

Invasion note

The ants of the Juan Fernández Islands: genesis of an invasive fauna

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Abstract

A first study of the ants on the three main islands of the Juan Fernández Archipelago (Chile) has revealed the presence of just three species, *Hypoconerops confinis*, *Linepithema humile*, and *Tetramorium bicarinatum*, all widely distributed invasive species. Most notable among them is the Argentine ant, *L. humile*, an ecologically destructive species that has established several populations and appears to be expanding.

Before human intervention, ants were relatively poor dispersers across oceanic islands. Native species are unknown east of Tonga on any archipelago until the Galápagos. The latter fauna is notably weak: one species of *Pheidole* and two species of *Camponotus* occur, and these are weakly divergent from their closest relatives on the South American mainland. *Pheidole williamsi*, a rare endemic found on several islands has recently been placed close to *P. crozieri* of Peru (Wilson 2003). Pacific archipelagoes between and including Hawaii abound with ants of many species, but they have evidently been introduced by human commerce from native ranges scattered throughout the Old and New Worlds (Wilson and Taylor 1967).

The Juan Fernández Islands (33°50' S, 78°50' W), located nearly as far from the South American mainland as the Galápagos (~700–800 km), have properties seemingly favorable for the development of a native ant fauna. Although containing less than one-tenth as much land area

as the Galápagos (~150 km²), they possess a cool Mediterranean climate and variable habitats including patches of cloud forest. They are also old for volcanic oceanic islands, with ages ranging from 1 million years (Isla Alejandro Selkirk, formerly Masafuera) to 4 million years (Isla Robinson Crusoe, formerly Masatierra) and 5.8 million years (Isla Santa Cruz), during which they have reached an advanced eroded state (Stuessy et al. 1984). There has been time to acquire a highly distinctive flora, with 132 of the 221 native vascular plant species endemic (Marticorena et al. 1998). One species, *Lactoris fernandeziana*, is the sole living representative of an entire family, the Lactoridaceae. Pollen evidence suggests that these plants existed in southern Africa as long ago as the late Cretaceous (Stuessy et al. 1998).

Native insects are few; they include only a small number of generalist pollinators, including a single halictid bee, a recently discovered new species of *Lasioglossum* that may well be an alien

(Anderson et al. 2001). Other animal groups prominent in the New World tropics are also sparse or absent. Notable exceptions are the two famous Firecrown hummingbirds, including the endemic Juan Fernández Firecrown *Sephanoides fernandensis*, the only native occupants of oceanic islands known among the world's 340 hummingbird species (Colwell 1988).

No concerted effort has heretofore been made to collect and study ants on Juan Fernández. Members of the Skottsberg expedition were reported by Wheeler (1924) to have obtained specimens of a *Paratrechina*, listed as '*Prenolepis (Nylanderia) obscura* subsp. *Vaga*' (now *Paratrechina vaga*) on Masatierra (Isla Robinson Crusoe). This, however, could easily be a labeling error, in which Juan Fernández and Easter Island labels were switched. For example, type specimens of *Paratrechina bourbonica* subsp. *skottsbergi* Wheeler (now *Paratrechina bourbonica*) in the Museum of Comparative Zoology, Harvard University, are labeled as coming from Juan Fernández, but Wheeler (1924) cites their origin as Easter Island. At the request of one of us (Wilson), two biologists who subsequently visited Juan Fernández searched for ants, with a yield (by Sylvia Earle) of only a single specimen, belonging to the ponerine species *Hypoponera confinis*. The ant was found on 16 December 1965 at Villagra Bay, Masatierra (Isla Robinson Crusoe), in dry soil around the roots of grasses growing on a rocky slope approximately 200 m from the edge of an extensive tidepool area (Wilson 1973).

It must be reckoned an extraordinary circumstance when ants are rare in any habitable part of the world, and especially one with a subtropical or warm temperate climate. Accordingly, two of the present authors (Ingram and Bernardello) visited Juan Fernández during a two-week period for the express purpose of surveying ant species on the archipelago. They visited the main islands, including the most distant and least accessible Masafuera, exploring representatives of the habitats and using a variety of collecting techniques.

Materials and methods

The collecting effort by Ingram and Bernardello was concentrated on Masatierra, with cross-

country transects, and collections on the other two principal islands, Masafuera and Santa Clara, were made during one-day excursions. Tiny offshore islands of Islote El Verdugo, Las Rosas, and Los Claveles were not visited. In each study location, standard collecting techniques were employed that included bait transects, under-rock surveys, and leaf-litter surveys. Bait transects were established in most locations by placing 10–20 index cards with Pecan Sandies® cookies at 15 m intervals and collecting ants 1 hour later. In sections of native forest, bait transects included cookies, peanut butter, and honey and were checked twice daily for 2 days. All samples collected were preserved in 95% alcohol. Specimens were deposited and identified by Stefan Cover at the Museum of Comparative Zoology of Harvard University.

The distribution of the Argentine ant *Linepithema humile* was estimated by using bait transects and under-rock surveys to determine the furthest extent of the ant colonies in each location. Each boundary of the range of this invasive species was determined as the collective points of furthest extent of *L. humile* colonies. The boundary points were marked by GPS and the extrapolation of these data points provides an estimate of the distribution area of this species on the Juan Fernández Islands.

Results

Three ant species were found on the Juan Fernández Archipelago: *Linepithema humile* (the Argentine ant), *Hypoponera confinis*, and *Tetramorium bicarinatum*. All of these species have been previously reported as occurring on other Pacific Islands (Wilson and Taylor 1967; Wilson 1973). The study locations, elevations, and species collected at each location are given in Table 1. Maps depicting the study locations, trails, and locations of each species are presented in Figure 1a and b.

Linepithema humile was found in abundance at nearly every site where ants were collected with the notable exceptions of Isla Santa Clara, where no Argentine ants were found, and Puerto Francés on Isla Robinson Crusoe, where only one nest was found. This species nested primarily

Table 1. Sampling localities and species found in the Juan Fernández Archipelago.

| Site # | Locale | Species present | Elevation | GPS |
|--------|------------------------|---|-----------|-------------------|
| 1 | Airport | <i>Linepithema humile</i> | 100 | S 33°40' W 78°55' |
| 2 | Villagra | None | 150 | S 33°38' W 78°51' |
| 3 | Vaquería | <i>Linepithema humile</i> | 0–200 + | S 33°36' W 78°52' |
| 4 | Puerto Inglés | <i>Linepithema humile</i> <i>Hypoconera confinis</i> | 0–200 + | S 33°37' W 78°50' |
| 5 | San Juan Bautista | <i>Linepithema humile</i> | 0–400 | S 33°37' W 78°52' |
| 6 | Pangal/Centinela | <i>Linepithema humile</i> | 0–200 | S 33°37' W 78°51' |
| 7 | Puerto Francés | <i>Linepithema humile</i> <i>Tetramorium bicarinatum</i> <i>Hypoconera confinis</i> | 0–100 | S 33°38' W 78°51' |
| 8 | Isla Santa Clara | <i>Tetramorium bicarinatum</i> | 0–100 | S 33°42' W 78°57' |
| 9 | Isla Alejandro Selkirk | <i>Linepithema humile</i> | 0–200 | S 33°45' W 78°51' |

under rocks in many different microhabitat types including rocky beaches, disturbed human inhabited regions, and introduced *Eucalyptus* forests. *Hypoconera confinis* was found in two locations on Isla Robinson Crusoe, Puerto Francés and Puerto Inglés. Nests of this species were both small and sparsely distributed at low elevations (0–50 m) under rocks near stream outlets. *Tetramorium bicarinatum* was collected on Isla Robinson Crusoe in Puerto Francés and on Isla Santa Clara. In these two locations, this species was found in relatively high abundance, occur-

ring in large nests under rocks along streambeds at low elevations only (0–100 m). No ants were found along the stretch of dry, eroded volcanic clay habitat from the airport to Villagra, or in the cooler, moist environments of native forest fragments near Selkirk lookout, Plazoleta El Yunque, and Pangal/Centinela.

The boundaries of the Argentine ant distribution are depicted by the shaded areas in Figure 1a and b. Nests of *L. humile* were found from the shoreline up to 400 m in elevation. The Argentine ants appear to be expanding on Isla

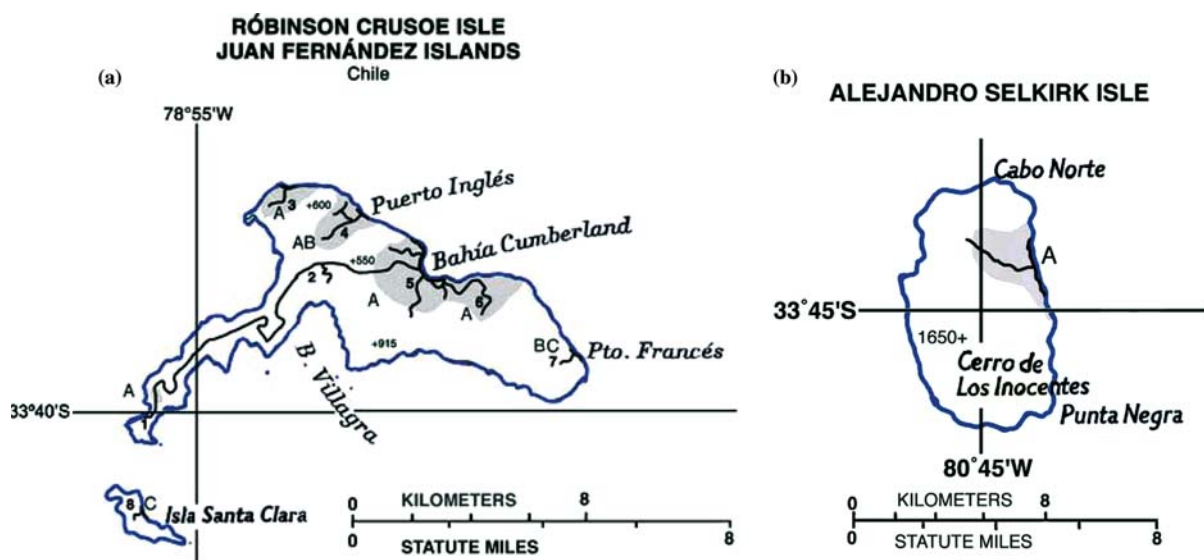


Figure 1. (a, b) Distribution of ant species on Juan Fernández Islands. Numbers represent sampling localities (see Table 1) and lines indicate trails followed during collecting efforts. Letters indicate the species found at each sampling location; species A is *Linepithema humile*, B is *Hypoconera confinis*, C is *Tetramorium bicarinatum*. The total area distribution of *L. humile*, the Argentine ants, is estimated by the shaded regions.

Robinson Crusoe in Vaquería, Puerto Inglés, and from the major human settlement of San Juan Bautista to Pangal/Centinela. The limited population size in Puerto Francés and at the Airport suggests that *L. humile* either were introduced recently to these locations or that there is some other barrier to their spread in these areas. On Isla Alejandro Selkirk, *L. humile* appears to be the only species present and was found spreading broadly from the only human settlement on the island, Quebrada Las Casas, inhabited approximately 30 people.

The time of the invasion of Juan Fernández by the Argentine ant cannot be fixed, but island residents reported that it has been present on the islands since at least as far back as 1990. Its current distribution suggests a history of landfalls followed by a slow spread inland.

Discussion

The paucity of ants in species and numbers on Juan Fernández remains a mystery. In contrast, seven species, all non-native, have been reported from Easter Island, which is even more isolated (Wilson 1973). Although Juan Fernández was never occupied or so far as known even visited by Polynesians, it has been a frequent port of call for European ships since its discovery in 1574 and a colonization site (at San Juan Bautista) since 1750 (Wester 2003).

All three recorded species of the ant fauna are subtropical and warm temperate species inadvertently spread by human commerce. *Tetramorium bicarinatum*, African in origin, is extremely adaptable. It occurs throughout Polynesia, even on the most remote islands such as Pitcairn, Henderson, Johnston, and Palmyra. It is dominant in some habitats of the New World. One of us (Wilson), for example, found dense populations nesting in banana stalks in a southern Costa Rican plantation. On the tiny wave-lapped Middle Key of Florida's Dry Tortugas, in soil at the base of the only bush growing there, he found the only ants present to be a colony of *T. bicarinatum*. *Linepithema humile*, originating in subtropical South America, is a major pest species in less humid environments around the world (Hölldobler and Wilson 1990).

Juan Fernández has thus developed an exceptionally small synthetic ant fauna of hypervagile or 'tramp' species. These ants have entered an ecosystem of native plant and animal species, also depauperate in number but specialized for life on the islands, in an environment that has lacked ants until the arrival of humans. Other invasive species are likely to follow now that commerce has increased between Chile and the islands. Studies of the environmental impact of these species on Juan Fernández will be of considerable interest with reference to comparisons with other biotas ant-free before the arrival of humans (including most of central Polynesia) versus those containing native ants.

Of special concern is the encroachment of the Argentine ant, *L. humile*, one of the most destructive of all invasive ant species worldwide. Its dense populations, in most places consisting of continuous supercolonies, are able to dominate and partially replace native insects. Unlike *Hypoponera confinis* and *Tetramorium bicarinatum*, it should be regarded as a potential threat to other native animals as well as the plants of this fragile archipelago. *L. humile* has recently been observed visiting some endemic plants around San Juan Bautista to collect nectar but not playing a role in their reproduction (Bernardello et al. 2002). However, they might be affecting the behavior of natural pollinators. Efforts to restrict the spread of this species would be well advised.

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