Pyrisitia lisa and its guild in tropical meadows (Pieridae)

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Abstract: Many butterfly species have benefitted from the expansion of their open grassland habitat. One of these is Little Yellow, *Pyrisitia lisa* Boisduval & Le Conte (Pieridae), a widespread species occurring in North America in Florida and the Gulf states, and throughout Central America south to Panama, the Caribbean Islands, and Bermuda. I examined the guild of meadow butterflies in a dairy pasture system in the Dominican Republic over a six-month period, surveyed possible nectar sources, and investigated the behavior of Little Yellow within this guild. Twenty-three species of insect-pollinated forbs were recorded. Thirty-three species of meadow butterflies were found in this habitat, and seven species of woodland edge butterflies transited the meadows in crossing between woodland patches. Little Yellow nectared mostly on *Sphagneticola trilobata*, and divided its time nearly equally between nectar foraging flights and active, nonstop flight. It engaged in ascending flights with conspecifics and related species.

Keywords: Biodiversity, Coliadinae, *Eurema lisa*, Greater Antilles, meadow butterflies.

INTRODUCTION

The Caribbean archipelagoes are a biogeographical crossroads, blending biota from the Nearctic and Neotropical faunal regions (Smith *et al.*, 1989). Hispaniola, in the Greater Antilles, illustrates this in its butterfly fauna, sharing some species with North America, others with South America (Scott, 1986), and also hosts an endemic radiation (Sourakov & Zakarov, 2011). Until the nineteenth century, the island was largely forested, but the expansion of livestock farming has resulted in extensive deforestation (Santana *et al.*, 1986). Today, the north coast is predominantly pasture, with forest remnants along rivers, and cacao plantations acting as woodland refugia. In some tropical regions, agricultural landscapes have been found to harbor a diversity of butterflies sometimes exceeding that of natural habitats (Tobar & Milder, 2009), but some studies have suggested the importance of forest reserves as a component of the overall landscape (e.g. Horner-Devine *et al.*, 2003). Since pasture has long been an important land use in much of the tropics (Gumbs, 1981), it is important to understand its particular role in tropical ecosystems.

Many butterfly species have benefitted from the expansion of their open grassland habitat (Nuñez, 2012). One of these is Little Yellow *Pyrisitia lisa* (Boisduval & Le Conte, [1830]), a widespread species occurring as a breeding resident in North America in Florida and the Gulf states (with seasonal colonization of much of the eastern United States (Howe, 1975)), throughout Central America south to Panama (DeVries, 1987), throughout most of the Caribbean Islands (Scott, 1986), and on the Atlantic island of Bermuda (Riley, 1975). It is a strong flier known to migrate out of the northern United States to the Florida Peninsula (Walker, 1991), and to cross regularly from North America to Bermuda (Scudder, 1876; Howe, 1975). Its larval hostplants are weedy Fabaceae such as *Chamaecrista fasciculata* (Micx.) Greene, *C. nictitans* (L.) Moench (Torres Bauza, 1991), and *Mimosa pudica* L. (Howe, 1975). Nuñez (2012) found this butterfly species of intermediate abundance in the habitats where it occurred on Cuba. It occurs on Aruba and Bonaire, both of which are extensively disturbed (Miller *et al.*, 2003), and was common on completely deforested Barbados a century ago (Clark, 1904). Conversely, it was the least common pierid in forested zones of the Yucatán (Martínez *et al.*, 2005), and in Copán, Honduras, was entirely absent from secondary forest, although found in every other agricultural tree cover type (Tobar & Milder, 2009).

The north coast of Hispaniola is dedicated largely to dairy production, with smaller areas of cacao, fruits, and field crops. The Cambium parcel, in Magante District, Espaillat Province, Dominican Republic, is typical of the region, with approximately 80% pasture and 20% shade grown cacao. The pasture areas, hereinafter "the Cambium meadows," are Roystonea-Samanea pastures in Borhidi's (1988) classification scheme, and are managed for dairy production, with a herd of 24 dairy cows and one stud bull on a ten-day rotation. They are periodically mowed to prevent encroachment by shrubs and tree seedlings, and have a mixture of grasses, sedges, and forbs. The Cambium meadows are approximately 2 km inland from the Atlantic Ocean, which can be seen from a few of their higher hills, and range in elevation from 40 m to 80 m above sea level. Many species of butterflies frequent the Cambium meadows, including Little Yellow. This study sought to understand the adult behavior of Little Yellow, its interactions with other members of the guild of meadow butterflies, its abundance in the dairy zone of Hispaniola's north coast, and the vegetation resources available to this butterfly guild.

METHODS

The Cambium meadows were divided into three zones, east, central, and west, and sampled monthly for six months, from December 2016 through May 2017. The central zone was the lowest and flattest, the west zone the highest, and the east zone had the most rugged topography. This range of dates included the lowest midday sun angle (47.9º, on the winter solstice, December 2016) and the highest (90º, during the May 2017 observations). This study had three components: *Pyrisitia lisa*, its meadow butterfly guild, and tropical meadows.

Pyrisitia lisa: Individual Little Yellows were followed one day a month, rotating zones so that each zone was sampled twice. The observer remained at least 2 m away from the butterfly, unless the butterfly approached the observer. Each butterfly was followed until it was lost to sight or for one hour, whichever came first, and observation sessions lasted a minimum of two hours and five individual butterflies. Each butterfly's behavior was noted throughout the time it was followed.

Meadow Butterfly Guild: Ten-meter transects were set up in the Cambium meadows six days per month, rotating so that each zone was sampled once in the morning and once in the afternoon each month. Transects were set up at least 20 m away from woodland edge, to avoid sampling woodland edge butterflies passing along the woodland-meadow interface. On each sampling day, six transects were sampled, each for twenty minutes, for a total of two hours sampling per day. During the sampling period, every butterfly crossing the transect was counted; a crossing was defined as any part of the butterfly's body passing directly over or under the midline of the transect. If the same butterfly crossed the transect several times, this was counted as one discrete crossing; but if a butterfly flew out of sight and later returned, this was indistinguishable from two discrete crossings and was counted as such. Every sampling day was partly cloudy, and some experienced rain showers. If a shower lasted for less than (<) half of the transect's sampling period, the data were kept; if a shower lasted for more than or equal to (≥) half the sampling time, the data were discarded and the transect restarted after the shower ended. In no case was a transect begun during a shower. Butterfly scientific nomenclature follows Warren *et al.* (2012).

Tropical Meadows: All plant species exhibiting an insect pollination syndrome within 0.5 m left and right of each transect were recorded for presence or absence. Grasses and other plants exhibiting a wind pollination syndrome were not identified or recorded. Transects were set up in different locations within the designated area each time, to maximize the number of vegetation data points.

RESULTS

Pyrisitia lisa: This species was the second most abundant butterfly in the Cambium meadows (906 crossings), after the endemic wood nymphs, *Calisto* Hübner, 1823. There were 306 morning crossings and 600 afternoon crossings, or 65% more afternoon crossings. The number of crossings per month increased from December through February, and declined from February through May (Fig. 1).

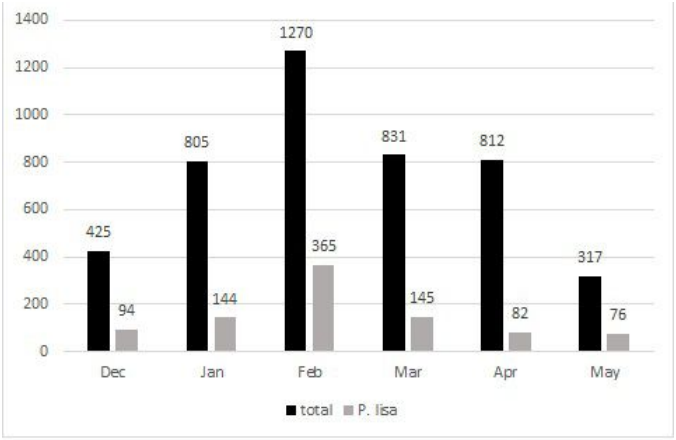

Figure 1. Number of butterflies crossing transects each month, comparing Little Yellow to all butterflies.

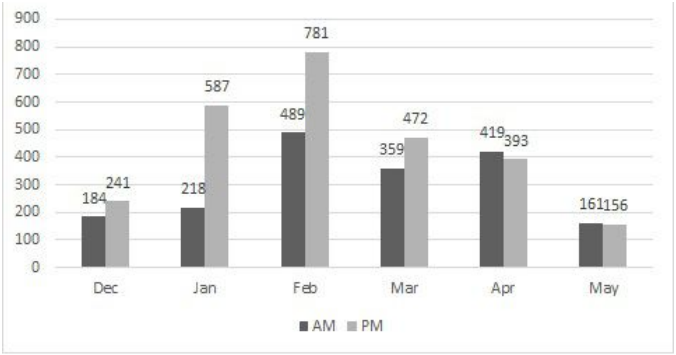

Figure 2. Total numbers of butterflies crossing transects in the morning and afternoon.

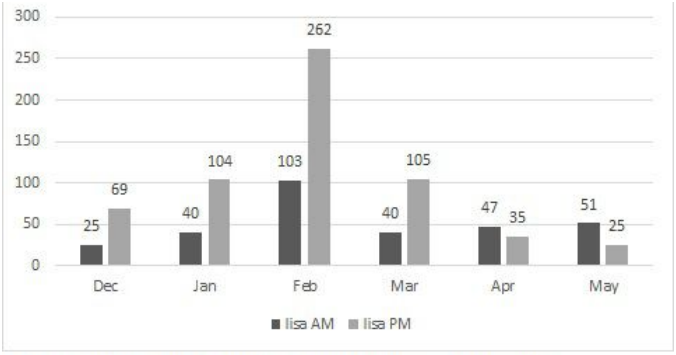

Figure 3. Number of Little Yellow crossing transects in the morning and afternoon.

A total of 42 individuals were followed, for a total of 378 minutes observation time. Active, nonstop flight constituted 44% of observation time, nectar foraging 42%, and the remaining 14% was divided among resting on vegetation, mud-puddling, and ascending flights. During nectar foraging, each nectar stop lasted only a few seconds. These butterflies habitually flew just above the height of the grass, and nectared mostly on Bay Biscayne Creeping Oxeye (*Sphagneticola trilobata* (L.) Pruski), which displayed its flowers level with the tops of the grass tufts. They were frequently observed bypassing taller forbs in flower, flying below the floral displays. Often, they traversed large areas of meadow without nectaring. Conversely, when actively foraging, they tended to visit every flower head

in the vicinity. Rest periods lasted 13-30 min, during which they perched motionless on stems or the underside of leaves. There were 49% more Little Yellows followed in the afternoon than in the morning (p=0.12).

The palest *Pyrisitia lisa* individuals could appear nearly as pale as the darkest individuals of Barred Yellow, *Eurema daira palmira* (Poey, [1852]), formerly considered congeneric. These two species could be distinguished by flight behavior: *Pyrisitia lisa* ranged widely over the pastures, flying meandering paths between grass tussocks; whereas *Eurema daira* hovered and zigzagged facing a single grass tussock before moving on to the next, and covered less distance. Their ascending flights also differed: *P. lisa* rose obliquely, sometimes nearly horizontally, whereas *E. daira* rose vertically and were sometimes lost to the observer's view. Heterospecific ascending flights of these two species also occurred, and these rose vertically, typical of *E. daira*. A total of 40 ascending flights involving *P. lisa* were observed, 31 (78%) with conspecifics, 9 (22%) with *E. daira*.

Adults of *P. lisa* showed no discernible territorial behavior, flying apparently random paths over the meadow and seldom returning to a point previously visited, and often crossing paths with conspecifics. However, they were a few times observed chasing or being chased by *Euema daira* and *Anartia jatrophae saturata* Staudinger, [1885], chasing a Great Southern White (*Ascia monuste eubotea* (Godart, 1819)), and being chased by a *Calisto* species.

No oviposition behavior was observed, although the *Mimosa* hostplant was abundant in the Cambium meadows. *Pyrisitia lisa* were never observed to enter the woodland or woodland edge. Two were observed flying back and forth near the woodland edge before rising vertically to fly over the woodland.

Meadow Butterfly Guild: Thirty-three species of meadow butterflies were observed in the Cambium meadows: 6 Nymphalidae, 8 Pieridae, 4 Papilionidae, 3 Lycaenidae, and 12 Hesperiidae (Table 1). Although Eumaeini are known from the region, all Lycaenidae encountered in the Cambium meadows were Polyommatinae. In addition, seven species of woodland edge butterflies, all Nymphalidae, crossed the transects while transiting the meadows from one woodland patch to another (Table 2). The five most frequently seen butterflies were: *Calisto* spp., 1232 crossings; *Pyrisitia lisa*, 906 crossings; *Hemiargus ceraunus ceraunus* (Fabricius, 1793), 710 crossings; *Anartia jatrophae saturata* Staudinger, [1885], and *Agraulis vanillae insularis* Maynard, 1889, 261 crossings. Curiously, the sexually dimorphic *Pyrgus oileus* (Linnaeus, 1767) showed an extremely skewed sex ratio, with 29 males and only 5 females. Three species of day-flying erebid moths also crossed the transects: Harlequin Moth (*Hyalurga vinosa* (Drury, [1773])), a Glasswing Moth *Clystea rubripectis* (Schaus, 1898), and Ornate Bella Moth (*Utetheisa ornatrix* (Linnaeus, 1758)).

Cattle were present in the vicinity of six transects. This was deemed an insufficient sample size to make a statistical comparison; however, their presence or absence did not visibly affect butterfly abundance or diversity. The average number of butterflies per transect was 29.5 in transects with cattle present, and 21.8 in transects without cattle present. In contrast to Askew (1980), who found butterfly activity greatest in the morning, this study found 35% more butterflies in the afternoon (p=0.13). However, April and May differed from the other months in having more butterfly activity in the morning.

Endemic wood nymphs, *Calisto* spp., with more than one thousand discrete crossings, were 28% of the total butterflies seen in the Cambium meadows. Two species of *Calisto* are known to occur widely in lowland habitats: *Calisto confusa* Lathy, 1899 and *Calisto obscura* Michener, 1943, which fly together and are easily confused with each other (Riley, 1975). Some of those in the Cambium meadows were identified as *C. confusa*, based on the images in Sourakov & Zakarov (2011), due to the presence of a trace of a tail on the hindwings; however, in many cases, it was not possible to make out distinguishing features on a fast-flying butterfly, so *Calisto* sightings were counted as one taxon, *Calisto* spp., on the assumption that both may have been present.

Little seasonality in species richness was observed over the six months of this study, with most butterfly species occurring in every month. A notable exception was Cassius Blue *Leptotes cassius theonus* (Lucas, 1857), which occurred only during the months of March and April. It was very abundant during those months, approaching equal abundance with the non-seasonal Ceraunus Blue *Hemiargus ceraunus*. Total butterfly activity, like Little Yellow activity, increased each month from December through February, and declined each month from February through May (Fig. 1). May was the only month during which every sampling day had <100 butterflies. There are a few points at which this differs from Racheli (2019): most notably, he found *Leptotes cassius* in every month that this study covered. Also, in his study, all butterflies became many times more abundant in June, July, and August, i.e. just after this study concluded. The uptick observed in May was likely a precursor to this increase.

Tropical Meadows: Twenty-three species of insect-pollinated forbs were recorded on transects in the Cambium meadows (Table 3). The three most abundant were White-star Sedge *Rhynchospora nervosa* (Vahl) Boeckeler, occurring in 100% of transects; Bay Biscayne Creeping Oxeye *Sphagneticola trilobata,* in 75% of transects; and Sensitive Plant *Mimosa pudica*, in 40% of transects. Additionally, *Rhynchospora* was the sole forb in 15 transects (6%). All three of these were seen being visited by honey bees and syrphid flies, and *S. trilobata* was also the flower most frequently visited by meadow butterflies. Other species on which butterflies were observed nectaring were *Stachytarpheta jamaicensis* (L.) Vahl., *Urena lobata* L. (not in transects), *Sida rhombifolia* L., and *Chromolaena odorata* (L.) R.M. King & H. Rob.

The three zones had similar floral species richness: 13 species in Central, 15 in East, 16 in West. However, similarity was low, with only seven species common to all three zones: *Sphagneticola trilobata, Chromolaena odorata, Hyptis capitata* Jacq., *Rhynchospora nervosa, Desmodium incanum* Desv., *Mimosa pudica,* and *Spermacoce remota* Lam. Two species were common to East and Central, one to West and Central, and four to East and West. Central had four species not shared with other zones, East one species, and West four species.

Table 1. Meadow butterflies crossing the transects. Taxonomic order follows Racheli (2019), scientific nomenclature follows Warren *et al.* (2012).

Scientific Name	Common Name	# Crossings	Host Plant	Host Present?
HESPERIIDAE				
EUDAMINAE				
Proteides mercurius	Mercurial Skipper	2	Fabaceae	N
Aguna asander	Gold-spotted Aguna	2	*Bauhinia*	N
Urbanus proteus	Long-tailed Skipper	20	Fabaceae	Y
Urbanus dorantes	Lilac-banded Skipper	1	Fabaceae	Y
Astraptes talus	Guaraguao Skipper	1	*Guarea*	N
PYRGINAE				
Ephyriades zephodes	Zephodes Duskywing	15	several	N
Gesta gesta	Impostor Duskywing	2	Fabaceae	Y
Eantis papinianus	Cuban Sicklewing	34	*Zanthoxylum*	N
Pyrgus oileus	Tropical Checkered-skipper	34	*Sida*	Y
HESPERIINAE				
Panoquina ocola	Ocola Skipper	11	Poaceae	Y
Wallengrenia otho	Southern Broken-dash	31	*Paspalum*	
INCERTAE SEDIS				
Unknown skipper 1	"Brown Skipper"	1		
PAPILIONIDAE				
PAPILIONINAE				
Battus polydamas	Polydamas Swallowtail	10	*Aristolochia*	N
Papilio demoleus	Lime Butterfly	21	*Citrus*	Y
Heraclides androgeus	Androgeus Swallowtail	1	*Zanthoxylum*	N
Heraclides pelaus	Caribbean Swallowtail	2	*Zanthoxylum*	N
PIERIDAE				
COLIADINAE				
Kricigona lyside	Lyside Sulphur	1	*Guaiacum*	N
Eurema daira	Barred Yellow	48	Fabaceae	N
Pyrisitia lisa	Little Yellow	906	Fabaceae	Y
Abaeis nicippe	Sleepy Orange	1	Fabaceae	Y
Phoebis argante	Apricot Sulphur	16	Fabaceae	N
Phoebis sennae	Cloudless Sulphur	40	*Senna*	N
Rhabdodryas trite	Straight-line Sulphur	18	*Senna, Inga*	N
PIERINAE				
Ascia monuste	Great Southern White	24	Brassicaceae	N
LYCAENIDAE				
POLYOMMATINAE				
Leptotes cassius	Cassius Blue	101	Fabaceae	Y
Pseudochrysops bornoi	Haitian Tailed Blue	93	*Albizia*	N
Hemiargus ceraunus	Ceraunus Blue	710	Fabaceae	Y
NYMPHALIDAE				
DANAINAE				
Danaus plexippus	Monarch	12	*Asclepias*	Y
Danaus eresimus	Soldier	1	*Asclepias*	Y
HELICONIINAE				
Agraulis vanillae	Gulf Fritillary	670	*Passiflora*	N
NYMPHALINAE				
Anartia jatrophae	White Peacock	261	Several	Y
Junonia zonalis	Tropical Buckeye	23	Several	Y
SATYRINAE				
***Calisto* spp. (consists of *C. confusa* and *C. obscura*)**	Endemic Wood Nymph	1232	Poaceae	Y

Plants showed diversity in seasonality. Nine species showed no seasonality, flowering throughout all six months; four species flowered December through February only; and two ceased flowering in March and April but flowered before and after those months (Table 3). *Acisanthera quadrata* Pers. and *Pseudelephantopus spicatus* (B. Juss ex. Aubl.) Rohr ex Gleason flowered only in February, and *Spiranthes torta* (Thunb.) Garay & H. R. Sweet only in April. The remaining five were too rare to assess seasonality.

Table 2. Woodland edge butterflies crossing the transects (all Nypmphalidae).

Subfamily	Scientific Name	Common Name	#Crossings
Danainae	*Lycoria halia*	Tiger Mimic-queen	2
Heliconiinae	*Dryas iulia*	Julia Heliconian	33
	Heliconius charithonia	Zebra Heliconian	32
Biblidinae	*Hamadryas amphichloe*	Caribbean Cracker	1
Nymphalinae	*Colobura dirce*	Dirce Beauty	1
	Spiroeta stelenes	Malachite	37
Charaxinae	*Archaeoprepona demophoon*	Silver King Shoemaker	1

DISCUSSION

Pyrisitia lisa: Unlike some of the butterflies in the Cambium meadows, *Pyrisitia lisa* lived in proximity to one of its hostplants, although no oviposition behavior was observed in this study. *Mimosa pudica* was abundant in the Cambium meadows. However, as suggested by its known ability to reach oceanic islands en masse (Scudder, 1876), Little Yellow is a strong flier that travels long distances, and need not remain near its hostplant. The Cambium meadows, due to the great abundance of *Sphagneticola trilobata*, are a rich foraging habitat for the adults, which are known to favor Asteraceae (DeVries, 1987).

Ascending flights in Pieridae occur when a male in search of a mate approaches a female already mated, which takes evasive action. In contrast to the observations of Rutowski (1978), Little Yellows in this area did engage in heterospecific ascending flights. The differing pattern between the two species in this study reveals a disparity: since heterospecific flights always showed the vertical direction typical of *Eurema daira*, not the oblique direction of *Pyrisitia lisa*, this suggests that male *P. lisa* will approach females of both species, but male *E. daira* will approach only their own species. It may be that male *P. lisa* mistake female *E. daira* for old, faded conspecifics.

In conclusion, the prevalence of meadow habitat has favored an abundance of *Eurema lisa*, which, together with *Calisto* spp., should be considered a dominant butterfly of this habitat type.

Meadow Butterfly Guild: The meadow butterfly guild showed a diversity of behaviors, from strong fliers traversing long distances to short-range fliers that seldom ranged far from their hostplants. Two of the day-flying moths exemplify the two extremes: *Hyalurga vinosa* flew straight and fast, with only momentary rest stops, and could occur in transects far from its *Tournefortia hispidissima* L. hostplant; whereas *Utethesia ornatrix* was seen only in transects containing its *Crotalaria* hostplant, and was not observed to fly far. The *Calisto* spp., *Panoquina ocola ocola* (W. H. Edwards, 1863), and *Wallengrenia drury* (Latreille, [1824]) all lived surrounded by their grass hostplants; whereas the exotic *Papilio demoleus* Linnaeus, 1758 ranged between isolated individuals of its citrus hostplant. *Agraulis vanillae* and *Eantis papinianus* (Poey, 1832) have hostplants of the woodland edge not found in the Cambium meadows, and are strong, wide-ranging fliers.

A possible reason for the differences observed in comparison with Racheli (2019) is that his survey was island-wide, whereas this survey was in a single locality. Some tropical Lepidoptera are known to migrate or otherwise appear in different locations at different times of the year (e.g. Janzen, 1983). However, no record was found of such a phenomenon in *Leptotes cassius.*

The woodland edge butterflies transiting the meadows were only a subset of the woodland edge butterfly species known to occur on the Cambium tract (Hernandez, unpublished data), suggesting that pastures are a barrier to some woodland edge butterflies. Tobar & Milder (2009) found that living fences, despite their narrowness, served as woodland corridors for butterflies which may not cross open meadows. Conversely, the *Pyrisitia lisa* observed to fly up and over the woodland suggests that woodland is not necessarily a dispersal barrier to meadow butterflies.

In conclusion, although meadows are a rich and diverse butterfly habitat in the Caribbean, maintaining the full complement of butterfly species will require maintaining woodland areas and connecting corridors.

Tropical Meadows: As is common in meadow habitats, Poaceae, Cyperaceae, Fabaceae, and Asteraceae showed the highest abundance and diversity. Two Cyperaceae showed an insect pollination syndrome, and one, *Rhynchospora nervosa,* was the most ubiquitous insect-pollinated forb in the Cambium meadows. Since several kinds of butterflies feed on Poaceae as larvae, meadow habitats are inherently suitable for these species. Likewise, several butterflies of the Cambium meadows, including Little Yellow, feed on weedy Fabaceae.

In his survey of several habitat types on Cuba, Nuñez (2012) found that disturbed vegetation was the only habitat in which all butterfly families were present; Lycaenidae were present only in this habitat type; and species richness was highest, but endemism lowest. Likewise, Askew (1980) found butterflies most abundant and diverse in disturbed habitat in the Cayman Islands. However, this abundance is composed mainly of widespread species, whereas habitat specialists and narrow endemics tend to occur in undisturbed habitats (Horner-Devine *et al.*, 2003; Nuñez, 2012). Butterfly conservation in agricultural lands faces an additional challenge in that some hostplants are considered noxious weeds. An example in the area of this study is milkweed, *Asclepias curassavica* L. and *A. nivea* L., hostplants of the Monarch. Local inhabitants consider these plants deadly poisonous to cattle, and make efforts to eradicate them. Although seen occasionally, they were not present in any of the transects.

In conclusion, a meadow with a diversity of hostplants and pollen and nectar sources becomes the habitat of butterfly species adapted to open, disturbed habitats, and a feeding zone for adults of certain species with larvae dependent on woodland hostplants, but not for more specialized woodland butterfly species. Butterfly conservation, then, requires a multipronged approach, with reserves set aside for those species requiring specific conditions, whereas the matrix of agricultural lands is sufficient for the large number of open-country species. Since human populations require agricultural lands to sustain them, it is important to understand what features of the agricultural landscape facilitate the coexistence of biodiversity. On the Cambium tract, these features include woodland corridors and floristically diverse meadows.

Table 3. Insect-pollinated herbs in the Cambium meadows.

Family	Species	# Transects				Season
		Central	East	West	Total	
Asteraceae	*Sphagneticola trilobata*	63	51	49	163	Nonseasonal
	Emilia sonchifolia	1	6	0	7	Nonseasonal
	Elephantopus mollis	0	4	7	11	Dec-Feb
	Pseudelephantopus spicatus	0	2	0	2	Feb
	Mikania sp.	0	0	3	3	Dec-Feb
	Chromolaena odorata	2	8	3	13	Dec-Feb
Cyperaceae	*Rhynchospora nervosa*	72	72	72	216	Nonseasonal
	Cyperus luzulae	10	0	2	12	Nonseasonal
Fabaceae	*Desmodium incanum*	12	21	26	59	Nonseasonal
	Centrosema pubescens	0	1	4	5	Dec-Feb
	Crotalaria incana	2	3	0	5	Non-March-Apr
	Stylosanthes biflora	0	3	0	3	Not assessed
	Mimosa pudica	27	18	41	86	Nonseasonal
Lamiaceae	*Hyptis capitata*	1	11	6	18	Non-March-Apr
Lythraceae	*Cuphea hyssopifolia*	3	0	0	3	Not assessed
Malvaceae	*Sida rhombifolia*	0	4	3	7	Nonseasonal
Melastomataceae	*Acisanthera quadrata*	1	0	0	1	Feb
Orchidaceae	*Spiranthes torta*	2	0	0	2	Apr
Plantaginaceae	*Misopates orontium*	0	0	1	1	Not assessed
Rubiaceae	*Spermacoce remota*	9	4	3	16	Nonseasonal
Verbenaceae	*Lantana camara*	0	0	2	2	Not assessed
	Lantana sp.	0	0	3	3	Not assessed
	Stachytarpheta jamaicensis	0	1	5	6	Nonseasonal

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LITERATURE CITED

Askew, R. R. 1980. The butterfly (Lepidoptera, Rhopalocera) fauna of the Cayman Islands. *Atoll Research Bulletin* 241: 121-138.

Borhidi, A. 1988. Vegetation dynamics of the savannization process on Cuba. *Vegetatio* 77: 177-183.

Clark, A. H. 1904. Notes on the insects of Barbados, St. Vincent, the Grenadines, and Grenada. *Psyche* December 1904: 114-117.

DeVries, P. J. 1987. *The Butterflies of Costa Rica and Their Natural History*. Princeton, Princeton University Press. 327 pp.

Gumbs, F. 1981. Agriculture in the wider Caribbean. *Ambio* 10: 335-339.

Horner-Devine, M. C., Daily, G. C., Ehrlich, P. R, Boggs, C. L. 2003. Countryside biogeography of tropical butterflies. *Conservation Biology* 17(1): 168-177.

Howe, W. H. (Ed.) 1975. *The Butterflies of North America.* Garden City, Doubleday. 637 pp.

Janzen, D. H. 1983. *Insects: Introduction*. *In:* Janzen, D. H., *Costa Rican Natural History*. Chicago, University of Chicago Press. 816 pp.

Martínez, A. M., Pozo, C., May Uc, E. 2005. Las mariposas (Rhopalocera: Papilioniade, Pieridae, y Nymphalidae) de la selva alta subperennifolia de la región de Calakmul, México, con nuevos registros. *Folia Entomologica Mexicana* 44(2): 123-143.

Miller, J. Y., Debrot, A. O., Miller, L. D. 2003. A survey of butterflies from Aruba and Bonaire and new records for Curaçao. *Caribbean Journal of Science* 39(2): 170-175.

Nuñez, R. 2012. The butterflies of Turquino National Park, Sierra Maestra, Cuba (Lepidoptera, Papilionoidea). *Arxius de Miscellánea Zoológica* 10(2012): 29-49.

Racheli, T. 2019. An updated list to the Butterflies of Hispaniola, with notes on the classification of *Calisto* Hübner, 1823 (Lepidoptera, Hesperioidea, Papilionoidea). *Neue Entomologische Nachrichten* 76: 1-135.

Ratowski, R. L. 1978. The form and function of ascending flights in *Colias* butterflies. *Behavioral Ecology and Sociobiology* 3(2): 163-172.

Riley, N. D. 1975. *A Field Guide to Butterflies of the West Indies.* London, Collins. 224 pp.

Santana, C. E., Potter, G. A., and Temple, S. A. 1986. Status and seasonal patterns of Turkey Vultures in Puerto Rico. *Journal of Field Ornithology* 57: 235-238.

Scott, J. A. 1986. Distribution of Caribbean Butterflies. *Papilio* New Series 3: 1-26.

Scudder, S. H. 1876. A cosmopolitan butterfly. I. Its birthplace. *American Naturalist* 26(3): 392-396.

Smith, D. S., Munroe, E., Ramos, S. J. 1989. Biogeographical affinities of the butterflies of the southwest Caribbean islands, San Andrés and Providencia. *Journal of the Lepidopterists' Society* 43(4): 274-288.

Sourakov, A., Zakarov, E. V. 2011. "Darwin's butterflies?" DNA barcoding and the radiation of the endemic Caribbean butterfly genus *Calisto* (Lepidoptera, Nymphalidae, Satyrinae). *Comparative Cytogenetics* 5(3): 191-210.

Tobar, D., Milder, J. C. 2009. *Conserving butterfly diversity in agricultural landscaspes in Copán, Honduras and Matiguas, Nicaragua: Final Report.* The Rufford Small Grants Foundation.

Torres Bauza, J. A. 1991. Biologia de *Eurema portoricensis* (Dewitz) (Lepidoptera: Pieridae). *Caribbean Journal of Science* 27(3-4): 124-129.

Walker, T. A. 1991. Butterfly migration from and to peninsular Florida. *Ecological Entomology* 16: 241-252.

Warren, A. D., Davis, K. J., Grishin, N. V., Pelham, J. P., Stangeland, E. M. 2012. *Interactive Listing of American Butterflies*. Online at http://www.butterfliesofamerica.com/, accessed 22 Feb 2021.