precision < 10 m. All samples were stored in 75% ethanol and carried to the laboratory for identification. *L. humile* was identified following Wild (2007). Identification was easy because there were no other *Linepithema* species in the area. Sample

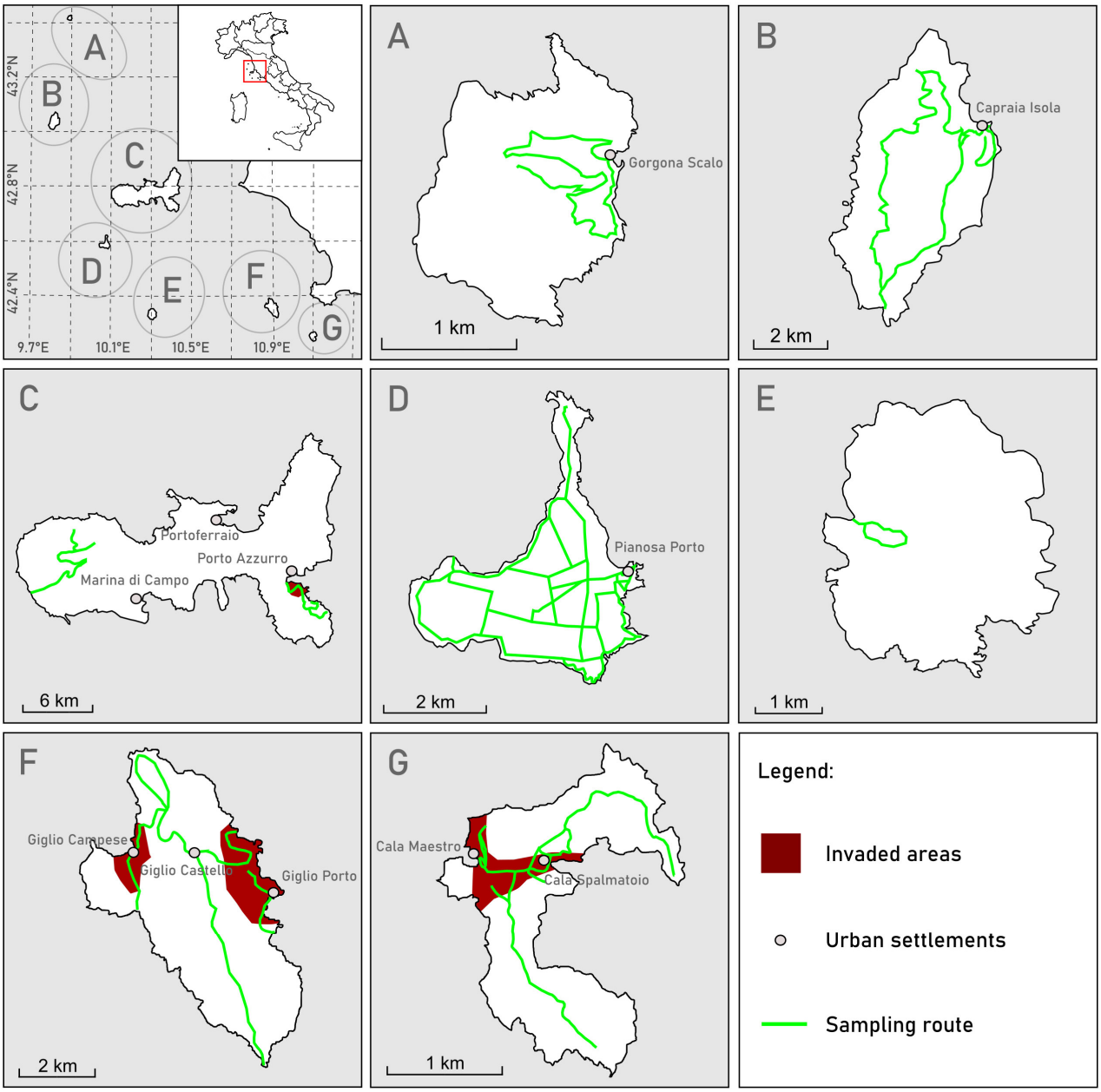

Figure 1. Sampling areas searched for *Linepithema humile* on the seven islands of the Tuscan Archipelago: (A) Gorgona, (B) Capraia, (C) Elba, (D) Pianosa, (E) Montecristo, (F) Giglio, and (G) Giannutri. Green lines represent the different paths and routes followed during the sampling work. Red areas show the distribution areas of the Argentine ant.

specimens were deposited in the Natural History Museum of Milan. We conducted sampling on Giannutri and Giglio in the first half of October 2016, on Pianosa in May 2017, on Elba in September 2017, on Capraia in June 2018, on Gorgona in May 2019, and on Montecristo in June 2019. Sampling was possible on Montecristo only in a limited part of the island, as access to the other parts is strictly forbidden. On each island, we started sampling from the few urban aggregates and the paths interconnecting them. We also sampled agricultural fields, vineyards and uncultivated areas encountered along the route, as these habitats are particularly suitable for this species. The paths travelled and the areas sampled on all islands are shown in detail in Figure 1. In the case of Elba, the largest island in the

archipelago, it was possible to monitor only the southeastern and western parts of the island.

Results

The Argentine ant was widely dispersed on Giglio and Giannutri (Figure 1). On Giglio, we found 29 nests (Supplementary material) of the species forming two distinct nuclei around the villages on the west (Giglio Campese) and the east (Giglio Porto) coasts. Numerous nests were detected within the villages and along all the roads/paths in their proximity. However, no *L. humile* were found in the central part of the island (Giglio Castello) or the northern and southern extremes. However, some nests were found at the beginning of the path connecting the locality of Monticello (east coast) with Giglio Castello; this presages an expansion of the species towards the interior which is already in progress. On Giannutri island, the species occupied the central belt between Cala Spalmatoio and Cala Maestra, up to the remains of the Roman villa, with 22 nests, but it was not present in other parts of the island. On Elba, we found five *L. humile* nests only in the urban aggregate of Naregno (southeastern coast), but not in the other areas we explored. No *L. humile* individuals were found on Pianosa, Capraia, Montecristo, and Gorgona.

Discussion

This note updates the knowledge of *L. humile* distribution in Tuscany, reporting for the first time its presence on the islands of Elba, Giglio and Giannutri. On the last two islands, we recorded considerable dispersal of this invasive ant, and the extent of the area occupied allows us to hypothesise that the introduction dates back several years before the survey. The presence of this species primarily in urban areas, or in their immediate neighbourhoods, suggests that introduction is probably due to accidental human transport. Young colonies can travel inside plant pots brought by residents or vacationers, or in building materials imported from the mainland. Accidental transport of fertile queens on the ferries connecting the islands to the Tuscan coast is also possible; we observed several (dead) winged queens of *Lasius* sp. on the outside decks of the ferry boat commuting between Argentario on the mainland, where *L. humile* is widespread, and Giannutri. Finally, the disjunct distribution observed on Giglio, with two seemingly isolated populations, one located on the west coast and the other on the east coast, suggests that the introduction had occurred at least twice, as this spatial distribution is hardly compatible with the spread from a single point of introduction. Less information is available for Elba, where we found *L. humile* only in a single location – a garden along the main road of a tourist locality.

Not surprisingly, the presence of the Argentine ant corresponded with lower observations of autochthonous ants in the invaded areas. The impact

of invasive ants on island ecosystems can be dramatically higher than that on mainland systems (Liebherr and Krushelnycky 2007), so focused research on these islands could be insightful. The negative impact of this species is not limited to loss of biodiversity; it also has a direct effect on various human activities. As this species easily colonises urban areas (Klotz et al. 1995; Gordon et al. 2001), its spread can hamper tourist activities which are the primary source of income for some of the islands. Moreover, numerous studies have highlighted the indirect damage caused by this species to vineyards and other agricultural crops, as they tend aphids and cochineal insects (Addison and Samways 2000; Holway et al. 2002; Daane et al. 2007; Cooper et al. 2008). Recently, Jones et al. (2016) described the impact of the Argentine ant on honey bee colonies, reporting direct plundering of both honey and the brood by the ants. As the economic growth of some of these islands depends on the expansion of high-quality green agriculture, the spread of the Argentine ant can be a further menace to the environmentally friendly development of the islands.

In conclusion, this study reports for the first time the spread of the Argentine ant on the Tuscan Archipelago, an important area for the conservation of Mediterranean ecosystems. The islands of Pianosa, Montecristo, Gorgona and Capraia were, at the time of sampling, free from the species. In contrast, *L. humile* occupied considerable parts of Giannutri and Giglio and was sporadically present on Elba. The distribution on Elba is probably underestimated, as not all the areas with the potential for invasion were surveyed. Beyond the evident need to better define the boundaries of the invaded areas, strategic plans for future control are required to minimise the impact of this invasive species on the native fauna and flora of this critical conservation area.

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Authors' Contribution

Masoni A. – writing of the manuscript, study design and sample collection; Frizzi F. – investigation and data collection, writing of the manuscript; Giannini F. – funding provision and sampling design and methodology; Santini G. – sampling design and methodology, data interpretation, writing of the original draft.

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Supplementary material

The following supplementary material is available for this article:

Table S1. Coordinates in Decimal Degrees format for *Linepithema humile* nests found on the islands of the Tuscan Archipelago.

This material is available as part of online article from:
http://www.reabic.net/journals/bir/2020/Supplements/BIR_2020_Masoni_etal_Table_S1.xlsx