Bulletin de la Société royale belge d'Entomologie/Bulletin van de Koninklijke Belgische Vereniging voor Entomologie, 150 (2014) : 250-255

Results of ant collections on Santa Cruz Island within the framework of the 2012 Global Taxonomy Initiative Ant Course at Galápagos (Hymenoptera: Formicidae)

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Abstract

During a ten-days ant course carried out in November 2012 within the framework of a Belgian Focal Point to the Global Taxonomy Initiative GTI type 2 grant, eight students and four instructors collected 22 ant species at ten sites distributed along an altitudinal gradient on Santa Cruz Island in the Galápagos Archipelago (Ecuador). Disturbed and urbanized zones as well as natural areas were visited. We discuss the results and link the collected species to altitude and vegetation types occurring on Santa Cruz Island.

Keywords: Formicidae, Galápagos Archipelago, habitat preferences, species lists, invasive species

Introduction

In September 2011, 18 Ecuadorian biologists participated in a training on ant taxonomy and biology at Loja, southern Ecuador (Belgian Focal Point to the Global Taxonomy Initiative GTI grant type 2, DELSINNE & DEKONINCK 2011)[1]. This first GTI Ant Course was considered a success since immediately after the course several students started conducting ant biodiversity studies and projects in different parts of Ecuador. Scientific collaborators of the Royal Belgian Institute of Natural Sciences (RBINS) collaborated as scientific experts to two of these Ecuadorian projects. A recurrent issue encountered by these students, even after that first training, was the difficulty to know what to do with suspected new species. To help them to tackle this problem, an in-depth training on ant taxonomy took place during a second GTI Ant Course in November-December 2012 in Ecuador, with a focus on taxa description (DEKONINCK & DELSINNE, 2012)[2]. As the myrmecofauna of Ecuadorian mainland is too diverse and poorly known to be accessible by taxonomist beginners, the second GTI Ant Course

[1] Additional information and report at: http://www.sciencesnaturelles.be/active/sciencenews/archive2011/antsecuador/index_html and at http://www.taxonomy.be/gti_calls/grants_awarded/2004-grants-obtained-rbins-promoters/delsinne-dekoninck-training-ant-taxonomy-and-ecology-loja-southern-ecuador

[2] Additional information and report at: http://www.taxonomy.be/gti_calls/grants_awarded/2004-grants-obtained-rbins-promoters/delsinne-t.-dekoninck-w.-rbins-2012

focused on a less complex, better studied fauna. The ant assemblage of the Galápagos Archipelago appeared as an ideal playground because it is less diversified and has been intensively studied over the last 10 years by RBINS members in collaboration with the Galápagos ant curator H.W. Herrera[3]. However the taxonomical status of some endemic and introduced species remains poorly understood. Therefore during this second GTI Ant Course, a group of three Ecuadorian students (G. Brito, L. Jumbo and D. Marin) previously trained by the 2011 Ant course were invited to the Charles Darwin Research Station (CDRS) on Santa Cruz Island. They were provided with the skills i) to disentangle the taxonomical status of several assumed endemic ant species, ii) to understand the importance of type-material for scientific research, and iii) to (re)describe ant species and genera. To attain these objectives, participants were supervised by four experts in ant taxonomy during ten days (F. Fernández, H.W. Herrera, T. Delsinne and W. Dekoninck). The course combined classroom lectures, laboratory and fieldwork. It was also open to interested Galápagos National Park rangers and CDRS students. Four days were dedicated to ant sampling.

The ant fauna of the Galápagos archipelago - one of the most preserved archipelagos on Earth- is composed of relatively few species (51 species according to the most recent papers HERRERA *et al*., 2013; 2014), most of which have been introduced. Recently WAUTERS *et al*. (submitted) evaluated the effects of environmental and spatial factors on the distribution of endemic, native and introduced ants on Santa Cruz Island. They collected 28 different ant species in 21 sites and found that the habitat type, altitude and grass cover influenced the composition of ant assemblages and that native ant communities were more structured spatially and environmentally than introduced ant communities.

In this paper we present the results of the fieldwork experience of the GTI Ant Course team on Santa Cruz Island in 2012, with special attention to ant communities (introduced versus native and endemic species) encountered in the different sampled vegetation types. Results are compared with those obtained by WAUTERS *et al*., submitted.

Material and methods

During a 10-day course (19.XI.2012 – 28.XI.2012) on ant taxonomy and ecology in the Galápagos Archipelago, ants were collected in the field by four instructors and eight students (including three Ecuadorian students who had attended the previous ant course in Ecuador (DELSINNE & DEKONINCK, 2011), two Galápagos National Park (GNP) rangers and three students in Entomology at the Charles Darwin Research Station). Ten sites (Table 1) were grouped into four categories of habitats based on humidity and disturbance (VON AESCH & CHERIX, 2005; WAUTERS *et al*., submitted): natural humid areas (NH) (*Miconia* (Fig.1), *Scalesia* (Fig. 2), pampa zones and marshes near lagoons), natural dry areas (ND) (littoral, arid and transition zones (Fig. 3)), disturbed dry areas (DD) (Fig. 4) (urban zones on the coast) and disturbed humid areas (DH) (agricultural zones: plantations, pastures, forest edges).

Fig. 1. Miconia forest at Media Luna (Photo T. Delsinne).

Two to four hours were spent at all sites to collect ants by visual searching and hand sampling (Fig. 5). A sifter was also used to collect the finest part of the leaf litter. The latter was spread immediately afterwards on a white sheet to search for ants directly in the field. All specimens were stored in 90% alcohol and brought to the laboratory for sorting and identification. Specimens were deposited either at the Formicidae collection of the Terrestrial Invertebrates Reference Collection of the Charles Darwin Research Station (ICCDRS) or at the Entomology collection of RBINS.

Ants were identified using Bolton's key to ant genera (BOLTON, 1994), comparisons with identified material deposited at the Invertebrates Collection of the Charles Darwin Research Station (ICCDRS) and the Galápagos virtual ant collection available on the AntWeb website (http://www.antweb.org/page.do?name=galapagos). The status of the ant species (endemic, i.e. only

[3] See: http://www.darwinfoundation.org/datazone/checklists/terrestrial-invertebrates/formicidae/

found on the archipelago or introduced species) was determined by compiling literature and databases (CLARK *et al*., 1982; HERRERA, 2014; HERRERA & CAUSTON, 2010; HERRERA *et al*., 2013; 2014; LATTKE, 2011; LUBIN, 1984).
For some taxa, identification at the species level using only morphological characteristics was impossible so far (*Nylanderia* sp. and *Pheidole* sp.). These genera await taxonomical revisions of combined morphological and genetic data.


Fig. 2. Scalesia forest at Los Gemelos (Photo T. Delsinne)

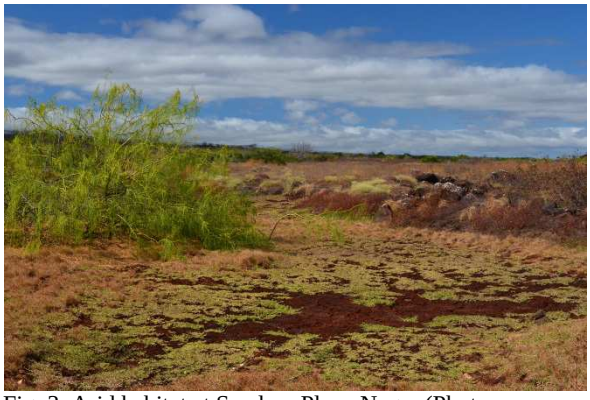
Fig. 3. Arid habitat at Sendero Playa Negra (Photo T. Delsinne)


Fig. 4. Transition zone: Mina de Granillo Rojo (Photo T. Delsinne)


Fig. 5. Collecting ants by visual searching and hand sampling at El Chato (Photo T. Delsinne)

Table 1 Overview of the sampled sites with information on vegetation type, elevation and disturbance level; with ND=natural dry habitat, NH=natural humid habitat, DD=disturbed dry habitat and DD=disturbed humid.

Number Site	Locality, toponym	Vegetation type/zone	Disturbed	Elevation (m)	Sampling date
Site 1 (ND)	Sendero Playa Negra, North Santa Cruz	Arid zone	No	30	22/11/2012
Site 2 (DD)	Mina de Granillo Negro	Transition zone	Partly	150	22/11/2012
Site 3 (DD)	Mina de Granillo Rojo	Transition zone	Yes	650	22/11/2012
Site 4 (NH)	Los Gemelos	*Scalesia* forest	No	570	22/11/2012
Site 5 (DH)	El Chato	Secondary forest	Partly	400	24/11/2012
Site 6 (DH)	Bellavista,	Abandoned plantation	Yes	210	24/11/2012
Site 7 (NH)	Media Luna	*Miconia* forest	No	612	24/11/2012
Site 8 (DH)	Santa Rosa, farm	Agricultural zone	Yes	200	25/11/2012
Site 9 (DD)	Puerto Ayora, El Barranco	Arid zone	Yes	20	26/11/2007
Site 10 (DD)	Puerto Ayora, Charles Darwin Research Station	Coast/urban area/gardens	Yes	12	26/11/2007

Results

General results on biodiversity

In total 22 species were collected (Table 2). *Camponotus planus* (Fig. 6) was the only certain endemic species collected out of seven known endemics to the islands (HERRERA, 2014; HERRERA *et al*., 2014). We collected three species of which their status is unknown or incertain so far: *Solenopsis gnoma* (only at Mina de Granillo Rojo), *Pheidole* sp. (Media Luna and Mina de Granillo Rojo) and *Nylanderia* sp. (found at Los Gemelos and Media Luna). All other species have been introduced into Galápagos.
Solenopsis geminata was collected at 8 sites, *Brachymyrmex heeri* at 7 sites (Table 2). The highest ant species richness was found at Los Gemelos (16 species) and at Mina de Granillo Rojo (15 species).

Fig. 6. Workers of the endemic species *Camponotus planus* (Photo HW Herrera)

Table 2: Ant species collected at 10 sites (occurrence data) located along an elevational gradient in Santa Cruz Island; status of the species I=introduced, E=endemic, SU=status unresolved, NQE=native questionable endemic.

Species (status)	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**	**Site 10**	**Total**
Brachymyrmex heeri (I)			1	1	1		1	1	1	1	7
Camponotus planus (E)	1			1						1	3
Camponotus conspicuus zonatus (I)	1	1	1	1					1	1	6
Cardiocondyla emeryi (I)	1	1	1	1	1						5
Cyphomyrmex rimosus (I)			1	1	1	1	1	1			6
Hypoponera opaciceps (I)			1	1	1	1	1	1			6
Hypoponera opacior (I)				1		1	1				3
Monomorium floricola (I)		1								1	2
Monomorium cf pharaonis (I)		1	1	1						1	4
Nylanderia sp. (SU)				1			1	1			3
Nylanderia steinheili (I)			1	1	1	1					4
Odontomachus bauri (NQE)			1	1	1		1	1		1	6
Paratrechina longicornis (I)	1		1						1	1	4
Pheidole sp. (SU)			1				1				2
Rogeria curvipubens (I)						1					1
Solenopsis geminata (I)	1	1	1	1	1	1		1		1	8
Solenopsis gnoma (NQE)			1								1
Strumigenys louisianae (I)			1	1	1	1	1	1			6
Tapinoma melanocephalum (I)			1							1	2
Tetramorium bicarinatum (I)			1	1			1	1			4
Tetramorium caldarium (I)						1					1
Wasmannia auropunctata (I)			1	1	1	1		1		1	6
Total (n= 22)	**5**	**5**	**16**	**15**	**9**	**9**	**9**	**9**	**3**	**10**	

Altitude and ant biodiversity

We found a significant correlation between the ant species richness and site elevation (Spearman Rank correlation, $p<0.05$, $r=0.909$) when excluding site 10; town of Puerto Ayora and CDRS *ie* the urban settlement site with a lot of introduced species as *Tapinoma melanocephalum* (Fig. 7) and *Camponotus conspicuus zonatus* (Fig. 8). The higher the altitude the higher ant diversity, with the highest species richness (n=16 species) at 650 m above sea-level at Mina de Granillo Rojo (Fig. 9).

Fig. 7. Workers of *Tapinoma melanocephalum* (Photo HW Herrera)

Fig. 8. Workers of *Camponotus conspicuus zonatus* (Photo HW Herrera)

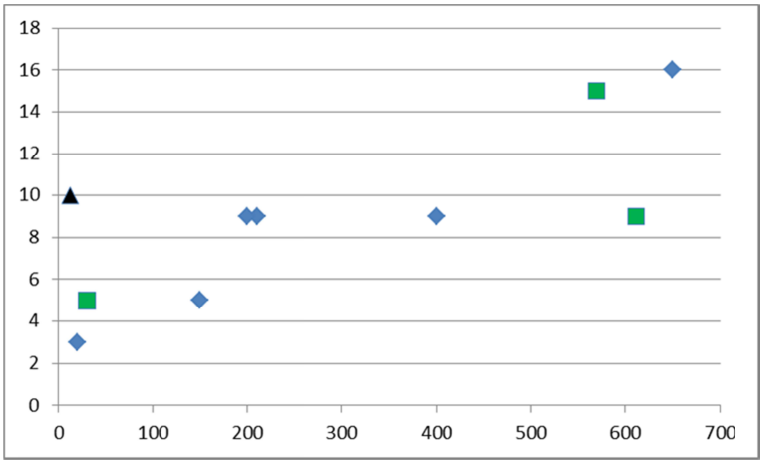

Fig. 9. Positive correlation between the number of ant species and the elevation of the sampled sites (blue ♦ symbol = disturbed sites, green ■ symbol = natural undisturbed sites, black ▲symbol = urban settlement).

Some special ant species

Nylanderia steinheili was only recently added to the Galápagos ant fauna (HERRERA *et al*., 2014) and here we added another three sites from Santa Cruz where the species was recorded, which might confirm its status of expanding. *Hypoponera opacior* was also recently discovered in Galápagos. We added two localities to the records mentioned by HERRERA *et al.* (2014).
We were not able to identify two genera (*Pheidole* and *Nylanderia*) to the species level. Taxonomical status, distribution and ecology of these taxa on Galápagos are still unclear and await revision as it is the case for the whole Neotropic.

Discussion

In one of the main inhabited islands of the Galápagos archipelago we were able to find 22 ant species in different vegetation types. In a recent study published by WAUTERS *et al*. (submitted) more species (n=28 species) were collected from the same island. Here we did not collect *Leptogenys* hh03, *Cardiocondyla minutior*, *Pheidole megacephala*, *Hypoponera beebei* and *Strumigenys emmae*.
Recent studies showed that higher species richness was found in disturbed and urbanized sites, mainly because of higher numbers of invasive and introduced species (WAUTERS *et al*., submitted). However some less disturbed sampled sites such as *Miconia* and *Scalesia* forests also had high species richness, mainly dominated by native species but also by introduced ones. The dry and thermophilic sites at lower elevation were poor in ant species except for the Puerto Ayora and CDRS station because, there again, the amount of introduced species increased the ant diversity.
Among the species recorded during this survey two were only recently added to the ant fauna of Galápagos: *Hypoponera opacior* and *Nylanderia steinheili*. HERRERA *et al*. (2014) suggested that the latter species could be already widely distributed, being now present on 6 islands, in all vegetation

zones and in natural, agricultural and urbanized areas as well. This fact warrants monitoring. Here we added a few new records confirming their recent spreading.
In general there was a positive trend between the total number of ant species, the number of invasive and introduced species and the degree of disturbance and urbanization of the visited sites. During the last 10-15 years, the number of newly introduced species in Galápagos was increasing very fast. For instance 10 introduced species were recently detected (HERRERA *et al*., 2013; 2014) and among them are highly problematic invasive species (*Pheidole megacephala*, *Tapinoma melanocephalum* (Fig. 7) and *Camponotus conspicuus zonatus* (Fig.8)) that are rapidely enlarging their distribution range and causing both economic and ecological problems.
Some genera and their species present at Galápagos await revision. *Hypoponera* (probably three species), *Pheidole* (two species and two morphospecies), *Nylanderia* (one species and two morphospecies), *Solenopsis* (three species and two morphospecies) and *Cyphomyrmex* (two species and one morphospecies) await both morphological and molecular studies, as well as comparison with similar morphospecies and sister species from the mainland Ecuador.

Acknowledgements

We want to thank the Galápagos National Park Directorate (GNPD) for providing export authorizations. This research was supported by Leopold III funding, Swiss Friends of Galápagos (Freunde der Galápagos Inseln), Department Entomology of RBINS and the Belgian Focal Point of the Global Taxonomy Initiative. Thibaut Delsinne also thanks the Secretary of Higher Education, Science, Technology and Innovation (SENESCYT) of the Government of Ecuador for financial support (Prometeo Grant) during the redaction of this article. This publication is contribution number 2015 of the Charles Darwin Foundation for the Galápagos Islands.

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