

# Alien Ants (Hymenoptera, Formicidae) in Sicily and Malta: A Review and Updated Checklist

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## ABSTRACT

In the last few years, due to globalization, which increases and speeds up the movement of people and goods around the world, the number of alien animal and plant species that have accidentally arrived in Europe has increased considerably; as a result, the problem of alien species, and especially invasive ones, has taken on greater significance. Since the Mediterranean has always been one of the main trade routes, it is of primary importance to turn our attention to those areas that constitute the main entry routes for new species into Italy and Europe, such as Sicily and the Maltese archipelago. This publication aims to collect all available data about alien invasive ants recorded in Sicily and Malta. Among all animal taxa, one of the groups with great adaptability and that easily follows human routes is the Formicidae, which also includes species with high invasive potential. Currently in Sicily there are 10 alien ant species, two of which, *Linepithema humile* (Mayr, 1878) and *Solenopsis invicta* Buren, 1972 (recently recorded), are invasive. Whereas for the Maltese archipelago 12 ant species are alien, two are considered invasives, namely *L. humile* and *Pheidole indica* Mayr, 1879. An additional species, *Cardiocondyla mauritanica* Forel, 1890, is considered cryptogenic in both countries. For a proper management of alien species, it is essential to carefully monitor the alien species already present on the territory and considered invasive but also to pay attention to those species that have already caused serious damage in other countries and are easy to introduce. Finally, it is important to monitor potential entry routes followed by invasive aliens, especially those involving interchanges between Sicily and the Maltese archipelago.

## KEY WORDS

Biological invasions; Formicidae; invasive alien species; tramp ants; Sicily; Malta.

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## INTRODUCTION

After habitat destruction, alien species represent the second most significant factor contributing to biodiversity loss (Pyšek et al., 2020). The diversity and abundance of native species could be reduced by alien species invasions, which can have a huge impact on different levels. The proliferation of invasive alien species (IAS) is facilitated by extensive

trade and transport routes around the world (Haubrock et al., 2021a).

The Mediterranean region is an important biodiversity hotspot with global significance. Concerning Italy, the Global Register of Introduced and Invasive Species (GRIIS) (Ries & Pagad, 2020) estimated that more than 3,000 alien species are currently present, at least 15% of which are invasive. These have occurred through various pathways, such as agricul-

ture and fishing, to name only a few. Italy is now defined as a hotspot and gateway for several groups of alien and/or invasive species (Haubrock et al., 2021b). For example, at least 923 insect species in terrestrial ecosystems of Italy can be considered aliens (Inghilesi et al., 2013). The central and strategic location in the Mediterranean region of Sicily and the archipelago of Malta makes them frequent targets for the arrival of new alien organisms, which poses a threat to local ecosystems. In particular, due to its peculiar geographic location, geology, and history, Sicily today has a rich biodiversity with important endemic species (Massa et al., 2011) that are seriously endangered by the arrival of alien species.

As far as insect groups are concerned, the incursion of non-native ants (Formicidae) is a serious ecological problem, especially in island ecosystems. Their invasion is generally human-mediated and involuntary. When this occurs, the negative impact on local biodiversity can be severe. Once established, invasive ants tend to proliferate extensively in their new habitat, often surpassing native ant populations in abundance (Holway et al., 2002). Therefore, tracking invasive ant movements and predicting their origins could be very helpful for local fauna conservation, but it is also a challenging aim to achieve (McGlynn, 1999).

Most established ant species in the Mediterranean region are synanthropic, i.e. related to indoor or human habitats, while fewer have managed to colonize semi-natural or natural habitats, and only a handful are recognized as significant pests (Schifani, 2019). Certain alien invasive ant species might be able to penetrate natural ecosystems, where they could reduce the diversity of native ants and other organisms (Holway et al., 2002).

Many species are often referred to as “tramp ants” because of their reliance on human-mediated dispersal and close association with humans. Approximately 40 exotic ant species are currently thought to have established populations in the Mediterranean Europe region since the late 1800s (Schifani, 2019), with limited understanding of their introduction processes and distribution in the Mediterranean and Palearctic regions before this period.

## MATERIAL AND METHODS

In order to make a list of exotic ant species for

both islands, a survey of major databases on alien species was performed, such as CABI, GISD, DAISIE, GRISS, GBIF, EPPO, some of which included data such as local and country distribution, status, and organism type; we also used national databases (Checklist of Italian Fauna; DIAS), journals, books, publications, regional decrees, and expert opinions. This paper summarizes and updates the information known so far for each species until 2023.

The word “cryptogenic” was used for species of which the original source is unclear (Rossi et al., 2022). We defined as “invasive” those species established on the territory and dangerous for ecosystems and human activities.

## RESULTS

All the exotic ants known for Sicily and Malta are actually established and well-integrated in the ecosystems, but only some species are considered invasive.

The updated checklist of alien and invasive ants in Sicily and Malta now includes fifteen (15) alien species across four (4) subfamilies, with three (3) of them being invasive [*Linepithema humile* (Mayr, 1868), *Solenopsis invicta* Buren, 1972, *Pheidole indica* Mayr 1879] (Table 1).

An additional species for both countries, *Cardiocondyla mauritanica* Forel, 1890, is considered cryptogenic.

The number of alien ant species in Sicily since the last checklist of 2022 has not changed significantly (Schifani, 2022). However, there has been a worrying new addition: the fire ant *S. invicta* (Menchetti et al., 2023). Therefore, up to now, in Sicily there are ten (10) exotic species, of which two (2), *L. humile* and *S. invicta*, are considered invasive. These two species, currently established in Sicily (Poldi et al., 1994; Schifani, 2022; Menchetti et al., 2023), belong to the five ant species ranked among the hundred most detrimental alien species globally, according to the IUCN list of 100 worst invasive alien species in the world (Lowe et al., 2000).

The population of *S. invicta* registered in Sicily is the first documentation of a big European established population; its real distribution on the island is still unclear. Eighty-eight (88) nests currently

Species	Sicily	Malta	Alien	Invasive	Crypto-genic	Established Status	Origin	First record
Subfamilia DOLICHOTHERINAE								
<i>Linepithema humile</i> (Mayr, 1868)	1926	1968	X	X		Established	South America (Neotropics)	Donisthorpe, 1927; Baroni Urbani, 1968
<i>Tapinoma melanocephalum</i> (Fabricius, 1793)		2018	X			Established	Asia	Salata & Borowiec, 2018
Subfamilia FORMICINAE								
<i>Nylanderia jaerskioeldi</i> (Mayr, 1904)	2014	2017	X			Established	Africa	Schifani & Alicata, 2018; Gomez, 2017
<i>Paratrechina longicornis</i> (Latreille, 1802)	2002	1975	X			Established	Asia (Indomalaya)	Schifani & Alicata, 2018; Schembri & Collingwood, 1981
Subfamilia MYRMICINAE								
<i>Cardiocondyla mauritanica</i> Forel, 1890	1987	1984			X	Established	Africa (Palearctic – N. Africa)	Schifani & Alicata, 2018; Mei, 1995
<i>Cardiocondyla emeryi</i> Forel, 1881		2018	X			Established	Africa	Salata & Borowiec, 2018
<i>Pheidole indica</i> Mayr, 1879	2014	1968	X	X		Established	Asia (Indomalaya)	Schifani & Alicata, 2018; Baroni Urbani, 1968
<i>Solenopsis invicta</i> Buren, 1972	2023		X	X		Established	Suth America (Neotropics)	Menchetti et al., 2023
<i>Strumigenys lewisi</i> (Cameron, 1886)		1984	X			Established	Asia	Schembri & Collingwood, 1981
<i>Strumigenys membranifera</i> Emery, 1869	1994	1975	X			Established	Africa	Poldi et al., 1995; Schembri & Collingwood, 1995
<i>Tetramorium bicarinatum</i> (Nylander, 1846)	2006	2017	X			Established	Asia (Indomalaya)	Schifani & Alicata, 2018; Gomez, 2017
<i>Tetramorium immigrans</i> Santschi, 1927	2017		X			Established	Asia (Anatolia and Caucasus)	Schifani & Alicata, 2018
<i>Tetramorium lanuginosum</i> Mayr, 1870	2014	1976	X			Established	Asia	Schifani & Alicata, 2018; Schembri & Collingwood, 1981
Subfamilia PONERINAE								
<i>Hypoponera punctatissima</i> (Roger, 1859)	2011	2019	X			Established	Africa (Sub-Saharan Africa)	Bolton & Fisher, 2011; Mifsud & Lapena Gjonova, 2019
<i>Parvaponera darwinii</i> (Forel, 1893)		1985	X			Established	Asia	Schembri & Collingwood, 1995

Table 1. List of exotic ant species in Sicily and Malta.

seem to be present in Sicily, extending about 4.7 ha during 2022/2023, near the city of Syracuse. Nevertheless, some locals reported the occurrence of ant stings in the area as early as 2019. Local reports, combined with the number of nests found, suggest

that the species has been in the area for quite some time before it was reported (Menchetti et al., 2023).

Currently, according to the Checklist 2022 (Schifani, 2022), there are about 132 total ant species in Sicily, but this data is continuously up-

dated and therefore subject to short-term variations. The percentage of exotic ant species among the total number of species is approximately 7%. The trend of alien ants reports in Sicily shows that an increase in introduction has occurred since the 2000s (Fig. 1).

Concerning the Maltese situation, the last update for exotic ants in Malta is dated to 2019 (Mifsud & Gjonova, 2019). Our data agree with the last checklist, reporting twelve (12) exotic species, and two (2) of them, namely *L. humile* and *P. indica*, are invasive (Seifert, 2017; Mifsud, 2023).

The percentage of exotic ant species among the total number of species (70 according to Mifsud & Gjonova, 2019) is approximately 17%.

Reports of exotic ant species in Malta occurred mainly between the 1970s and 1980s, and then picked up again in the 2000s (Fig. 2). The geographic origin of species found in Sicily and Malta is not homogeneous: approximately more than half comes from Asia (53%), while the remaining species originate from Africa (34%) and South America (13%) (Fig. 3).

## DISCUSSION

Sicily and Malta show similar data concerning exotic ant species; in fact, 10 species occur in both regions (Fig.1). Two species are only present in Sicily: *Solenopsis invicta* and *Tetramorium immigrans* Santschi, 1927 (Schifani & Alicata, 2018), meanwhile 4 are only present in Malta: *Tapinoma melanocephalum* (Fabricius, 1793); *Cardiocondyla emeryi* Forel, 1881; *Strumigenys lewisi* (Cameron, 1886); *Parvaponera darwini* (Forel, 1893) (Gomey, 2017; Salata & Borowiec, 2018).

A special case is *Pheidole indica*, which behaves differently in the two territories. *P. indica*, according to Gomez (2017) and Mifsud (2023), is considered invasive in Malta, but it is not invasive in Sicily (Schifani & Alicata, 2018). This difference is probably due to a higher presence of populations of *Pheidole pallidula* (Nylander, 1849) in Sicily, which is sufficient to keep *P. indica*'s spread under control.

*Linepithema humile* is another highly invasive ant species in both regions. This species comes from South America and is a potential threat to native ecosystems. Due to its tendency to form 'super

colonies' in which individuals from different colonies work together, it is able to conquer and dominate new habitats quickly. This represents a big threat for native biodiversity: this species displaces native ants, preys directly on native invertebrates as well as small vertebrates and, protecting aphids and scale insects, it may facilitate the spread of such sap-feeding invertebrates which cause damage to vegetation and crops (Mifsud et al., 2023).

The most concerning scenario for Sicily and Malta regards the species *Solenopsis invicta*. This invasive species comes from South America as well and, until now, it has been only found in Sicily. Although we do not know exactly the timeline of introduction of *S. invicta*, it is possible to observe how fast it has been spreading since 2019 until now (Menchetti et al., 2023). This species is known for its capability to conquer and dominate new habitats with deleterious effect on local ants and arthropods biodiversity. It is known that *S. invicta* shows a preference for urban areas and disturbed habitats. This species is an aggressive and omnivore forager ant that occurs with high density, spreading rapidly, and it is able to quickly move the colony if disturbed. It uses its stinging ability to prey and repel other animals, causing declines in invertebrate and vertebrate populations as well as the decimation of autochthone ants. If disturbed, it can attack humans with painful stings, and its generalist behaviour is a problem for agricultural crops and human activities as well (Holway et al., 2002). Strategies for control and eradication of this species from the region of Sicily are currently being developed (Delib. n.466, 22.11.23, Regione Siciliana). It is important to employ constant monitoring and immediate containment measures to prevent its spread to neighboring regions especially in the Maltese islands.

*Cardiocondyla mauritanica* Forel, 1890 is not considered an alien species in Sicily or Malta, because its status is yet unclear, and therefore is referred to as cryptogenic. We do not know yet the boundaries of its native range distribution; it is generally considered as an exotic species in Greece and Spain, meanwhile North Africa is considered to be its native range. It may be challenging to determine the nature of *C. mauritanica* presence in Sicily and Malta, since it was found in both natural and anthropogenic habitats as naturally present (Schifani & Alicata, 2018).

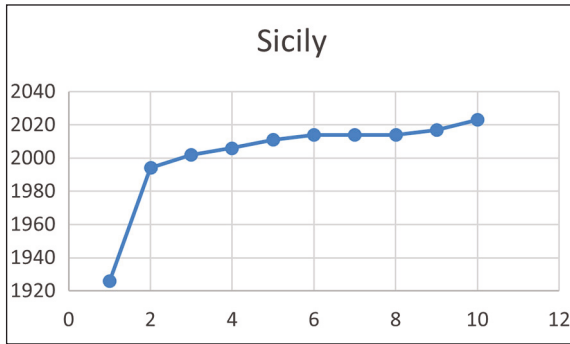


Figure 1. Trend of alien reports in Sicily. It was produced using first record data in Sicily. It shows the time on the y-coordinate and the number of species on x-coordinate.

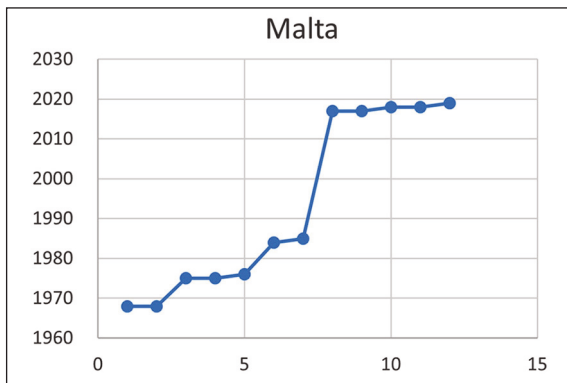


Figure 2. Trend of alien reports in Malta. It is produced using first record data in Malta. It shows the time on the y-coordinate and the number of species on x-coordinate.

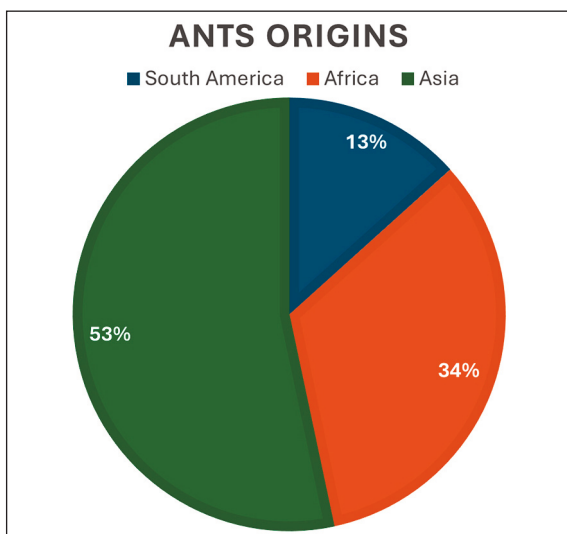


Figure 3. Corresponding percentage of ants originated from different geographical areas.

The percentage of exotic species on the Malta archipelagos is particularly high (17%) considering the island’s size. It is likely that Malta’s reputations as tourist destination, along with intense commercial activities, has contributed to the increase in the number of non-native taxa present on the archipelagos.

The increasing of the records amount in Sicily and Malta, is linked to the globalization phenomenon as well as to the bigger monitoring effort employed during the last years from the specialists, with relative new studies published.

The variety of alien provenance can be attributed to a variety of factors, including commercial flows, and global ecological interactions.

### CONCLUSIONS

Alien species require careful attention from both the scientists and the general public; their behavior may vary depending on the environment and how each species adapts, which may change over time and space. It is important to implement measures to prevent the spread of exotic species outside the already invaded area, and to prevent the exchange of aliens between Sicily and Malta. To this end, it is of fundamental importance to monitor the trans-boundary areas and the main alien species’ entry routes through a coordinated effort by local administrations.

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