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ENTOMOFAUNA ASSOCIATED WITH *HELICONIA* SPP. (ZINGIBERALES: HELICONIACEAE) GROWN IN THE CENTRAL AREA OF COLOMBIA

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Abstract

We conducted a survey of insects and pest management practices on 40 farms growing *Heliconia* spp. and other Zingiberales in the central coffee region of Colombia in 2006 and 2007. Most farmers (87%) were concerned about insect pests in the plantation and 90% used broad-spectrum insecticides (chlorpyrifos, carbofuran, acephate and malathion) at least monthly. Fewer (approximately one third) used biological or cultural control practices. In total insects from 13 orders and 99 families were collected from *Heliconia* farms. The most abundant orders were Diptera (23 families), Hemiptera (22 families), Hymenoptera (14 families), Coleoptera (13 families), and Lepidoptera (7 families). The most common phytophagous species were hispine beetles (Chrysomelidae), scales (Coccidae*: Ceroplastes* sp., *Saissetia* sp.), leafhoppers (Cicadellidae), stinkbugs (Pentatomidae), squash bugs (Coreidae) and leaf cutting ants (*Atta* and *Acromyrmex* spp.). Other insects such as *Metamasius* and *Pandeleteius* weevils were found on the rhizome or pseudostem. Beneficial insects collected included several predatory families (Coccinelidae, Chrysopidae and Reduviidae) but only low numbers of parasitoids (Ichneumonidae, Braconidae, Chalcididae and Stephanidae). A range of insects occurred in empty and water-filled bracts of inflorescences notably flower feeding or detritivorous Diptera (Chironomidae, Drosophilidae, Richardiidae, Syrphidae, Tephritidae and Ulidiidae). Our survey suggests many new insect host associations for *Heliconia*. The use of broad-spectrum insecticides may not be the best long term strategy for insect pest management in *Heliconia* due to adverse risks to human and environmental health.

Key Words: Tropical foliage, insect communities, insecticides, questionnaire, integrated pest management

Resumen

Una encuesta sobre las prácticas de manejo de insectos plagas fue conducida en 40 fincas productoras de Heliconias y otras Zingiberales en la región central cafetera de Colombia durante 2006 y 2007. La mayoría de los productores (87%) estaban preocupados por los insectos plagas en las plantaciones y el 90% usaban gran espectro de insecticidas (Clorpiriphos, carbofuran, acephato, y malatión) al menos una ves al mes. Pocos, (aproximadamente una tercera parte) utilizaba controles biológicos o realizaba practicas de control cultural. En total, insectos de 13 órdenes y 99 familias fueron colectados de fincas productoras de Heliconias. Los ordenes mas abundantes fueron Hemíptero (23 familias), Coleóptero (13 familias), Díptera (24 familias), Himenóptera (15 familias) y Lepidóptero (7 familias). Las especies mas comunes de fitófagos fueron cucarrones (Chrysomelidae), scamas (Coccidae: *Ceroplastes* sp., *Saissetia* sp.), saltadores de hojas (Cicadellidae), chinches apestosos (Pentatomidae), chinches (Coreides) y hormigas cortadores de hojas (*Atta* y *Acromyrmex* spp.). Otros insectos picudos como *Methamasius* y *Pandeleteius* fueron encontrados en rizomas o en seudo tallos. Los Insectos benéficos colectados incluyen varias familias de predadores (Coccinelidae, Chrysopidae y Reduviidae) pero un bajo número de parasitoides (Ichneumonidae, Braconidae, Chalcididae y Stephanidae). Un rango de insectos también fue presentado en las braceas vacidas o llenas de agua de las inflorescencias, especialmente alimentadores de flores o larvas detritivoras de Díptera (Chironomidae, Drosophilidae, Richardiidae, Syrphydae, Tephritidae y Ulidiidae). Nuestro muestreo documenta muchos nuevos insectos hospederos asociados con *Heliconia.* El uso de un amplio espectro de insecticidas puede no ser la mejor estrategia a largo plazo para el manejo de insectos plagas en *Heliconia* debido a sus riesgos adversos en humanos y en la salud ambiental.

Palabras Claves: flores tropicales, comunidades de insectos, encuesta, manejo integrado de plagas, insecticidas

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Native to the tropical Americas and Pacific Islands, *Heliconia* spp. (Zingiberales: Heliconiaceae), are herbaceous plants known for their large banana-like leaves and colored flowery bracts produced on long, erect or drooping panicles (Berry & Kress 1991). Due to their beauty, *Heliconia* species are grown in tropical regions for cut flowers or potted plants and use in landscapes in USDA hardiness zones 10b through 11 (Gilman & Meerow 2011). In addition to use as ornamental plants, *Heliconia* species play an important role in eco-evolution with insects, animals and other plants. For example, they are pioneers in the regeneration of tropical rainforest ecosystems (Santos & Malvido 2012) and are important food sources for forest birds (especially hummingbirds which serve as pollinators) and some bats (Kress 1985; Martén-Rodríguez et al. 2011).

Colombia is the second largest producer and exporter of cut flowers after Holland with 14% of the global production produced on over 7,200 ha (ASOCOLFLORES 2008). Colombia also has the highest natural diversity of *Heliconia*; of the more than 250 species, 45% are native to Colombia (Maza 2004). In recent years *Heliconia* and related tropical plants have become widely cultivated for the international market (Diaz et al. 2002). Like many other tropical foliage plants, *Heliconia* are subject to attack from various insect in their native and introduced range. Santos & Malvido (2012) described three major groups of herbivores, hispine beetles (Coleoptera: Chrysomelidae), caterpillars (Lepidoptera: Nymphalidae), and leaf-cutting ants (Hymenoptera: Formicidae: *Atta*) attacking *Heliconia* leaves in southern Mexico. In addition, some *Heliconia* species naturally accumulate water or plant exudates in their bracts, which form a micro habitats or 'phytotelmata' that serve as breeding habitats for aquatic or semi-aquatic invertebrates, especially Diptera (Seifert 1982).

To date, few studies have documented insect pests affecting commercial *Heliconia* production in Colombia. Here, we report an investigation of phytophagous, detritivorous and beneficial insects associated with *Heliconia* plantations in the central coffee region of Colombia. This region has seen an increase in the production of tropical foliage plants (especially *Heliconia*) in recent years due to reduced coffee prices and growth in demand for tropical foliage. In addition, we surveyed growers to determine the most important pests and quantify the pest management practices adopted by farmers in the plantations.

Material and Methods

Study Location

Surveys were conducted on 40 small farms (each approximately 1 ha) producing tropical foliage (primarily *Heliconia*) in 'Eje Cafetero' or 'Central Coffee' Region, located in central western part of Colombia encompassing Caldas, Quindío, and Risaralda Departments. The farms were distributed in 12 municipalities located between 930 and 1800 meters asl with average temperatures ranging from 18 to 25 °C, 70 to 85% RH, and annual precipitation between 180 and 220 cm. The region has 2 rainy seasons (Mar to May and Sep to Nov).

The 'Eje Cafetero' region specializes in tropical flowers and represents about 5% of the cultivated area of the Colombian floriculture industry destined for export (ASOCOLFLORES 2008).

Questionnaire

A questionnaire comprising 43 items was given to owners or managers of the farms. Information was obtained regarding production practices, including crops currently grown. Respondents were also asked about their experiences with insect pests, use of insecticides, biological control agents and other pest management practices. Cases where answers were not obtained were excluded from the results.

Insect Survey

Concurrently to the farmer questionnaire, *Heliconia* plantations were sampled for both phytophagous and beneficial insects. Insects were also collected from inflorescences (bracts) of older plants during periods when upright bracts were filled with water. Two surveys were conducted on each farm between Aug 2006 and Aug 2007. Due to the large number of sites sampled, it was not feasible to count all insects encountered (absolute abundance). Rather the purpose was to identify the regional diversity of insects, i.e., frequency that particular species were present at different farms (relative abundance). A standard sampling methodology was used. Plants were selected along a zigzag transect (50 m in each direction) that traversed at least 30% of the plantation area; a min of 5 plants were sampled per farm. Representative specimens from all different species found during a 5 minute inspection per plant were collected and placed in vials containing 70% alcohol. Specimens were identified to family, genus and, where possible, species level using taxonomic keys and illustrated guides of Andrade et al. (1996), Forero (2004), González et al. (2005), Morales (1988), Wolff (2006) and Zumbado (1999). Voucher specimens were stored at the Entomology Laboratory of the University of Caldas.

Results and Discussion

Production Statistics

Overall, production area of the 40 surveyed farms covered 47.7 ha and included species from

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four families of Zingiberales: Heliconiaceae, Zingiberaceae, Strelitziaceae, and Marantaceae. *Heliconia* spp. were the most common plants in this region, comprising 71% of total production area, with 7 species grown: *H. rostrata* (16% of total area) *H. wagneriana* (14%), *H. bihai* (13%), *H. orthotricha* (10%), *H. stricta* (10%), *H. caribea* (6%) and *H. psittacorum* (2%). Some farms diversified and the following non-*Heliconia* genera were also grown concurrently in small blocks, primarily various ornamental gingers, *Alpinia* (14%), *Etlingera* (8%), *Zingiber* (3%), as well as *Calathea* (3%) and bird-of-paradise (*Strelitzia*) (1% of production area). These statistics are representative of the region. ICA (2009) listed 236 farms growing *Heliconia* and other tropical foliage on 617 ha in the 'Eje Cafetero' region, while ASOCOLFLORES (2008) listed 9 species and 33 cultivars of *Heliconia* along with ten other species of tropical foliage grown.

Pest Management

The questionnaire revealed the vast majority (87%) of farmers were concerned about insect pests in the plantation, with 25% listing weevils (Coleoptera: Curculionidae) as the principal pest, followed by worms (phytophagous Lepidoptera or Coleoptera) (19%), ants (Hymenoptera: Formicidae) (19%), crickets (Orthoptera) (13%), thrips (Thysanoptera) (6%), and wasps (Hymenoptera: Vespidae) (6%), respectively. Only 13% percent of respondents reported no problems with insect pests.

Insecticides were the most common pest management tool in the plantations, used by 90% of respondents. Most farmers used at least 2 insecticides, with the broad spectrum materials favored. Chlorpyrifos was the most common (reported by 48% of farmers), followed by carbofuran (35%), acephate (28%), and malathion (15%). The reported frequency of insecticide applications varied among producers in the following categories, weekly (21% of respondents), every 2 wk (29%), monthly (21%), and every 3 mos (29%). Insecticides were often tank mixed with fungicides and herbicides. Although most growers had access to protective spray suits and masks, 70% of respondents reported that they were not used routinely. The frequent indiscriminate use of broad spectrum insecticides increases overall production costs and raises questions regarding human and environmental health consequences.

Amongst other pest management practices, a majority (71%) of farmers employed yellow sticky traps. These traps were mostly used to monitor thrips populations, since species such as *Thrips palmi* Karny were considered restricted pests for exporting. However, fewer (29%) reported monitoring other insect pests in order to make control decisions. Insect pests may be managed to some extent through sanitary or cultural control measures in the field (Kogan 1998). However, only approximately one third of respondents (35%) reported pruning and removal of crop residues to limit the build-up of pests.

Regarding biological control practices, 55% of *Heliconia* producers were familiar with the importance of beneficial insects. Approximately one third (35%) reported having used formulations of entomopathogenic fungi based on *Beauveria bassiana* (Balsamo) Vuillemin (Hypocreales: Cordycipitaceae), *Metarhizium anisopliae* (Metchnikoff) Sorokin (Hypocreales: Clavipitaceae), and *Isaria* sp. (Hypocreales: Clavipitaceae), with a smaller number (8%) applying vegetables extracts such as garlic and pepper extracts to repel insects. Beneficial insects such as green lacewings, *Chrysopa* sp.(Neuroptera: Chrysopidae), and egg parasitoids, *Trichogramma* sp.(Hymenoptera: Trichogammatidae), were released in some plantations. Overall, 33% of respondents considered biological control agents effective, 10% not effective and 57% did not know. Thus, it appears that there is a need for research and education efforts in biological control practices.

Insects were also encountered during post-harvest processing, reported by 89% of respondents. Earwigs (Dermaptera: Forficulidae) were described as the principle pest problem by 41% of respondents, followed by ants (18%), thrips (12%), aphids (6%), worms (6%), and spiders (6%). The majority (82%) of farms washed plants after harvest and 71% also used post-harvest insecticides, with chlorpyrifos most commonly used followed by mineral oils. Hot water treatment may be an alternative for insecticides. Jaroenkit & Paull (2003) reported that exposure to 49-50 °C for 12-15 min was a viable approach to kill post-harvest pests on red ginger (*A. purpurata*) inflorescences.

Insect Survey

In total insects from 13 orders and 99 families were collected from *Heliconia* producers in the Central Coffee Region in Colombia. The most abundant orders were Diptera (23 families), Hemiptera (22 families), Hymenoptera (14 families) and Coleoptera (13 families), (Fig. 1). Representative families of the next most abundant orders included Lepidoptera (Amatidae, Gelechiidae, Noctuidae, Nymphalidae, Pieridae, Psychidae, and Pyralidae), Orthoptera (Acrididae, Eumastacidae and Tetrigidae), Blattodea (Blattellidae and Blattidea), Dermaptera (Forficulidae and Labiidae), Thysanoptera (Phlaeothripidae and Thripidae) and Psocoptera (Liposcelidae

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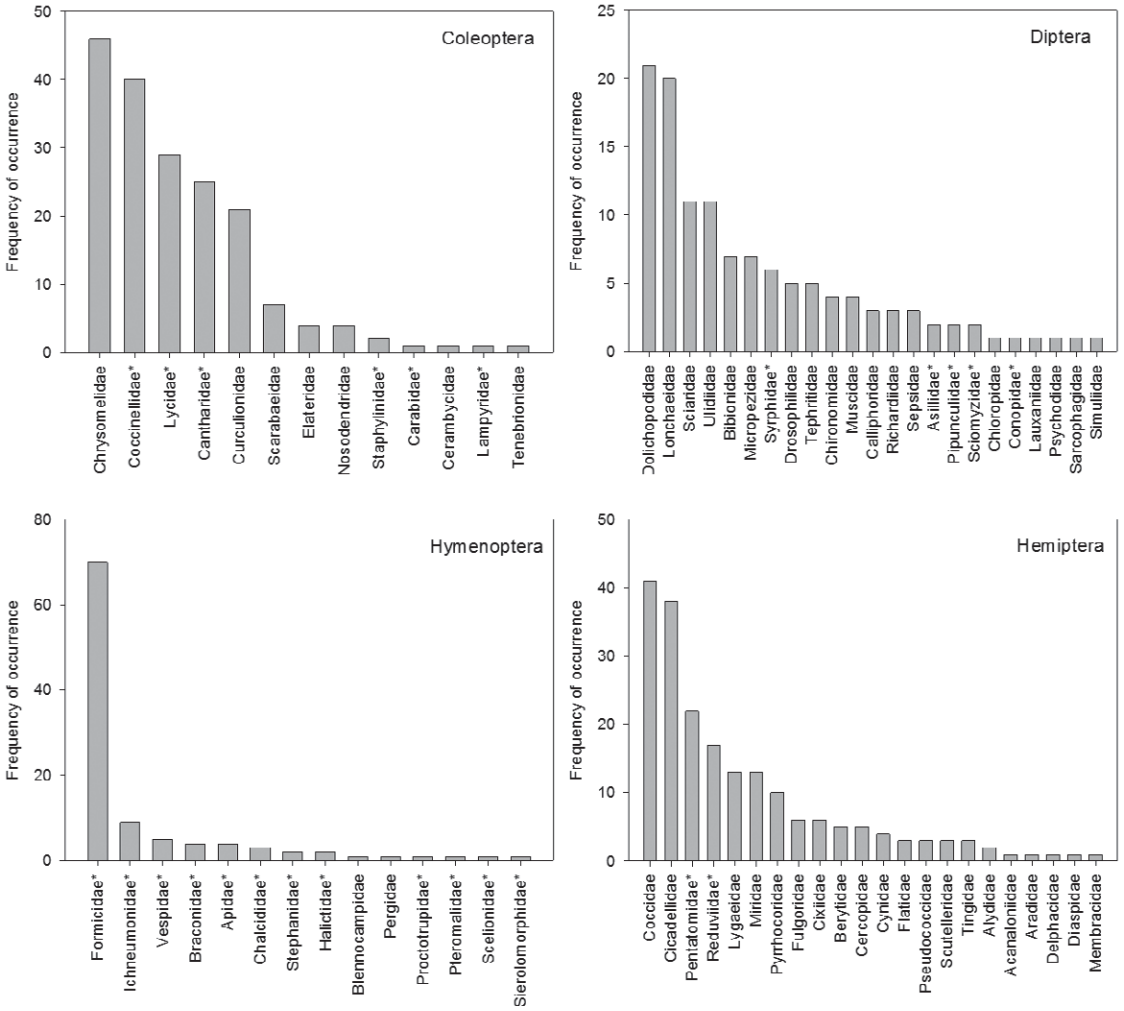

Fig. 1. Relative abundance of insect families among the four most common orders, collected among 40 farms growing *Heliconia* spp. in Eje Cafetero in central western Colombia. Data are total number of infested plants surveyed. Asterisks denotes occurrence of beneficial species.

and Psocidae). Notes on the more common species (identified to at least genera) are provided below.

Leaf-Feeding Insects

Heliconia foliage provided habitat for a diverse range of insects. Hispine beetles (Chrysomelidae) were the most common herbivores encountered on young foliage, with specimens identified from seven genera (Table 1). Adults and larvae of many species are flattened ventrally which facilitates feeding on the inside of rolled leaves (Strong 1982). Hispine beetles of the tribe Arescini (four genera) are specialists on Heliconiaceae, while those of the Cephaloleiini tribe also feed on other Zingiberales families (Strong 1977).

A wide range of phytophagous Hemiptera was also recovered from leaves; notably 4 genera of leafhoppers (Cicadellidae) and 3 genera of stinkbugs (Pentatomidae) and squash bugs (Coreidae). In large numbers, leafhoppers can cause considerable damage by feeding directly on the plants, producing honeydew or as a vector of plant pathogens (Freytag & Sharkey 2002). Other Hemiptera collected from leaves included a lygus bug (Lygaeidae), treehopper (Membracidae), mirid (Miridae), stiltbug (Berytidae), hard scale (Diaspidae), stainers (Pyrrhocoridae), jewel bugs (Scutelleridae), broad-headed bug (Alydidae), flat bug (Aradidae), lacebug (Tingidae) and several families of planthoppers (Delphacidae, Fulgoridae, Acanaloniidae, and Cixiidae). Insects including leafhoppers, spittlebugs and mirids are pests of

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TABLE 1. RELATIVE ABUNDANCE OF PHYTOPHAGOUS AND DETRITIVOROUS GENERA COLLECTED AMONG 40 FARMS GROWING *HELICONIA* SPP. IN EJE CAFETERO IN CENTRAL WESTERN COLOMBIA.

Order	Family	Genus (species)	#Plants[a]	Location[b]	Collected from[c]
Coleoptera	Chrysomelidae	*Agroiconota*, *Cerotoma*, *Colaspis*, *Crepidodera*, *Diabrotica*, *Galeruca*, *Systena*	46	L	2,3,4,5,6,7,9
	Curculionidae	*Metamasius hemipterus* Oliver, *M. hebetatus* Champion, *Pandeleteius*	21	R,P	1,2,3,4,5,6,7
	Scarabaeidae	*Onthophagus clypeatus* Blanchard, *Ontherus didymus* Erichson, *Gymnetis pantherina* Burmeister	7	P	4,5,8
Dermaptera	Labiidae	*Labia dorsalis* Burmeister	8	P	2,4,5,7
Diptera	Bibionidae	*Bibio*	7	L,B	1,2,3,4,7
	Dolichopodidae	*Pelastoneurus*	21	L,B	3,4,5,7
	Lonchaeidae	*Dasiops*	20	L,B	5,9
	Tephritidae	*Anastrepha*	5	B	1,5,7
	Ulidiidae	*Chaetopsis*	11	L,B	1,2,4,7,8
Hemiptera	Berytidae	*Jalysus mellitus* Stál	5	L	3,4,5
	Cercopidae	*Zulia, Cercopis*	6	R,P	3,5
	Cicadellidae	*Draeculacephala, Erythroneura, Emposca kraemeri* Ross & Moore, *Tylozygus*	38	L	1,2,4,5,8,9
	Coccidae	*Ceroplastes, Saissetia*	41	P	1,2,3,4,5,7,8,9
	Coreidae	*Leptoglossus, Chariesterus cuspidatus* Distant, *Hypselonotus interruptus* Hahn	16	L	1,2,5
	Cynidae	*Cyrtomenus bergi* Froeschner	4	R	3,5
	Delphacidae	*Liburniella*	3	L	9
	Flatidae	*Anormenis*	3	P,L	3,5
	Fulgoridae	*Cyrpoptus*	6	L	2,4,8,9
	Lygaeidae	*Lygaeus*	13	L	4,5,7
	Membracidae	*Archasia*	1	L	7
	Miridae	*Collaria*	13	L	1,7
	Pentatomidae	*Edessa, Mormidea, Proxys*	22	L	2,4,5,7,9
	Tingidae	*Derephysia foliacea* Fallén	3	L	5
Hymenoptera	Apidae	*Trigona*	1	B	5
	Formicidae	*Atta cephalotes* L., *Acromyrmex*	8	L	1,5,8,9
Lepidoptera	Nymphalidae	*Actinote anteas* Doubleday	1	L	7
	Pieridae	*Ascia*	1	L	8
	Psychidae	*Oiketicus*	11	L	1,5,7,8,9
Orthoptera	Eumastacidae	*Homeomastax*	1	L	4
Thysanoptera	Thripidae	*Thrips palmi* Karny	1	L	4,8

[a]Total number of plants infested (based on a minimum of 5 plants per farm).
[b]B = bracts, L = leaves, P = pseudostem, R = rhizome
[c]*Heliconia* spp. (1 = *H. bihai*, 2 = *H. caribaea*, 3 = *H. orthotricha*, 4 = *H. stricta*, 5 = *H. rostrata*, 6 = *H. psittacorum*, 7 = *H. wagneriana*), 8 = *Musa coccinea* (scarlet banana), 9 = *Alpinia purpurata* (red ginger)

various grasses (Tscharntke & Greiler 1995), and some may have originated from grasses close to plantations.

Although caterpillars (Lepidoptera) have been reported as pests of *Heliconia* elsewhere in the neotropics (Ribeiro et al. 2012; Watanabe 2007), relatively few were found in our survey. A bagworm *Oiketicus* sp., the most common species encountered in our survey, was reported as a pest in other crops including banana (*Musa* sp.; Zingiberales: Musaceae), cacao (*Theobroma cacao* L.; Malvales: Malvaceae), citrus (*Citrus* sp.; Sapindales: Rutaceae), and palm (*Elaeis* sp.; Arecales: Arecaeae) (Mexzón et al., 2003).

Leaf cutting ants *Atta cephalotes* L. and *Acromyrmex* sp. were found removing foliage in all

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the *Heliconia* species, occasionally causing severe damage. Santos & Malvido (2012) reported that human disturbance in natural *Heliconia* communities decreased caterpillar abundance, but favored damage by leaf cutting ants. Other insects recovered from leaves in low numbers included thrips, a sawfly (Pergidae), barklice (Psocidae) and grasshoppers (Orthoptera). The grasshopper *Cornops frenatum* Marschall (Acrididae: Leptysminae) has been reported as a *Heliconia* pest in Brazil (Lemos et al. 2010).

Insects Infesting Pseudostem and Rhizome

Several insects were found infesting other parts of the plant (Table 1). Two genera of soft scales *Ceroplastes* sp. and *Saissetia* spp. (Coccidae) occurred on the pseudostem, a first report for these species on *Heliconia*. Three species of scarab beetles (Scarabaeidae) along with mealybugs (Pseudococcidae), a longhorn beetle (Cerambycidae), *Pandeleteius* weevils (Curculionidae), click beetles (Elateridae), a plant hopper (Flatidae: *Anormenis* sp.) and a leafhopper (*Empoasca* sp.) were also found on the pseudostem. Some ants were found in association with scales and mealybugs in these areas, which was also observed by Ramírez et al. (2001). Two species of weevil (Curculionidae) were recovered from the pseudostem or rhizome of *Heliconia*. *Metamasius* weevils are pests of bananas (Ramirez-Lucas et al. 1996) which are also grown in this region of Colombia. Alarcón (2007) previously reported bacterial diseases, such as *Erwinia* and *Ralstoniai,* affecting *Heliconia* in the Eje Cafetero region and suggested that they may be spread by insects such as weevils. Spittlebugs (Cercopidae) and a burrowing shield bug (Cynidae) were also collected from the rhizome.

Insects in Inflorescences

Insects recovered from *Heliconia* inflorescence (bracts) included a range of flower feeding or detritivorous Diptera, including species of Bibionidae, Drosophilidae, Tephritidae, Richardiidae, Simuliidae, Syrphidae, Chironomidae and Sciaridae. *Trigona* sp. (Apidae) was found feeding in the bracts. While the larvae of many flies feed on detritus, algae and bract tissue, the adult flies likely feed on pollen and nectar in the same environment (Seifert 1982). Pipkin et al. (1966) reported host specificity in flower feeding by some neotropical species of Drosophila on *Heliconia* in Panama and Colombia. Fully aquatic species (e.g. Chironomidae) are found in the bracts of species with erect inflorescence (such as *H. stricta*, *H. wagneriana,* and *H. bihai*) which readily accumulates water. Mullins (2007) recovered larvae of Chironomidae, Tipulidae and Stratiomyidae inside *H. wagneriana* bracts in Dominica. Various other incidental Diptera were collected on leaves and flowers; their effect on *Heliconia* production is unknown but likely insignificant. Our findings are broadly similar to those of De Oliveira et al. (2010) who sampled 759 insects from *H. bihai* phytotelmata in Brazil and found the majority (87.6%) were Diptera. The order of abundance comprised Psychodidae, Tipulidae, Tabanidae, Culicidae, Muscidae, and Dolichopodidae (De Oliveira et al. 2010).

Diptera found in *Heliconia* inflorescences may change during the growing cycle. Richardson and Hull (2000) compared fly species from different stages of bract development in Puerto Rico. Ceratopogonid larvae were early colonizers, followed by psychodids, syrphids, and culicids, and finally tipulids later in the cycle. Relatively few predators are known from *Heliconia* flower bracts (Seifert 1982). We observed two species of syrphid flies, although Seifert (1982) noted syrphid larvae in *Heliconia* feed on the flowers and developing seeds. Frank & Barrera (2010) documented staphylinid beetles (*Belonuchus* and *Odontolinus* spp.) feeding upon dipterous and lepidopterous larvae in *Heliconia* bracts in Venezuela. Ramírez et al. (2001) observed 15 species of predaceous ants feeding on extrafloral nectaries of *Heliconia*, although they also harvested honeydew from scales (Coccidae) and mealybugs (Pseudococcidae) and thus may increase the populations of these pests.

Beneficial Insects

A range of beneficial species including insect predators and parasitoids was recovered from *Heliconia* plantations (Table 2). The most abundant generalist predators were ladybeetles (Coccinellidae) and lacewings, *Chrysoperla* spp. observed feeding on scales and other pests. We observed some net-winged beetles (Lycidae) feeding on leafhoppers, and assassin bugs *Apiomerus* sp. (Reduviidae) and wasps (Vespidae) preying on caterpillars. Parasitic Hymenoptera were found in low numbers, presumably due to insecticides used. Species included Ichneumonidae and Braconidae (caterpillar parasitoids) and Stephanidae (ectoparasitoid of Cerambycidae). Several parasitic flies (Conopidae and Pipunculidae) were recorded. While ants (*Solenopsis* sp. and *Pseudomyrmex* sp.) are also insect predators, some farmers consider them pests, because they are found inside bracts of flowers such as *H. wagneriana*. Other families may have mixed impacts depending on the actual species or life stage. For example *Podisus* are beneficial stinkbugs (Wiedenmann & O'Neill 1992) while larvae of soldier beetles, *Chauliognathus* sp., are generalist predators but adults feed on pollen and nectar (Shohet & Clarke 2007).

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Table 2. Diversity of beneficial genera collected among 40 farms in Eje Cafetero in West-Central Colombia.

Order	Family	Genus (species)	#Plants[a]	Location[b]	Collected from[c]
Coleoptera	Cantharidae	*Chauliognathus*	25	L	1,3,4
	Coccinellidae	*Azya orbigera* Mulsant, *Cycloneda sanguinea* L., *Delphastus*, *Hippodamia*, *Hyperaspis*, *Scymnus*	40	L	1,2,3, 4,5,7,9
	Lycidae	*Lygistopterus sanguineus* L., *Calopteron*	29	L	1,2,5,7
Diptera	Syrphidae	*Volucella*, *Eristalis*	6	B	1,2,4,5,6,7
Hemiptera	Pentatomidae	*Apateticus*, *Podisus*	5	L	4,7,8
	Reduviidae	*Apiomerus*, *Agriocleptus, Cryptophysoderes*, *Zirta*	17	L	5,7,9
Hymenoptera	Apidae	*Apis*	3	L,B	5,7
	Braconidae	*Aphidius*, *Glyptapanteles*	4	L	1,2
	Chalcididae	*Melanosmicra*	3	L	5
	Formicidae	*Ectatomma*	24	L	1,9
		Pseudomyrmex	6	L,B	2,3,5,7
		Solenopsis	6	L,B	1,2,7
	Ichneumonidae	*Grotea*	9	L,B	5,7
	Proctotrupidae	*Phaneroserphus*	1	L	1
	Stephanidae	*Foenatopus*	2	L	5
	Vespidae	*Polistes canadensis* L., *Polybia nigra* Saus.	5	L	1,2,5,7
Neuroptera	Chrysopidae	*Chrysoperla*	38	L	1,2,3,4,8
Mantodea	Mantidae	*Mantis*	1	L	4

[a]Total number of plants from which collected (based on a minimum of 5 plants per farm).
[b]B = bracts, L = leaves, P = pseudostem, R = rhizome
[c]Collected from *Heliconia* spp. (1 = *H. bihai*, 2 = *H. caribaea*, 3 = *H. orthotricha*, 4 = *H. stricta*, 5 = *H. rostrata*, 6 = *H. psittacorum*, 7 = *H. wagneriana*), 8 = *Musa coccinea* (scarlet banana), 9 = *Alpinia purpurata* (red ginger)

Conclusions

This is one of the first surveys of insects and pest management practices associated with *Heliconia* production in Colombia. We note that the abundance and diversity of insect species in the commercial farms maybe lower than found in equivalent sections of natural forest growth (Seifert 1982; Seifert & Seifert 1976; Strong 1982), which likely reflects the widespread use of broad spectrum insecticides. Nevertheless, we documented a wide range of herbivorous and beneficial insects occurring throughout the region, which suggests many new insect associations with *Heliconia*. Since this was not an ecological study, we cannot conclude that all plants on which insects were collected were reproductive hosts, especially for the less commonly found species, which may have originated from adjacent crops. Also the visual sampling method may have biased the reporting towards more conspicuous species. Other cryptic insects, such as cerambycid larvae, also are not effectively sampled with non-destructive sampling methods and thus may be underrepresented.

We noted the frequent use of broad spectrum insecticides in this region. This approach may not be the best long term strategy for insect pest management because of adverse risks to human and environmental health as well as risks of evolving insecticide resistance. Many farmers expressed interest in receiving training to improve their knowledge about integrated pest management. It would be informative to know how the insect fauna might respond to a more judicious and selective insecticide program. We hope this survey provides guidance for future pest management efforts on *Heliconia* and related tropical foliage in the Neotropics.

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