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Where and how Argentine ant (*Linepithema humile*) spreads in Corsica?

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Abstract

The Argentine ant, *Linepithema humile* (Dolichoderinae), is one of the most widespread invasive ant species in the world. When established in optimal habitat, this species usually excludes most other local ants and can heavily impact other arthropods as well. Although Argentine ants have been present in southern Europe for more than 100 years, they were first noted in Corsica, a French Mediterranean island, in 1957 in only one urban station. In this study, we aimed to map precisely their geographical distribution in Corsica and to quantify their presence by using an infestation index. We recorded changes in the distribution of Argentine ants in Corsica over the past decade. Argentine ants appeared to be well established within their introduced range and spreading along the Corsican coasts principally through Human-mediated jump-dispersal but not homogenously. ***To cite this article: O. Blight et al., C. R. Biologies 332 (2009).***

Résumé

Où et comment la fourmi d'Argentine (*Linepithema humile*) s'étend en Corse ? La fourmi d'Argentine, *Linepithema humile* (Dolichoderinae), est une des espèces de fourmis invasives les plus répandues dans le monde. Quand elle est établie dans un habitat optimal, cette espèce exclut généralement les espèces de fourmis locales et peut également affecter d'autres arthropodes. Bien que les fourmis d'Argentine soient présentes dans le sud de l'Europe depuis plus de 100 ans, elles n'ont été observées en Corse, une île méditerranéenne, qu'en 1957 dans une unique station. Dans cette étude, nous avons décidé de cartographier précisément leur distribution en Corse mais également de quantifier leur présence en utilisant un indice d'infestation. Nous avons enregistré un changement de la distribution des fourmis d'Argentine en Corse sur la dernière décennie. Les fourmis d'Argentine semblent être bien établies dans leur zone d'introduction et s'étendent le long des côtes corses principalement par l'intermédiaire de l'Homme mais de façon hétérogène. ***Pour citer cet article : O. Blight et al., C. R. Biologies 332 (2009).***

Keywords: Argentine ant; Corsica; Map; Human-mediated dispersal

Mots-clés : Fourmi d'Argentine ; Corse ; Dispersion ; Cartographie

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1. Introduction

The Argentine ant is a highly invasive species that has successfully spread from its native range in South America across many zones of the globe with Mediterranean and subtropical climates [1]. When established in optimal habitat, this species usually excludes most other local ants and can heavily impact other arthropods as well [2–4]. It dominates competitors or prey through numerical superiority [5,6]. Since the end of the ninetieth century and the beginning of the twentieth, Argentine ants have expending their range and invaded the south of France [7] but also Spain, Portugal [8,9] and Italy. They were first recorded in France by Marchal [10] in 1906. Although Argentine ants have been in southern Europe and occur there widely for at least 100 years, few data is available on their invasion and their dynamic of expansion in islands and all the more in Mediterranean islands. Espadaler and Gomez [8] recorded them in high densities in Balearic Islands. In Corsica, *Linepithema humile* was first recorded in 1957, in only one urban station, Calvi [11]. Forty years later, Casewitz-Weulersse and Brun [12] located Argentine ants in few urban locations over the coastline. In this study we aimed to prospect the whole Corsican coast lines to determine the extent to which the invasion occurs in Corsica 10 years after the last survey. This survey can provide valuable information on the temporal and spatial invasion dynamic of Argentine ants in a Mediterranean island. Moreover, the precise mapping of Argentine ants constitutes the first step for managements and controls of this invader in Corsica.

2. Materials and methods

Corsica is the biggest French Mediterranean island. It has an area of 8680 km^2 with coasts of 1000 km long. The coastal strip is very narrow, Corsica being highly mountainous with an elevation of 2710 m. This island is characterized by a Mediterranean climate with an average annual temperature of 16.1 °C and average annual precipitation of 698 mm. The population density is 30 inhabitants/km^2 mainly concentrated on the coastal strip. In summer, during the activity peak of tourism, the population increase from about 200 000 inhabitants to more than one million.

A comprehensive sampling of the Corsican coastline has been performed, visiting notably sites inspected by Casewitz-Weulersse and Brun [12] (Fig. 1, sites 2, 6, 13, 15, 17 and 22). We conducted the survey of 79 sites from June to September in 2007 and in 2008. At each site, we inspected the ground, under stones or dead woods during a 20 minutes scan. If no Argentine ants were found, the site was stated as *L. humile*-free. Inversely, when a site was scored as infested, we calculated an infestation index which was the ratio between the number of Argentine ant observations and the total number of inspections during the 20 minutes scan. One corresponded to a highly infested site and zero to a free site. In both cases, infested or not, we recorded the date, the habitat type, the coordinates and a sample was taken of all species encountered and stored in a vial of 75% ethanol. This fine description with coordinates and infestation index of the whole infested sites will permit a better survey in the future of the Argentine ant expansion dynamic.

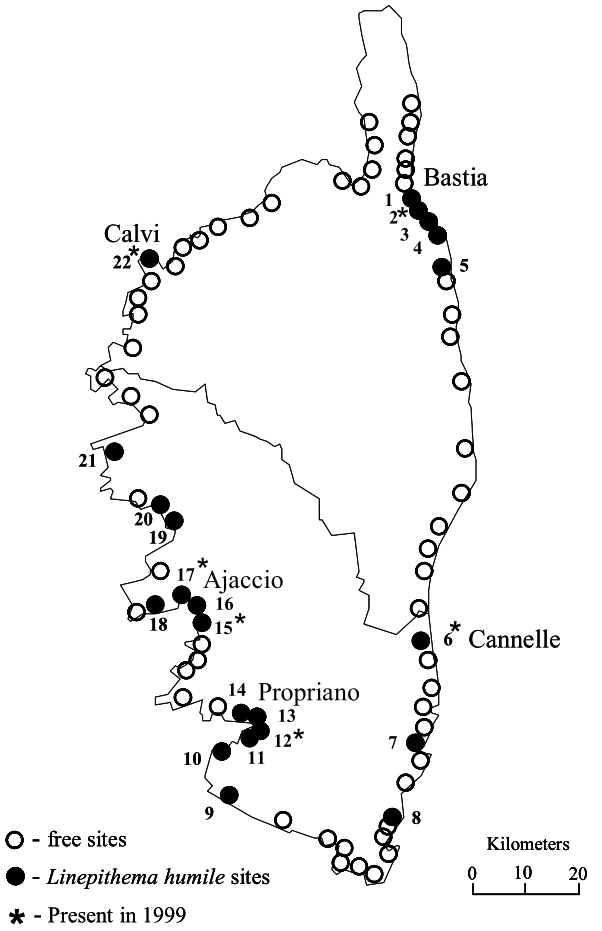

Fig. 1. Argentine ants distribution along the Corsican coast. 79 prospected sites: 22 infested sites by Argentine ants (closed circles) and 57 free sites (open circles). An asterisk notes the presence of Argentine ants in 1999.

3. Results

Argentine ants are present and expanding in Corsica since the last survey by Casewitz-Weulersse and Brun

Table 1
Coordinates of the 22 infested sites by Argentine ants, *Linepithema humile*, in Corsica. An asterisk shows the presence of Argentine ants in 1999.

Codes	Locality	Coordinates	Codes	Locality	Coordinates
1	Biguglia	42°39′21.1″N 9°27′06.1″E	12	Propriano*	41°40′33.06″N 8°54′11.55″E
2	Biguglia*	42°36′51.68″N 9°28′55.00″E	13	Olmeto	41°41′13.45″N 8°55′07.30″E
3	Biguglia	42°35′36.4″N 9°30′09.5″E	14	Cala Piscona	41°41′47.4″N 8°51′36.5″E
4	Pineto	42°34′47.6″N 9°30′51.9″E	15	Porticcio*	41°52′53.38″N 8°47′13.36″E
5	Vescovato	42°30′43.9″N 9°31′55.1″E	16	Campo Dell'Oro	41°54′32.5″N 8°47′47.3″E
6	Cannelle*	41°47′59.8″N 9°23′41.1″E	17	Ajaccio*	41°55′09.80″N 8°44′14.06″E
7	Porto-Vecchio	42°36′05.86″N 9°16′14.66″E	18	Vignola	41°54′36.31″N 8°38′27.64″E
8	St Giulia	41°31′33.2″N 9°16′18.0″E	19	Tiuccia	42°03′57.16″N 8°44′15.64″E
9	Tizzano	41°32′09.3″N 8°51′26.0″E	20	Liamone	42°04′25.0″N 8°43′12.7″E
10	Campomoro	41°37′46.5″N 8°48′50.7″E	21	Pero	42°08′47.4″N 8°35′38.7″E
11	Capu Laurosu	41°39′01.14″N 8°52′45.60″E	22	Calvi*	42°34′00.60″N 8°45′23.66″E

[12]. Ten years later, we found *L. humile* along the coast but not continuously (Fig. 1). We recorded this invader in 28% of the 79 prospected sites (22/79) (Fig. 1). We recorded three major infested zones, one on the oriental coast in the South of Bastia (Fig. 1, sites 1 to 4) and two on the occidental coast, in the gulf of Ajaccio (Fig. 1, sites 15 to 17) and in the gulf of Propriano (Fig. 1, sites 11 to 14). We recorded Argentine ants in seven urban sites (31.8% of occurrences), four had already been noticed by Casewitz-Weulersse and Brun [12] Propriano, Porticcio, Ajaccio and Calvi (Fig. 1, sites 22, 17, 15, 12, respectively) and three were recorded for the first time, i.e. Campomoro, Porto-Vecchio and Vignola (Fig. 1, sites 10, 7, 18, respectively). Contrary to our expectations, urban sites were not very highly invaded, with a mean infestation index of 0.36 ± 0.07 S.E. ($n = 7$). This could be explained by the use of different chemical treatments for management and control of this invader. In instance, during this ant survey we found in Calvi only one ant trail in a flowerpot whereas this location is the oldest infested site. Consistently, we did not found Argentine ants in Bastia, the second city of Corsica, whereas they were present few kilometres to the south in Biguglia (Fig. 1).

We also recorded Argentine ants in relative high densities in semi-natural or natural sites (15/22) with a mean infestation index of 0.56 ± 0.06 S.E. ($n = 12$) and 0.85 ± 0.04 S.E. ($n = 3$) respectively in coastal grassland and in forest/scrub sites. The forest/scrub habitat was the most infested among the three habitat types ($P < 0.05$, Mann–Whitney U tests). No significant difference was recorded between urban and coastal grassland habitats ($P = 0.06$, Mann–Whitney U test). Thirteen sites were first documented in this study. *In Natura*, we frequently found *L. humile* in open landscape, mostly in coastal grassland (12/22 sites, 54.5% of occurrence). We also mapped Argentine ants in three forest/scrub sites (13.6% of occurrence). When they were present in forest, they were always in high densities in adjacent to open habitat (Table 1, sites 3, 5, 13). Moreover, we found *L. humile* in protected areas with high biological value. This is the case of Cannelle, Capu Laurosu and Cala Piscona (Table 1, sites 6, 11 and 14) which are three of the four locations for a rare endemic ant plant *Anchusa crispa* [13].

4. Discussion

This study documents changes in the distribution of Argentine ants in Corsica over the past decade. Argentine ants appeared to be well established within their introduced range and spreading along the Corsican coasts. The spread of Argentine ants seemed to be mainly the result of jump-dispersal through Human transport. The

examples of likely human-mediated dispersal were for sites 8, 9, 16, 20 and 21 (Fig. 1). The majority of the newly infested sites recorded in this study are rather isolated. In these locations, Argentine ants were absent in the adjacent zones suggesting that they did not diffuse naturally but were introduced accidentally from foci by Human. Indeed, natural diffusion distances are usually believed to be of 150 meters per year [14] which is insufficient to explain the colonization of the new sites. This relative slow spread stems principally from the colony reproduction strategy; i.e. by budding [14].

Where the Argentine ant has invaded native habitats in other parts of the world it has predominantly been in open areas [14,15]. Our results are consistent with these studies as, among the 15 natural or semi-natural sites, 12 were characterised by open areas. We also recorded Argentine ants in forest in three times only. This is also consistent with former studies showing that forests are less susceptible to host the invasion or are not invaded. However, in these three sites, Argentine ants were present in high densities, probably naturally diffused from adjacent open areas to forest.

Despite a marked spread over the last decade, Argentine ants were present discontinuously along the coastal strip. This is particularly true for the oriental coast, where we recorded a 80 km-long line free of Argentine ants going from site 5 to site 6. This is not consistent with the widely recognized vulnerability of the island populations to biological invasions [16]. These simplified ecosystems offer generally less resistance to biological invasions. In other invaded islands, Argentine ants colonized almost the entirety of the islands. In Bermuda, Argentine ant was recorded in the 1950s. Since then, the Argentine ant is currently the most common ant both by its occurrence and its extremely high densities. Wetterer and Wetterer [17] found this ant almost everywhere they collected in Bermuda. Argentine ant was found in Madeira for more than 100 years. However, Wetterer [18] balanced its impacts considering that Argentine ant impacts were exaggerated in former studies. Gomez and Espadaler [19] recorded the presence of Argentine ants in the Balearic Islands where the infestation was considered as very important in the islands of Ibiza, Mallorca, and Menorca. In these three Mediterranean islands, Argentine ants spread rapidly, much more easily in the more humid environment [19].

Several studies demonstrated that the spread of Argentine ants could be limited by both abiotic [20] and biotic factors [15,21]. Abiotic conditions have been implicated as one of the most important factors driving the potential of the Argentine ant invasion. At the ultimate of their distribution, Argentine ants are limited by extremes in temperatures [22] and water limitation [23]. Abiotic factors can shape species distributions mainly in harsh environments while biotic factors may play a role in shaping species distributions in milder conditions. Our ant sampling showed the presence of two species widely distributed along the coasts and notably along this Argentine ant-free zone (Fig. 2). These species belonged to the *genus Tapinoma*, *Tapinoma simrothi* and *Tapinoma nigerrimum*. While they usually shared the same habitat, we noticed only twice co-occurrence between Argentine ants and at least one of the two *Tapinoma*. In these two cases, only one small nest of Argentine ants was found suggesting recent introductions. Consistently, a systematic exclusion seemed to arise between Argentine ants and *Tapinoma*. Bioassays between *L. humile* and *Tapinoma* testing competition for food and space will permit to test the hypothesis of a biotic resistance. Accordingly, we will be able to state whether *Tapinoma* can delay or prevent the spread of Argentine ants, which would be relatively unusual on island ecosystems.

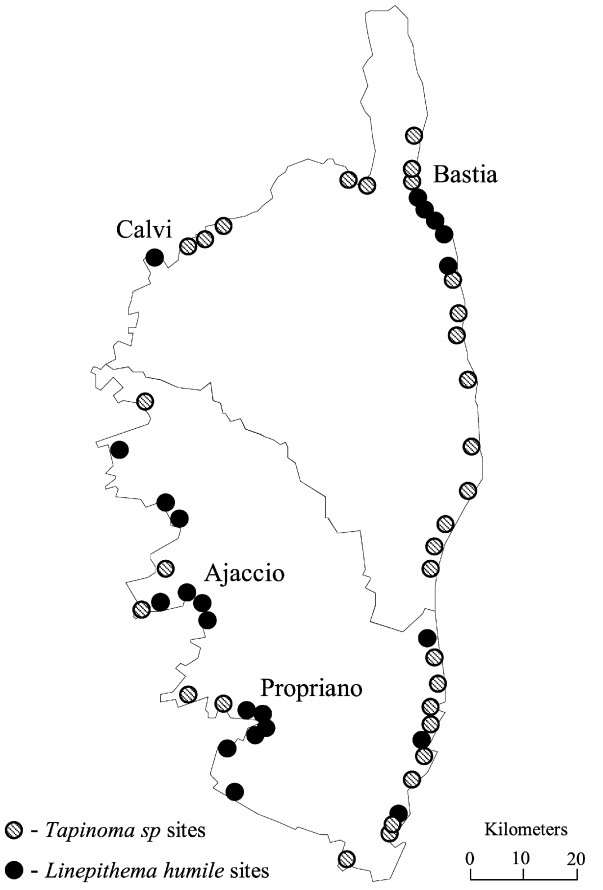

Fig. 2. Distributions of Argentine ant and *Tapinoma sp* along the Corsican coast.

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