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A survey of homopteran species (Auchenorrhyncha) from coffee shrubs and poró and laurel trees in shaded coffee plantations, in Turrialba, Costa Rica

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Abstract: A survey of homopteran species (Auchenorryncha) was conducted in coffee plantations with no shade (C), and in those with shade of either poró (*Erythrina poeppigiana*) (CP) or poró plus laurel (*Cordia alliodora*) (CPL), in Turrialba, Costa Rica. A total of 130 species in ten families were collected, dominated by Cicadellidae (82 species). Species richness was highest in the CP system (88), followed by CPL (74) and C systems (60). Five most common species for all systems were *Fusigonalia lativittata*, *Hebralebra nicaraguensis*, *Neocoelidia* sp., *Oliarus* sp. and *Clastoptera* sp. Diversification of the coffee agroecosystem favors some species while limiting others, and have no effect on the majority of species. Thus, only *F. lativittata*, *Neocoelidia* sp. and *Scaphytopius* ca. *latidens* were well represented in all systems, but were more abundant in coffee shrubs. Additionally, the following were the dominant species in each system: *Graphocephala* sp. 1 (C), *F. lativittata* (CP) and *H. nicaraguensis* (CPL). Four species abundant on laurel trees, including *H. nicaraguensis*, appeared almost exclusively on these tree species. Species similarity was highest on the CP and CPL systems (51 % of the species in common), followed by the C and CP (39 %) and the C and CPL systems (38 %). These findings show that even disturbed systems can harbor many insect species, so that they deserve attention from conservation advocates and biologists.

Key words: Coffee, poró, laurel, shade trees, biodiversity, Homoptera, Costa Rica.

The study, conservation, and utilization of tropical biodiversity are current major issues among conservation biologists (Wilson 1988). Nevertheless, research has been focused mainly on pristine ecosystems, to a large extent disregarding the actual or potential value of biodiversity in agroecosystems (Vandermeer and Perfecto 1997). For instance, agroecosystems such as shaded coffee plantations in Mesoamerica are an important refuge for biodiversity, including birds and insects (Perfecto *et al.* 1996). Some Hymenoptera and Coleoptera groups have high levels of diversity in traditional coffee plantations (Nestel *et al.* 1993, Perfecto and Vandermeer 1994, Perfecto and Snelling 1995, Perfecto *et al.* 1997), which resemble natural forests in terms of their multistrata structure and floristic diversity (Perfecto *et al.* 1996).

Shade trees in these systems play important agronomic and economic roles (Beer *et al.* 1998). Combinations including nitrogen-fixing trees, such as poró (*Erythrina poeppigiana* (Walpers) O.F. Cook, Fabaceae: Papilionoideae) and laurel (*Cordia alliodora* (Ruiz and Pavón) Oken, Boraginaceae), are rather common in several areas of Costa Rica. From either a species conservation or a pest management standpoint, it is important to know whether these systems, with only one or two tree species, can harbor and maintain a high diversity of insect species, in comparison to coffee monocultures.

Homopterans (Auchenorryncha), a taxonomically well known insect group, was chosen as to appraise the importance of shade trees in promoting species abundance and diversity in coffee plantations. Previous data on Auchenorrhyncha associated with coffee plantations in Costa Rica are quite poor, as only 19 hopper species had been recorded for coffee (C. Godoy unpublished), 17 for poró (Hilje *et al.* 1993), and two for laurel (Hilje *et al.* 1991, Arguedas *et al.* 1997).

This paper reports on the particular homopteran groups present in these systems, whereas data on patterns of species diversity and similarity appear elsewhere (Rojas *et al.* 2000).

MATERIALS AND METHODS

The survey was carried out in Turrialba, Costa Rica, where average annual values of climatic variables are 2 616 mm precipitation, 21.7 ºC temperature, and 87.9 % RH. Even though Turrialba is located in the Caribbean watershed, where seasonality is not well defined (Herrera 1985), the eight-month sampling period (March-October, 1997) allowed collecting of a representative sample of homopteran species during both dry and rainy periods.

Sampled coffee farms were located between 600-800 m elevations, at 9º55'N and 83º39'O, within premontane wet forest and tropical moist forest life zones. Presence and abundance of homopteran species were recorded in three systems: unshaded coffee (C), coffee-poró (CP), and coffee-poró-laurel (CPL). Three commercial farms were sampled for each system on three dates. Farms differed in coffee variety, planting densities, and size, as well as in the type of surrounding vegetation.

Four hundred coffee plants and 20 poró or laurel trees were sampled in each farm. Poró and laurel trees were selected so that they did not exceed 3 m in height, to allow sampling with an aerial insect net. Each coffee plant was swept three times with the net, at different heights, whereas the poró and laurel trees were swept 15 times along the lower edge of their crown. Samples were placed in plastic bags and taken to the laboratory, where they were killed. Specimens were separated to morphospecies and the numbers of individuals per species were recorded. Representative specimens were mounted and identified by one of the authors (C. Godoy).

RESULTS

A total of 10 612 specimens, representing 130 species in ten families, were collected during the study. The number of species follows: Cicadellidae (82), Membracidae (22), Cercopidae (6), Flatidae (4), Delphacidae (3), Derbidae (3), Dictyopharidae (3), Issidae (3), Tropiduchidae (3), and Cixiidae (2) (Table 1). Eight families in common were represented among the three systems. Delphacidae and Dictyopharidae were not found in unshaded coffee. Species richness was highest in the coffee-poró (CP) (88), followed by the coffee-poró-laurel (CPL) (74) and the unshaded coffee (C) (60) (Table 1).

Cicadellidae represented 58 % of the species and 71 % of the individuals, followed by Membracidae and Cercopidae. At least four species of Cicadellidae (*Omegalebra* n. sp., *Oncometopia* n. sp., *Nielsonia* n. sp. and Cicadellidae n. sp.) are undescribed.

Not all species were equally abundant (Table 2). In the unshaded coffee system, 13 % of the species were represented by 100-1 000 individuals, 19 % by 10-100 individuals, and 68 % by less than 10 individuals. In the coffee-poró system, a single species (1 %) had more

TABLE 1

Total numbers of families, species and individuals of homopterans (Auchenorrhyncha) collected in three coffee systems in Turrialba, Costa Rica. 1998

Families	Species	Individuals
Unshaded coffee		
Cercopidae	1	294
Cicadellidae	45	2 120
Cixiidae	2	145
Derbidae	1	3
Flatidae	1	4
Issidae	2	109
Membracidae	7	34
Tropiduchidae	1	17
TOTAL	60	2 726
Coffee-poró		
Cercopidae	5	340
Cicadellidae	53	2 851
Cixiidae	2	292
Delphacidae	1	2
Derbidae	3	98
Dictyopharidae	3	38
Flatidae	4	19
Issidae	3	124
Membracidae	12	223
Tropiduchidae	2	26
TOTAL	88	4 013
Coffee-poró-laurel		
Cercopidae	1	38
Cicadellidae	43	3 287
Cixiidae	2	124
Delphacidae	3	3
Derbidae	3	76
Dictyopharidae	2	5
Flatidae	3	8
Issidae	3	86
Membracidae	12	205
Tropiduchidae	2	41
TOTAL	74	3 873

than 1 000 individuals, 10 % had between 100-1 000, 25 % had between 10-100, and 63 % had less than 10 individuals. In the coffee-poró-laurel system, one species (1 %) had more than 1 000 individuals, 8 % had between 100-1 000, 29 % had between 10-100, and 62 % had less than 10 individuals.

The five most abundant species for the three systems, as a whole, were: *Fusigonalia lativittata* (1 679), *Hebralebra nicaraguensis* (1 346), *Neocoelidia* sp. (924), *Oliarus* sp. (877) and *Clastoptera* sp. (629). Nonetheless, when data were split by system, only two species (*F. lativittata* and *H. nicaraguensis*) remained as dominant ones for a particular system (Table 3), whereas *Graphocephala* sp. 1, despite not ranking among the five most abundant species, was the dominant one in the C system. With the exception of *F. lativittata*, which ranked among the ten most abundant species for the three systems (Table 3), the other two dominant species (*H. nicaraguensis* and *Graphocephala* sp. 1) were barely or not represented at all in the other systems.

Also, only *F. lativittata*, *Neocoelidia* sp. and *Scaphytopius* ca. *latidens* were well represented in the three systems, but they were more consistently present and abundant in coffee, regardless of the system (Table 2), although all of them also appeared in poró and laurel. Another five species (*Clastoptera* sp., *G. permagna*, *Oliarus* sp., *Empoasca* sp. and *Bothriocera* sp.) ranked among the most common in two of the systems. The first three were closely associated with coffee, but only in the C and CP systems. *Empoasca* sp. and *Bothriocera* sp. were abundant in poró in the CP and CPL systems, although both also appeared in coffee and laurel.

Species similarity was highest between the CP and CPL systems, which shared 55 (51 %) of the 107 species present; C and CP systems shared 41 (39 %) out of 104 species, and the C and CPL systems shared 37 (38 %) out of 97 species. Most shared homopteran species between systems were barely represented in any of the compared systems. *Fusigonalia lativittata*, *Neocoelidia* sp. and *Scaphytopius* ca. *latidens* were consistently high in the three systems, although their densities were always higher in coffee shrubs. *Empoasca* sp., *Bothriocera* sp. and Derbidae sp. 1, which were almost absent from the C system, were the most abundant shared species between the CP and CPL systems. They always reached higher numbers in poró trees.

TABLE 2

Families and species of homopterans collected in three types of coffee systems in Turrialba, Costa Rica. 1998

Family	Coffee	Coffee-poró		Coffee-poró-laurel		
		Coffee	Poró	Coffee	Poró	Laurel
Cercopidae						
Aeneolamia postica (Walker)	0	1	0	0	0	0
Cercopidae sp. 1	0	0	1	0	0	0
Cercopidae sp. 2	0	0	2	0	0	0
Clastoptera sp.	294	290	45	28	5	5
Sphenorhina conspicua (Distant)	0	1	0	0	0	0
Cicadellidae						
Agallia panamensis Linnavuori and DeLong	5	0	0	1	0	0
Agallia sp. 1	0	1	0	0	0	0
Agallia sp. 2	1	0	0	0	0	0
Agallia sp. 3	1	1	1	0	0	0
Agalliopsis flagellata Nielson and Godoy	1	0	0	0	0	0
Agalliopsis sp. 1	3	0	0	0	0	0
Agalliopsis sp. 2	1	0	0	0	0	0
Agrosoma placetis Medler	0	1	0	0	0	0
Bahita sp.	10	19	1	18	1	2
Baleja flavoguttata (Latreille)	1	1	0	0	0	0
Caldwelliola reservata (Fowler)	1	0	1	0	0	1
Carneocephala dyeri (Gibson)	1	0	0	0	0	0
Carneocephala sp.	0	1	0	0	0	0
Cicadellidae n. sp.	67	266	12	40	5	1
Curtara sp.	5	12	2	23	0	1
Diestostemma schmidti Melichar	0	0	1	0	0	0
Dilobopterus instratus (Fowler)	0	2	0	0	0	0
Dilobopterus pardalinus (Fowler)	2	15	2	0	0	0
Empoasca sp.	7	26	191	11	315	34
Erythrogonia areolata (Signoret)	1	0	1	0	0	0
Fusigonalia lativittata (Fowler)	411	1 066	42	157	2	1
Graminella sp.	1	0	0	0	0	1
Graphocephala coccinea (Forster)	1	0	0	0	0	0
Graphocephala permagna Nielson and Godoy	272	113	11	0	0	0
Graphocephala sp. 1	640	22	6	2	0	0
Graphocephala sp. 2	70	72	6	62	0	0
Graphocephala sp. 3	79	29	6	28	2	0
Gypona ca. *axena*	6	0	0	0	0	0
Gypona postica Walker	4	2	0	1	0	0
Gypona sp. 1	8	2	0	4	0	0
Gypona sp. 2	0	2	1	1	0	0
Gypona sp. 3	0	2	0	1	1	0
Gypona sp. 4	1	0	0	4	0	0
Gypona sp. 5	0	0	0	1	0	0
Gypona sp. 6	7	0	0	0	0	0
Gyponana sp.	0	1	0	0	0	0
Hebralebra nicaraguensis (Baker)	0	0	1	17	5	1 324
Hebralebra panamensis (?) Young	0	0	1	0	1	80
Hecalapona sp. (?)	38	35	1	34	1	0
Hortensia similis (Walker)	0	1	0	0	0	2
Idiocerinae sp.	1	0	0	0	0	0
Juliaca pulla Young	42	20	3	0	0	0
*Ladoffa sannionis*Young	0	2	0	1	0	0

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Ladoffa variolaria (?) Young	0	0	1	0	0	0
Macugonalia testudinaria (Fowler)	14	15	0	0	0	0
Macunolla ventralis (Signoret)	17	19	0	0	0	0
Mareja reticuliceps Young	0	0	0	1	0	0
Microgoniella sociata (Fowler)	61	46	5	10	0	0
Neocoelidia n. sp.	199	317	173	110	92	33
Nielsonia n. sp.	0	7	0	1	0	0
Omegalebra n. sp.	0	0	0	19	7	512
Omegalebra sp. 1	0	0	0	0	0	23
Oncometopia clarior (Walker)	00	0	0	0	1	0
Oncometopia n. sp.	1	1	0	0	3	1
Oncometopia sp.	2	5	0	2	1	0
Oncometopia sp. 1	0	3	0	0	0	0
Osbornellus affinis (Osborn)	12	31	7	16	11	1
Osbornellus ca. *rarus* DeLong	1	1	0	1	0	0
Pilosana bivirgata Nielson	4	2	0	1	0	0
Pilosana gratiosa (Spångberg)	0	7	1	2	0	0
Planicephalu flavicosta Stål	0	1	0	0	0	0
Plesiomata sp.	1	0	0	0	0	0
Polana sp. 1	5	20	5	32	3	16
Polana sp. 2	0	0	0	1	0	0
Polana sp. 3	0		0	1	1	0
Scaphytopius ca. *latidens* (DeLong)	109	151	12	155	6	20
Scaphytopius sp. 1	0	3	0	0	0	0
Sibovia occcatoria (Say)	3	0	0	0	0	0
Stephanolla rufoapicata (Fowler)	0	2	1	4	0	0
Tylozygus geometricus (Signoret)	0	1	0	0	0	0
Typhlocybinae Erythroneurini 1	1	0	0	0	0	0
Typhlocybinae Erythroneurini 2	0	0	0	0	0	1
Typhlocybinae Alebrini	0	1	0	0	0	0
Xestocephalus tessellates Van Duzee	2	2	2	1	0	0
Xestocephalus sp.	1	0	0	0	0	0
Cixiidae						
Bothriocera sp.	1	67	121	17	50	28
Oliarus sp.	144	72	32	8	2	19
Delphacidae						
Delphacidae sp. 1	0	1	1	0	1	0
Delphacidae sp. 2	0	0	0	0	1	0
Herpis sp. (?)	0	0	0	0	0	1
Derbidae						
Derbidae sp. 1	3	6	78	6	46	19
Derbidae sp. 2	0	0	10	0	1	3
Derbidae sp. 3	0	0	4	0	1	0
Dictyopharidae						
Myndus sp.	0	1	0	0	2	1
Taosa herbida Walker	0	8	28	1	1	0
Flatidae						
Flatidae sp. 1	4	6	4	2	1	0
Flatidae sp. 2	0	1	0	0	0	0
Flatidae sp. 3	0	1	3	0	2	1
Flatidae sp. 4	0	2	2	1	1	0

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Issidae						
Colpoptera sp. 1	108	57	35	21	14	32
Colpoptera sp. 2	1	21	10	7	3	8
Issidae sp.	0	1	0	1	0	0
Tropiduchidae						
Cyphoceratopini colgorma (?)	17	15	10	5	6	29
Tropiduchidae sp. 1	0	0	0	0	0	1
Tropiduchidae sp. 2	0	0	1	0	0	0
Membracidae						
Amastris sp.	1	2	6	3	11	1
Bolbonota sp.	27	53	58	19	19	3
Dysyncritus sp.	0	1	1	0	0	0
Dysyncritus sp. (?)	0	3	7	1	1	0
Enchenopa sp.	0	2	1	0	1	0
Enchophyllum sp.	1	6	19	6	22	0
Erechtia sp.	0	0	1	1	2	0
Hyphinoe asphaltina (Fairmaire)	0	2	0	0	0	0
Ischnocentrus niger (?)	1	0	0	0	0	0
Ischnocentrus sp.	0	0	0	1	2	0
Membracis peruviana (Fairmaire)	0	1	45	0	2	0
Micrutalis sp.	0	0	0	1	0	100
Smiliinae amastrini	1	0	0	0	0	0
Smiliinae ceresini	2	0	3	1	1	0
Stictopelta sp.	0	0	0	0	1	0
Tolania sp.	0	0	1	0	1	0
Tribu Ceresini	1	1	10	0	6	1
TOTAL	2 726	2 974	1 039	899	666	2 308

TABLE 3

A list of the ten most common homopteran species in each coffee system, in Turrialba, Costa Rica. 1998

Coffee		Coffee-poró		Coffee-poró-laurel	
Graphocephala sp.	1 640	*F. lativittata*	1 108	*H. nicaraguensis*	1 346
F. lativittata	411	*Neocoelidia* sp.	490	*Omegalebra* n. sp.	538
Clastoptera sp.	294	*Clastoptera* sp.	335	*Empoasca* sp.	360
G. permagna	272	Cicadellidae n. sp.	278	*Neocoelidia* sp.	235
Neocoelidia sp.	199	*Empoasca* sp.	217	*S.* ca. *latidens*	181
Oliarus sp.	144	*Bothriocera* sp.	188	*F. lativittata*	160
S. ca. *latidens*	109	*S.* ca. *latidens*	163	*Micrutalis* sp.	101
Colpoptera sp.	108	*G. permagna*	124	*Bothriocera* sp.	95
Graphocephala sp.	379	*Bolbonota* sp.	111	*H. panamensis*	81
Graphocephala sp.	270	*Oliarus* sp.	104	Derbidae	171

DISCUSSION

The fact that not all homopteran species were equally abundant in each of the three systems studied reveals that they follow the same pattern observed in natural communities (Krebs 1978). In this case, the dominant (*i.e.* most abundant) species for the coffee-tree communities were *F. lativittata*, *H. nicaraguensis*, *Neocoelidia* sp., *Oliarus* sp. and *Clastoptera* sp.

In addition, data suggest that diversification of the coffee agroecosystem directly or indirectly favors some species while limiting others, but had no effect on the majority of species. For instance, *Graphocephala* sp. 1 was the dominant species in unshaded coffee, but its numbers declined drastically when coffee was associated with either poró or laurel. The species was barely present in poró but not in laurel, and its numbers in coffee declined severely as diversification increased, to the point that in the CPL system it did not appear in coffee. Other congener species, *Graphocephala* sp. 3 and *Graphocephala* sp. 2, showed an analogous trend. It is possible that microclimatic changes associated with diversification could have given rise to these patterns for homopteran species closely associated with coffee, as coffee itself did not vary within any of the three systems, except for normal variations in variety and age, as well as in planting densities. In contrast, *F. lativittata*, which also has a close association with coffee, reached highest numbers in the CP system, fewer in the C system, and dropped sharply in the CPL system.

Other homopteran species seem to benefit from diversification, at least to some extent. For instance, there was a great deal of variation for other species closely associated with coffee which also appeared in poró and laurel. Even though all of them preferred coffee regardless of the system, their highest numbers were attained in different systems. Thus, *Neocoelidia* sp. and *Clastoptera* sp. reached highest numbers in the CP system, whereas *S.* ca. *latidens* did so in the CPL system. *Colpoptera* sp. showed rather even numbers between the C and CP systems and was more common in laurel than in coffee in the CPL system. Finally, *Oliarus* sp. was almost absent in coffee in the CPL system. It is likely that varying responses of homopteran species to diversification are more complex, perhaps involving a combination of factors related to both coffee systems (variety, age, planting densities, amount of shade, size, and surrounding vegetation) as well as to hopper differential ability to exploit food resources associated with foliage of coffee, poró and laurel trees.

Higher efficiency in exploiting food resources may allow some species to increase their numbers and in turn become more abundant and even dominant. Homopterans vary in their food preferences and have specific morphological and physiological adaptations to feed on the sap of phloem, mesophyll, or xylem (Backus 1986). For example, leafhoppers in the subfamily Cicadellinae (*e.g. F. lativittata*, *Graphocephala* sp. 1 and *G. permagna*) and Cercopidae feed in xylem, whereas leafhoppers in the subfamily Typhlocybinae (*e.g. H. nicaraguensis* and *Empoasca* sp.) probably feed in mesophyll (Nault and Rodriguez 1985). Most of the other taxa included in this study probably feed principally in phloem, like Cicadellidae (*e.g. Agallia* spp., *Gypona* spp., *Neocoelidia* sp.), Fulgoroidea (Cixiidae, Delphacidae, Derbidae, Dictyopharidae, Flatidae, Issidae, Tropiduchidae), and Membracidae. Xylem feeders tend to be more polyphagous than the phloem and mesophyll feeders. Species that feed on phloem sap secrete honeydew, which often attracts ants.

In addition to species closely associated with coffee, other homopteran species associated with companion trees, *Empoasca* sp. and *Bothriocera* sp., were predominant in poró trees, although they also appeared in coffee and laurel. Five most abundant species in poró were also present in coffee, and a few of them appeared in laurel trees. Since poró trees are routinely pruned once or twice a year, homopterans have to recolonize them once they resprout. This suggests that these species move to surrounding coffee shrubs when poró is defoliated. Their reproductive rate is probably maximized when they recolonize poró trees, due to the high nitrogen content of poró leaves (Beer *et al.* 1998).

Four species (*H. nicaraguensis*, *H. panamensis*, *Omegalebra* n. sp. and *Micrutalis* sp.) were abundant and appeared almost exclusively on laurel trees. This peculiarity in species composition may be explained not only in terms of specific preferences for laurel foliage, but also because of tree isolation, as laurel trees are sparsely planted in coffee plantations. In Turrialba, a hectare of coffee typically contains 70-150 laurel trees, 155 poró trees and 5 000-6 000 coffee shrubs. Moreover, isolation of laurel trees is increased by lack of disturbance throughout the year, as the lower branches are the only ones occasionally pruned.

In regards to species similarity, it was highest between the CP and CPL systems. Nonetheless, Rojas *et al.* (2000) showed that species diversity was higher in the CP system (2.84), than in the most complex system (CPL) probably owing to the latter generally receives less external inputs, such as fertilizers. Also, Rojas *et al.* (2000) provide a more detailed analysis of similarity patterns within each system, considering plant components (coffee, poró or laurel), geographic location of each plot and sampling date.

In summary, from a species conservation viewpoint, these results reinforce the idea that even disturbed systems can harbor many insect species, including some undescribed ones, so that they deserve to be studied in terms of their biodiversity patterns (Vandermeer and Perfecto 1997). On the other hand, from a pest management standpoint, even though homopterans have not been reported as coffee pests in Costa Rica (Anonymous 1989), shade trees may play a role in maintaining populations of their parasitoids and predators, thus possibly preventing homopteran outbreaks. However, this requires more study.

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RESUMEN

En Turrialba, Costa Rica, se efectuó un inventario de especies de chicharritas (Homoptera: Auchenorryncha) en plantaciones de café sin sombra (C), así como en café asociado con árboles de poró (*Erythrina poeppigiana*) (CP) o de poró y laurel (*Cordia alliodora*) (CPL). Se recolectaron 131 especies, pertenecientes a diez familias, entre las cuales predominó Cicadellidae (82 especies). La riqueza de especies fue mayor para el sistema CP (88 especies), seguido por CPL y C, con 74 y 60 especies, respectivamente. Las cinco especies más comunes para los tres sistemas juntos fueron *Fusigonalia lativittata*, *Hebralebra nicaraguensis*, *Neocoelidia* sp., *Oliarus* sp. y *Clastoptera* sp. La diversificación del agroecosistema cafetalero parece favorecer a algunas especies y limitar a otras, pero no influye en la mayoría de ellas. Así, solamente *F. lativittata*, *Neocoelidia* sp. y *Scaphytopius* ca. *latidens* estuvieron bien representadas en los tres sistemas, aunque fueron más abundantes en los arbustos de café. Asimismo, las siguientes especies particulares fueron dominantes para cada sistema: *Graphocephala* sp. 1 (C), *F. lativittata* (CP) y *H. nicaraguensis* (CPL). Cuatro especies que fueron abundantes en los árboles de laurel, incluyendo a *H. nicaraguensis*, aparecieron casi exclusivamente en estos árboles. La similitud de especies fue mayor entre los sistemas CP y CPL (51 % de las especies en común), mientras que fue de 39 % entre C y CP, y de 38 % entre C y CPL. Estos hallazgos muestran que incluso algunos sistemas perturbados pueden albergar muchas especies de insectos, por lo que merecen la atención de los biólogos y conservacionistas.

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