THE ANTS OF MARCHENA ISLAND, TWELVE YEARS AFTER THE INTRODUCTION OF THE LITTLE FIRE ANT *WASMANNIA AUROPUNCTATA*

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INTRODUCTION

Marchena is a small and isolated island to the north of the Archipelago. The island is largely covered by pyroclastic cones and fresh lava fields. The vegetated area is small (32.8 km^2), compared with the size of the island (130 km^2). The vegetation is formed by a dry forest dominated by *Bursera graveolens* (HBK) Trian. & Planch., *Croton scouleri* Hook.f., *Waltheria ovata* Cav., *Lantana peduncularis* Anderss., *Opuntia helleri* K. Scum., and *Castela galapageia* Hook.f. (Hamman 1981). Published information refers to only one species of ant being found on Marchena, *Camponotus macilentus bidloensis* (Wheeler 1919). Lubin (1984) reports three species from this island, but does not mention which species.

In 1988, the little fire ant, *Wasmannia auropunctata* (Roger), was first reported on Marchena by Baert (1988). In a short visit to this island, Baert found "some Wasmannia ants" in a campsite in Playa Negra (Fig.1). This is probably the most aggressive species of invertebrate that has been introduced in the Galápagos Islands. Where *W. auropunctata* is found, few native ants and other invertebrates exist (Lubin 1984). There is also evidence that they have an impact on the nesting activities of reptiles and nesting birds (Roque and Causton 1999).

Four years after the visit of Baert's team, Sandra Abedrabbo, a Charles Darwin Research Station (CDRS) entomologist, detected the occurrence of *W. auropunctata* in two fishing camps, in Playa Negra, Marchena, but she did not determine the area infested.

In 1993, the Galápagos National Park Service (GNPS) and CDRS began an ant control project in the island, adopting the methodology used in a control project for the same ant species in Santa Fé Island (Abedrabbo 1994). In 1993, the area of infestation of little fire ant was investigated. Bait stations were set up using transects with a grid design to estimate the area of infestation and AMDRO applied to control the ants. The area was determined as 5.2 ha. The GNPS carried out a second control trip in 1994 and the ant infestation was apparently reduced to 3.5 ha (Zuniga 1994). Unfortunately, the control program stopped for two years and only in 1996 was it possible to continue it. A GNPS team in 1996 apparently detected a reduction of the area of infestation to between 1 and 1.5 ha (Garcia 1996).

In August 1998 (during the El Niño event) and May 2000, we visited the island to determine the status of the *W. auropunctata* population and to initiate activities to eradicate this species. This paper provides information about its distribution. We also discuss a plan to control this species in Playa Negra, Marchena, and report new island records for the ant fauna of the Galápagos Islands.

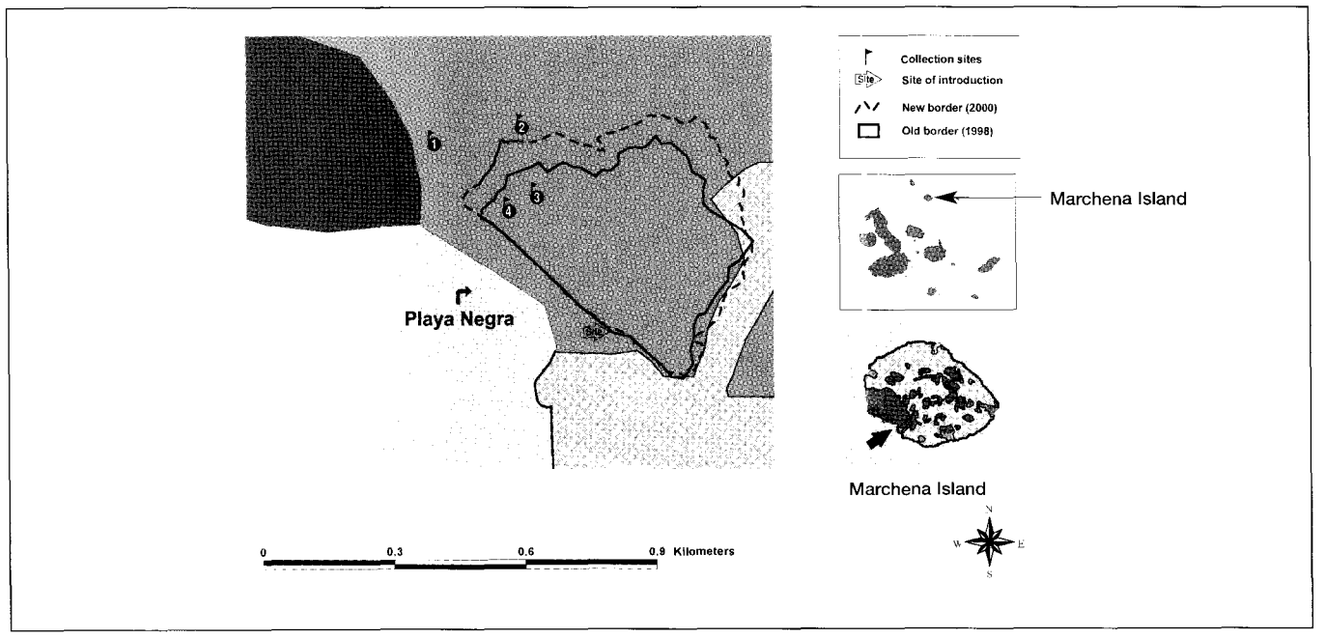

Figure 1 Playa Negra, Marchena Island

Ant Species	Status	1919	1988	1993	1994	1996	1998	2000
Camponotus macilentus bidloensis	E	X	X				X	X
Camponotus planus	E						X	X
Paratrechina fulva	N		X				X	X
Tapinoma melanocephalum	I			X			X	X
Dorymyrmex piramicus albemarlensis	E			X		X		
Hypoponera beebe	E						X	X
Cardiocondyla emery	I						X	X
Cardiocondyla nuda	I						X	X
Monomorium floricola	I			X			X	
Solenopsis globularia pacifica	I			X				
Tetramorium simillimum	I			X				
Wasmannia auropunctata	I		X	X	X	X	X	X

Table 1. Ant species found on Marchena during seven expeditions. Status in the Archipelago: E = endemic; I = introduced; N = native.

Ant Species	Number collected			
	Uninfested	Infested		
	T1	T2	T3	T4
Camponotus planus	1	0	0	0
Paratrechina fulva	3	16	0	1
Tapinoma melanocephalum	8	4	0	0
Hypoponera sp	0	1	0	0
Cardiocondyla nuda	3	6	0	0
Cardiocondyla emery	92	46	8	6
Wasmannia auropunctata	0	0	2124	1390

Table 2. Ant abundance from pitfall traps placed in uninfested and infested areas.

METHODS

Fieldwork was carried out in August 1988 and May 2000 by CDRS and GNPS personnel at the south side of Marchena (Playa Negra) (Fig. 1). Bait stations were used in order to determine the area infested by *W. auropunctata*. Hot dogs (frankfurters) marked with red flags were placed every 5 m along a 50 m transect from the last infestation point recorded on the previous visit. The baits were checked after 30 minutes and additional baits placed if little fire ants were recorded from the last bait station along the transect. A Geographical Position System (Garmin 12 CX) was used to calculate the infested area with a GIS Arcview program.

The ant fauna was collected using a variety of methods. We collected ants with bait traps (honey, tuna fish, and frankfurters). These traps were checked after one hour because aggressive species monopolized the baits. Pitfall trapping, leaf litter sifting, and hand collecting methods were also used. Samples of the ants collected were preserved in 70% ethanol and transported to the CDRS for identification. This material was deposited in the CDRS entomological collection.

In May 2000, pitfall traps were used to obtain quantitative information about the ant community. Four transects were established, two in the *W. auropunctata* infested area and two outside this area (Fig. 1). Ten traps per transect were placed along a line of 10 m. They consisted of 500-ml plastic cups containing detergent, formalin, salt, and water (two-thirds of the volume) as a preservative. Traps were placed in the ground for two days. Ant identification followed that of Bolton (1994, 1995), Wheeler (1919), and Wilson and Taylor (1967). Two indices were chosen to measure species diversity, namely the Margalef index (M.I.), which highlights richness in term of the number of species, and the Shannon and Weaver index (H'), which emphasizes species dominance.

RESULTS AND DISCUSSION

Ant diversity

Among the species we collected in 1998 and 2000 were five new records for Marchena: *Camponotus planus* Smith, *Cardiocondyla emery* Forel, *Cardiocondyla nuda* (Mayr), *Paratrechina fulva* (Mayr), and *Hypoponera beebe*

(Wheeler). These are in addition to five species recorded for the first time on Marchena in 1988 and 1993 by L. Baert and S. Abedrabbo (unpublished and reported for the first time in this paper): *Tapinoma melanocephalum* (Fabricius), *Monomorium floricola* (Jerdon), *Dorymyrmex piramicus albemarlensis* (Wheeler), *Tetramorium simillimun* (Smith), and *Solenopsis globularia pacifica* Wheeler.

We found that many more species of ants exist on the island than has previously been published. A total of 12 species have been recorded from Marchena (Table 1) out of the 55 ant taxa recorded from the Galápagos Islands (Wheeler 1919, 1924, 1933, Clark *et al.* 1982, Lubin 1984, Pezatti *et al.* 1998). The ant fauna of the island is characterized by a high number of tramp species. Among the 12 species encountered on Marchena, five are introduced. Only four, *C. m. bidloensis, C. planus, D. p. albemarlensis,* and *H. beebe* are endemic to the Galápagos. The remaining native species could have been introduced to Marchena in recent years from the inhabited islands or may have been missed previously.

When comparing the collections made in early surveys with our recent collections, we noted a marked increase of the species richness in the island. Two factors could be responsible for this increase: a) the early surveys were incomplete or lacked locality data, or b) ants have continued to migrate to the islands by natural means or have been introduced by humans. Although it is difficult to answer this basic question, anecdotal evidence can be discussed.

We suspect that some species were simply overlooked by early collectors who visited the island *(e.g., C. planus and H. beebe).* Unfortunately, we do not have published records that mention how much time or effort was invested in the early ant collections. Some records also appear to be incorrect. For example, Wheeler (1919) described *C. m. bidloensis* from material collected by the "*Albatross* Expedition of 1899"; however, Slevin (1931) and Linsley and Usinger (1966) do not report the visit of the steamer *Albatross* to Marchena in its two Galápagos expeditions (1888 and 1891). The material studied by Wheeler was probably collected during the Hopkins-Stanford Expedition in 1888 and 1889. However, it does appear that their effort was restricted to a few hours, since Marchena is not considered a special place for collecting wildlife specimens. If this is true, species which are localized would have escaped early collectors. For example, during our collection, pitfall traps captured most of the species present at a site, but hand-collecting and leaf-sifting techniques using a Berlesse funnel collected more rare or localized species *(e.g. H. beebe).*

Peck *et al.* (1998) documented the known introduced insects in the Galápagos Islands, including ants. He found a strong correlation between the species numbers of introduced insects and the number of human inhabitants per island.

Marchena was never inhabited, and has only been visited by fishermen, scientists, Park guards, and some tourists, with most visits being concentrated in Playa Negra. Tramp ants have a high capacity for reaching isolated habitats because of their small size and the strong relation with transport by humans. This permits them to travel long distances and establish themselves in remote islands. We propose that *T. melanocephalum, T. simillinum, S. globularia, M. floricola, P. fulva,* and *W. auropunctata* probably arrived in Marchena in camping provisions and equipment.

Species diversity in the presence and absence of *W. auropunctata*

In May 2000, pitfall trapping was the only method used to determine the species density of ants, because our aim was to identify ground species that can be influenced by *W. auropunctata.* There was a striking contrast between ant communities in habitats where *W. auropunctata* was present and absent (Table 2, Fig. 1). *Wasmannia auropunctata* was collected in all traps in the infested area. Meanwhile, a low number of other ant species, *P. fulva* (1) and *C. emery* (14), were collected in the infested area. This co-occurrence was also reported by Clark *et al.* (1982) in certain areas of Santa Cruz Island where *W. auropunctata* was dominant during the wet season. In contrast, six species were collected from the uninfected area, including the two species found in the habitats occupied by *W. auropunctata.* These species were *C. planus, T. melanocephalum, H. beebe, and C. nuda.* Although *C. emery* was dominant in the uninfected habitat, it was not numerically as dominant as *W. auropunctata.*

The exposure time of pitfall traps (two days) apparently affected the collections. In some traps only a few ants were collected, with some species represented by a single specimen. However, on this trip it was not possible to leave the traps out for longer. In the future, pitfall traps will be placed in the field for one week.

The results of the tests using the Margalef Diversity Index and the Shannon Weaver Index confirm that there was a greater species richness and equitability in areas where *W. auropunctata* was absent. The values from the Margalef Diversity Index were 0.60 and 0.95 in the little fire ant-occupied area, while in the uninfected area they were 1.97 and 2.15. A similar pattern was observed with the Shannon Weaver Index (0.01 in the infested area and 0.25 and 0.45 in the uninfected area). The total number of ants increased by about twenty times in the infested area due to the high density of *W. auropunctata* individuals. On the other hand, representatives of other ant species dropped by 90% and species richness declined by 50%, from 6 to 3 (Table 2). Similar impacts were reported by Porter and Savignaro (1990) for *Solenopsis invicta* Buren in Texas.

Distribution of *W. auropunctata* on Marchena

During the El Niño event of 1998, 17 ha of the vegetation

surrounding Playa Negra was occupied by dense mats of *W. auropunctata*. Two years later the infested area had increased by 41% to 24 ha. The area of distribution shows a marked increase from estimates made on trips prior to 1998. Although high precipitation rates during El Niño may account for a rise in ant numbers (high rainfall leads to vegetation growth and increased prey numbers), it is unlikely that it is responsible for such dramatic population growth (1.5 to 17 ha in one year). This may be due to the techniques that were used on earlier trips. What is evident, however, is that the distribution of *W. auropunctata* in Marchena is expanding. This ant typically infests vegetated areas. In Marchena, vegetation covers 25% of the total area of the island. If this ant continues to spread at this rate, it could have a high impact on the native invertebrate species, especially those that are localized in distribution.

Can we control *W. auropunctata*?

Two factors should contribute towards the success of this project: (a) the area occupied by *W. auropunctata* is still relatively small and manageable, and (b) new colonies are formed by colony budding, thus generally restricting the dispersal capacity of this species to areas immediately adjacent to existing colonies. During the monitoring trip in May 2000, a project design to eradicate *W. auropunctata* from Marchena Island was elaborated. Over the next four years, AMDRO®, the ant bait identified as most effective for *W. auropunctata* in the Galápagos Islands (Williams and Whelan 1994), will be hand-spread over the infested area. Bait applications will be carried out according to the results of a monitoring program that will run parallel to the eradication efforts. This program will be initiated in September 2000. It is expected that the project will run for four years.

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