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The conservation value for birds of cacao plantations with diverse planted shade in Tabasco, Mexico

Russell Greenberg[1], Peter Bichier[1] and Andrea Cruz Angón[2]

[1] Smithsonian Migratory Bird Center, National Zoological Park, Washington, DC 20008, USA
[2] Instituto de Ecologia, Xalapa, Veracruz, Mexico

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Abstract

We surveyed birds in cacao (*Theobroma cacao*) plantations in the state of Tabasco, Mexico. The shade canopy was planted by farmers and consisted of approximately 60 species of trees with no single dominant species. Canopy height averaged 15 m and the structure was multi-storied. We conducted 220 ten minute, 25 m radius point counts for birds and detected 1550 individuals from 81 species. The average number of birds/point and the expected diversity in a fixed number of individuals within the cacao surveyed were well within the range of other lowland habitats, including agricultural sites, that we have surveyed previously in neighbouring Chiapas. In the Tabascan cacao, the migrant group was composed, in part, of forest species, and dimorphic species were represented primarily by males, which in other areas are known to dominate forest or forest-like habitats. In contrast to the composition of migrant species, we found few resident forest specialists in Tabascan cacao. Instead, the tropical resident group was composed of large-bodied generalist species that use small patches of trees in open habitats. These results (moderate diversity, low numbers of forest specialists) differ from the few studies completed in 'rustic' cacao systems located near large tracts of forest. The planted shade cacao agroecosystem – at least in the absence of nearby forest – may have a limited value for conserving lost tropical forest bird diversity, but it provides habitat for woodland-associated migratory species. Our results also indicate that the planted shade cacao plantations supported few small omnivorous or frugivorous species, probably because cacao itself, as well as the dominant shade trees, produce primarily mammal or wind dispersed fruit and seeds.

INTRODUCTION

Since the seminal paper by Pimentel et al. (1992), increasing attention has been focused on the role that agricultural systems might play in the conservation of biological diversity. In particular, considerable research has been directed at the potential for shade crops, such as coffee (*Coffea arabica*) and cacao (*Theobroma cacao*) in maintaining otherwise lost biodiversity in deforested landscapes (Estrada, Coates-Estrada & Merritt, 1993, 1994, 1997; Young 1994; Perfecto *et al*., 1996; Wunderle & Latta, 1996; Greenberg *et al*., 1997*a*; Greenberg, Bichier & Sterling, 1997*b*, Parrish, Reitsma & Greenburg 1998; Power & Flecker, 1998). Such habitats can enhance the existence and maintenance of biological diversity by providing additional habitat and resources for organisms visiting from intact forest, or they can support forest-dependent organisms throughout the annual cycle. In the latter case, shade crops provide a refuge for biodiversity in areas that have lost most or all of their natural forests. In the former, shade crops could be useful as a buffer zone crop for forest reserves. Planted coffee and cacao 'forests' are a mode of reforestation that could provide both revenue for local landowners as well as wildlife habitat.

To date, biological diversity in cacao has been poorly studied. We know that in some circumstances and for some groups of organisms, much of the local forest biota can be found on cacao farms (Leston, 1970). A few studies of birds in cacao grown under modified natural forest have shown a diversity substantially higher than other non-shaded agricultural systems that include some, but not all, forest species (Alves, 1990; Estrada *et al*., 1997, Parrish *et al*., 1998; Power & Flecker, 1998). However, cacao farms vary considerably in shade management and their geographical position with respect to natural habitats (Wood & Lass, 1985; Beer, 1997). Cacao is sometimes cultivated under thinned forest canopy (rustic cacao or *cabruca*), but more often it is found beneath a diverse canopy of planted shade trees (planted shade cacao) and these alternative systems probably support

All correspondence to: Russell Greenberg. Tel: 202 673 4908;
E-mail: antbird@erols.com.

very different levels of diversity of tropical forest organisms. For example, a number of studies of ant communities in rustic cacao farms have determined that species composition often resembles that in local forest (Room, 1971; Majer, 1994). However, cacao farms with a species-poor planted shade in Papua New Guinea had a diversity typical of a variety of agricultural and disturbed habitats (Room, 1975). Further studies of these moderately diverse planted forests should be instructive, since the future of much cacao cultivation probably lies in these types of systems.

In this paper we present the results of bird surveys in planted cacao farms in Tabasco, a region that long ago lost most of its natural moist tropical forest. The data provide an initial assessment for the ability of planted shade cacao systems to harbour bird diversity and presumably has implications for the role of cacao in protecting biodiversity as a whole.

STUDY SITES

Tabasco, located in the Gulf lowlands of Mexico, has little remaining natural forest (Gomez Pompa *et al*., 1993), but produces a large quantity (40 000 metric tons annually) of cacao in shaded plantations. Our surveys were conducted in two major cacao-growing regions: Comalcalco in the north (18° 16′ N, 92° 56′ W) and Teapa (17° 35′ N, 93° 10′ W) in the south. Specific sites were: Comalcalco, Cunducacan, El Paraiso, Jalpa and Nacajuca in the north and Teapa, Puyatengo, Sarabia and Aldamia in the south. The original habitat of this region was tall, perennial tropical forest (Rzedowski, 1986). The Teapa area is considered by local farmers to be less technified (more diverse shade, fewer chemical inputs) and is referred to as 'rustic' cacao. However, in reality the cacao there is cultivated under planted shade and we found few consistent differences in vegetation or avifauna, so we have pooled the data for analyses.

METHODS

We employed fixed radius point counts, a popular methodology for rapidly providing information on the relative abundance of birds in tropical habitats (Petit *et al*., 1993; Greenberg *et al*., 1997*a*,*b*). This technique allows us to compare our results with those of a number of other studies. Areas of extensive cacao cultivation were located and accessed initially by road; to access individual point count circles, we walked transects maintaining a compass direction whenever possible, but deviating to remain in cacao habitat. Surveys were conducted in the morning between 6.30–10.00. Individual census points were located 200 m apart and all birds observed or heard within a 25 m distance during a 10 min time period were tallied. Birds flying over and raptors were excluded from the analysis. A total of 220 point count circles were studied.

We compared the composition of the cacao bird assemblage to that in other habitats, including rustic cacao, in the Gulf lowlands of Mexico. Because no significant amount of forest was available in our study area, we relied upon data we had gathered in and around the Selva Lacandona (Chajul Field Station of Universidad Nacional Autónoma de México) in Chiapas, 200–300 km south of our cacao areas during 2 years of research in 1990–1992. That research consisted of intensively surveyed transects in agricultural fields and pasture, patches of trees in fields (usually along arroyos) and natural forest (in the Montes Azules Reserve). The disturbed habitats were immediately across the Lacantun River from the largest extensive patch of lowland tropical forest remaining in Mexico (>150 000 ha). Based on the relative abundance of species in these three habitat types we classified each species into one of four habitat distribution types (see Salgado-Ortiz, 1993): Forest specialist, found exclusively in large forest tracts; woodland generalist, found in both patches of trees and in forest; agricultural generalist, found in open fields and in association with patches of trees; and generalist, found across all habitats.

We considered migrants and residents separately in the habitat association analysis because: (1) the constraints on habitat selection are generally thought to be greater for birds that breed locally; (2) we noticed large differences in the patterns of foraging guild and morphology between the two types of birds; (3) recent concern about the decline of some migratory birds has focused on the importance of agricultural lands in tropical wintering areas (Robbins *et al*., 1992; Greenberg *et al*., 1997*b*). In fact, Robbins *et al*. reported that cacao plantations supported a particularly high diversity and abundance of migratory species. 'Migrant' signifies birds that breed in the Temperate Zone; none of the 'resident' species detected are known to be altitudinal migrants in the region (Ramos, 1988; and our pers. obs.). We also analyzed the two components of the avifauna for their distribution across body size classes and foraging guilds. The foraging guilds (foliage–twig–dead leaf insectivore, ground forager, bark forager, nectarivore, omnivore and frugivore) are based on observation and inferences from the literature (Greenberg *et al*., 1997*a*), and not on quantitative foraging studies. Size classes (0–20 g, 21–40, 41–60, > 60) were determined from avian weights published in Dunning (1993).

The following habitat variables were recorded for each 25 m point count circle: the identity and height of each tree, the number and average height of cacao plants, estimated canopy cover, estimated ground cover, epiphyte density classified into four classes (based on percentage branch cover: 1 = 0–5%, 2 = 5–25%, 3 = 26–50%, 4 = >50%), distance to plantation edge and edge habitat.

RESULTS

Habitat description

The plantations had an average canopy height of 15.2 m (SD = 3.9 m) and canopy cover of 33% (SD = 12.5). The cacao understory had a mean height of 4.4 m (SD = 0.8) with the cacao planted an average of 4.1 m apart (SD = 0.4). Trees (other than cacao) occurred at a density of 110 trees/ha (SD = 48) with an average of 6.4 species/sampling circle. We identified a total of 60 species of trees over all 220 point count circles. The most common tree (*Gliridicia sepium*) comprised only 14.8% of the 4674 non-cacao trees censused. The 10 most common trees accounted for 61.4% of the total and were *Gliricidia* (14.8%), *Erythrina* sp. (9.1%), *Colubrina* sp. (7.5%), *Castilla elastica* (7.5%), *Hevea brasiliensis* (6.1%), *Cedrela mexicana* (4%), *Guazuma ulmifolia* (3.7%), *Cecropia* sp. (3.2%), *Erythrina fusca* (2.9%) and *Cordia aliodora* (2.6%). The tree cover was multi-storied: we found approximately 575 cacao and 13 other trees/ha that were less than 5 m in height; 32.5 trees/ha at 5–10 m in height; 46.2 trees/ha at 11–20 m in height; and 2.9 trees/ha that were above 20 m height. Epiphytes were scarce – the average density class was 1.1, which corresponds to less than 10% branch cover. Patches of cacao habitat averaged aproximately 5 ha (range = – 1–20 ha). Census points averaged 82 m from cacao-patch edge (SD = 65 m). Edge habitats were predominantly pasture and other agricultural crops, and with the exception of two transects in the Teapa region, there was no nearby natural forest.

Bird abundance and diversity

The mean number of birds detected/point was 7.0 (SE = 0.3). This total included 45% that were migrants from the temperate zone. The census total included 81 species (28 migrant and 53 resident, Table 1). The estimated species richness for 225 individuals was 52.6 (SD = 3.1), based on rarefaction analysis (James & Rathbun, 1981).

Habitat affiliation of residents and migrant species and sex ratio of migrant species

Based on habitat classifications developed in the lowlands of eastern Chiapas, we found (Table 2) that migratory species were primarily woodland or agricultural generalists. Of the possible migrant species that could occur in the plantation (based once again on the Chiapas list), the agricultural generalists were the most poorly represented, with only 57% of the species possible being detected. In terms of abundance, the generalists comprised the highest proportion (36%), with forest specialists and agricultural generalists also well represented (approximately 25% each). In contrast to migrants, we found virtually no forest specialist residents (3 species, 12 individuals) with only 6% of the possible forest specialist species being detected. Woodland and agricultural generalists made up the bulk of both the resident species and individuals, and the agricultural generalists were the best represented of the possible species. All species of migrants with a sufficiently large sample size for analysis showed a strong male bias in numbers (Table 3). The tendency towards having a greater proportion of males across species is significant using a simple sign test ($P < 0.01$).

Size distribution and foraging guilds of migrants and residents

Migratory species in these plantations were primarily small and insectivorous (Table 4). Fifty-seven percent of the migratory species and 85% of the individuals detected were both less than 20 g in weight and foraged on foliage or twig arthropods. Resident species in this habitat were generally large and not insectivorous. Most resident birds were frugivorous, nectarivorous, or omnivorous; 80% of the individuals were in these diet groups and 42% of the species and 57% of the individuals detected were greater than 60 g in weight. The overall percentage overlap in guild distribution (calculated as the sum of the minimum value for each cell in Table 4) was only 10%.

Because of the differences in average size and foraging ecology, the impact of migrants on food resources is much lower than the abundance numbers would indicate. Whereas, residents comprised 55% of the birds surveyed, this represented 90% of the biomass (mean abundance × mass). The discrepancy between relative biomass and relative abundance varied, however, among foraging guilds. The relatively small number of resident insectivores has a disproportionately large impact on arthropods. For example, residents comprise only 8% of the foliage and twig gleaning species by individual, yet make up 21% of the biomass. Similarly, residents comprise 19% of the total insectivorous individuals (including bark and ground foragers), which accounts for 57% of the biomass. However, residents make up 92% of the omnivorous, frugivorous and nectarivorous species by individual, which is similar to the 98% value for relative biomass.

DISCUSSION

Composition, abundance and diversity of birds on cacao farms in Tabasco

The cacao farms of Tabasco support an avifauna with levels of diversity and abundance that are well within the range for habitats in the Gulf lowlands of Mexico. In previous work in southern Mexico and Guatemala (Greenberg *et al.*, 1995; Warkentin, Greenberg & Salgado-Ortiz, 1995, Greenberg *et al.*, 1997*a*, *b*), we found the abundance of birds/point in pasture, agricultural fields, shrubby second growth and sun coffee farms to range between 4–6, compared to the 7 birds/point found in this study. On the other hand, gallery woods, undisturbed and high-grade tropical forest and rustic shade coffee plantations supported 11–13 birds/point. The estimated number of species in 225 bird samples (based on rarefaction) was 38–50 for agricultural habitats and 69 for lowland second growth scrub, but only 52 for the planted cacao. By contrast, the values for gallery forest and shade coffee were 69 and 66, respectively, and 81 for lowland tropical forest. Total species richness from 100 points was 141 for lowland tropical forest, 110 for rustic shade coffee, 97 for milpa

Table 1. Abundance, migratory status, foraging guild and habitat affiliations of species detected during point counts in cacao plantations in Tabasco

Species	Latin name	Ind./point	Status†	Habitat‡	Guild§
Clay-coloured robin	*Turdus grayi*	0.48	R	A	O
Magnolia warbler	*Dendroica magnolia*	0.46	M	G	FI
Hooded warbler	*Wilsonia citrina*	0.46	M	F	FI
American redstart	*Setophaga ruticilla*	0.44	M	G	FI
Blue-grey gnatcatcher	*Polioptila caerulea*	0.31	M	A	TI
Brown jay	*Cyanocorax morio*	0.30	R	G	O
Band-backed wren	*Campylorhynchus zonatus*	0.26	R	W	BI
Yellow warbler	*Dendroica petechia*	0.25	M	A	FI
Rufous-tailed hummingbird	*Amazilia tzacatl*	0.24	R	A	N
Black-throated green warbler	*Dendroica virens*	0.23	M	W	FI
Yellow-bellied flycatcher	*Empidonax flaviventris*	0.21	M	F	FI
Golden-fronted woodpecker	*Melanerpes aurifrons*	0.21	R	A	BI
Melodious blackbird	*Dives dives*	0.19	R	A	O
Yellow-winged tanager	*Thraupis abbas*	0.18	R	A	O
Altamira oriole	*Icterus gularis*	0.16	R	A	O
Social flycatcher	*Myiozetetes similis*	0.14	R	A	O
Yellow-throated euphonia	*Euphonia hirundinacea*	0.14	R	W	F
Wilson's warbler	*Wilsonia pusilla*	0.13	M	G	FI
Black-headed saltator	*Saltator atriceps*	0.12	R	W	O
Masked tityra	*Tityra semifasciata*	0.11	R	W	F
White-fronted parrot	*Amazona albifrons*	0.11	R	W	F
Red-billed pigeon	*Columba flavirostris*	0.11	R	W	F
Olive-throated parakeet	*Aratinga nana*	0.10	R	A	F
Kentucky warbler	*Oporonis formosus*	0.10	M	F	FI
Great kiskadee	*Pitangus sulphuratus*	0.10	R	A	O
Montezuma's oropendola	*Psarocolius montezuma*	0.10	R	W	O
White-eyed vireo	*Vireo griseus*	0.09	M	A	O
Wood thrush	*Hylocichla mustelina*	0.09	M	F	G
Summer tanager	*Piranga rubra*	0.07	M	W	O
Black-and-white warbler	*Mniotilta varia*	0.07	M	G	BI
Great-tailed grackle	*Quiscalus mexicanus*	0.07	R	A	O
Blue-crowned motmot	*Momotus momota*	0.06	R	W	O
Northern parula	*Parula americana*	0.06	M	A	FI
Scrub euphonia	*Euphonia affinis*	0.06	R	A	F
Red-legged honeycreeper	*Cyanerpes cyaneus*	0.06	R	W	O
Boat-billed flycatcher	*Megarhynchus pitangua*	0.05	R	A	O
Baltimore oriole	*Icterus galbula*	0.05	M	W	O
Little hermit	*Phaethornis longuemareus*	0.05	R	W	N
Gray catbird	*Dumetella carolinensis*	0.04	M	A	O
Buff-bellied hummingbird	*Amazilia yucatanensis*	0.03	R	A	N
Dusky-capped flycatcher	*Myiarchus tuberculifer*	0.03	R	A	FI
White-necked puffbird	*Notharchus macrorhynchos*	0.03	R	W	FI
Azure-crowned hummingbird	*Amazilia cyanocepala*	0.03	R	A	N
White-bellied emerald	*Amazilia candida*	0.03	R	W	N
Groove-billed ani	*Crotophaga sulcirostris*	0.02	R	A	G
Ferruginous pygmy owl	*Glaucidium brasilianum*	0.02	R	W	
Rose-throated becard	*Pachyramphus aglaiae*	0.02	R	W	FI
Yellow-olive flycatcher	*Tolmomyias sulphurescens*	0.02	R	W	FI
Blue-winged warbler	*Vermivora pinus*	0.02	M	W	FI
Greenish elaenia	*Myiopagis viridicata*	0.02	R	W	FI
Northern waterthrush	*Seiurus noveboracensis*	0.01	M	G	G
Northern bentbill	*Oncostoma cinereigulare*	0.01	R	F	FI
Golden-olive woodpecker	*Piculus rubiginosus*	0.01	R	W	BI
Ovenbird	*Seiurus aurocapillus*	0.01	M	W	G
House wren	*Troglodytes aedon*	0.01	R	A	TI
Chestnut-headed oropendola	*Psarocolius wagleri*	0.01	R	W	O
Roadside hawk	*Buteo magnirostris*	0.01	R	A	
Wedge-tailed sabrewing	*Campylopterus curvipennis*	0.01	R	W	N
Worm-eating warbler	*Helmitheros vermivorus*	0.01	M	F	FI
Violaceous trogon	*Trogon violaceus*	0.01	R	W	O
Black-headed trogon	*Trogon melanocephalus*	0.01	R	W	O
White-tipped dove	*Leptotila verreauxi*	0.01	R	A	F
Chestnut-sided warbler	*Dendroica pensylvanica*	0.01	M	W	FI
Plain chachalaca	*Ortalis vetula*	0.01	R	W	F
Red-throated Ant tanager	*Habia fuscicauda*	0.01	R	F	O
White-breasted wood wren	*Henicorhina leucosticta*	0.01	R	F	TI
Great crested flycatcher	*Myiarchus crinitus*	0.01	M	W	O
Squirrel cuckoo	*Piaya cayana*	0.01	R	W	FI
Ochre-bellied flycatcher	*Mionectes oleagineus*	0.01	R	W	F
Spot-breasted wren	*Thryothorus maculipectus*	+ "	R	W	TI
Pale-billed woodpecker	*Campephilus guatemalensis*	+	R	W	BI
Indigo bunting	*Passerina cyanea*	+	M	A	F

Table 1. *Continued*

Species	Latin name	Ind./point	Status[†]	Habitat[‡]	Guild[§]
Tawny-winged woodcreeper	*Dendrocincla anabatina*	+	R	F	BI
Olivaceous woodcreepr	*Sittasomus griseicapillus*	+	R	W	BI
Blue-headed vireo	*Vireo solitarius*	+	M	W	FI
Olive-backed	Euphonia *Euphonia gouldi*	+	R	W	F
Nashville warbler	*Vermivora ruficapilla*	+	M	W	O
Black-cowled oriole	*Icterus dominicensis*	+	R	A	O
Yellow-bellied sapsucker	*Sphyrapicus varius*	+	M	W	BI
Yellow-throated vireo	*Vireo flavifrons*	+	M	W	FI
Yellow-throated warbler	*Dendroica dominica*	+	M	W	TI

[†] M, migrant; R, resident.
[‡] A, agricultural generalist; F, forest specialist; G, generalist; W, woodland generalist
[§] BI, bark insectivore; F, frugivore; FI, foliage insectivore; G, ground insectivore; N, nectarivore; O, omnivore; TI, twig insectivore.
" + = < 0.01.

Table 2. Distribution of habitat afiliations by species and proportion of individuals

	Number of species	% total available	% individuals
Migratory species			
Forest specialist	5	100	24
Woodland generalists	11	92	14
Agriculture generalists	8	57	25
Generalists	4	100	36
Resident species			
Forest specialists	3	6	1
Woodland generalists	28	37	28
Agriculture generalists	21	90	61
Generalists	1	100	9

Table 3. Total number of individuals and % males observed for warblers with plumage dimorphisms during cacao point counts

Species	*N*	% males
Black-and-white warbler	14	78
Yellow warbler	30	80
Magnolia warbler	54	83
Black-throated green warbler	29	83
American redstart	78	78
Hooded warbler	67	96
Wilson's warbler	19	89

Table 4. Percentage of estimated biomass and species of migrants and residents (**bold**) in guild–size classes

Guilds	<20g	>20<40g	>40<60g	>60g	Total
Foliage and twig gleaners					
Biomass	85,**3**	0,**1**	0,**1**	0,**1**	85,**6**
Species	57,**14**	0,**4**	0,**2**	0,**4**	57,**24**
Bark gleaners					
Biomass	2,+	0,**7**	+,+	0,**6**	2,**13**
Species	4,**2**	0,**4**	4,**2**	0,**4**	8,**12**
Ground insectivores					
Biomass	+,**0**	0,**0**	3,**0**	0,**0**	3,**0**
Species	7,**0**	0,**0**	4,**0**	0,**0**	11,**0**
Frugivore + omnivore					
Biomass	3,**7**	5,**4**	0,**9**	0,**50**	8,**70**
Species	7,**12**	14,**4**	0,**6**	0,**34**	21,**56**
Nectarivore					
Biomass	0,**10**	0,**0**	0,**0**	0,**0**	0,**10**
Species	4,**12**	0,**0**	0,**0**	0,**0**	4,**12**
Total					
Biomass	90,**20**	5,**12**	3,**10**	0,**57**	
Species	79,**40**	14,**12**	8,**10**	0,**42**	

+, <1%

and 60 for sun coffee (J. Sterling & R. Greenberg, unpublished results). The 67 species found during 100 point counts for cacao is at the low end of these values.

In terms of habitat affiliations, migrants and residents responded quite differently and will be discussed separately. Forest specialist and woodland generalist migrants were well represented in the cacao plantations, both in terms of the proportion of possible species found in the plantations and the proportional abundance of these species in the sample. Furthermore, in dimorphic species, males were predominant. Males typically winter in more forest-like habitats (Lopez Ornat & Greenberg, 1990), and their high relative abundance further suggests that migrants respond to the cacao plantations as if they were a forest-like habitat.

In contrast, most resident species were characteristic of open habitats – either pastures and fields or small patches of trees and shrubs within pastures and fields. Only eight out of 1550 individuals surveyed were of three forest specialist species – leaving at least 43 forest specialist species from the region unrecorded (assuming an avifauna similar to that of the Selva Lacandona existed in Tabasco prior to deforestation). Even for these few individuals, further research will be required to determine whether they represent occasional wanderers or small numbers of a resident and reproducing population (Remsen, 1994). The paucity of resident forest birds probably results from the lack of specialized habitat structures and food resources necessary for reproduction, combined with an absence of natural forest in the region as a source for dispersing individuals.

Apart from patterns of habitat use, migrants and residents show a great degree of ecological complementality in the cacao farms. The planted cacao habitat is typical of human disturbed or early succesional habitats in the region in its lack of small resident insectivorous birds (R. Greenberg, unpublished results). Migrants are, by and large, small foliage insectivorous species, whereas residents are more likely to be large omnivores. The 10% overlap in the distribution of individuals across size–diet guilds is far lower than in other habitats we surveyed in south-eastern Mexico (R. Greenberg, unpublished results). This overlap value falls consistently between 35–45% for both disturbed second growth and mature forest habitats.

Fig. 1. Photograph from the edge of a typical Tabascan cacao plantation (Camalcalto, Tabasco).

Fig. 2. Profile of more rustic style cacao plantation near Teapa, Tabasco. (Photo by Peter Bichier).

The difference in average body size between migrants and residents is particularly profound and means that on the level of the entire avian assemblage, migrants augment the biomass of birds very little (approximately 10%). However, focusing on the guild that they dominate (small foliage gleaning birds) they make a relatively large contribution both of individuals (92%) and biomass (79%). This suggests that migrants could play a disproportionate role in the control of arthropod populations in cacao farms. One striking feature of the cacao avian assemblage is the low abundance of small frugivores and omnivores. Only 12% of birds detected were of these dietary guilds and less than 40 g. In contrast, 25–40% of the birds censused in second growth habitats in the Chiapas lowlands fell into these categories and this value is 18–28% for old growth and disturbed forests. The low abundance of small fruit-eating birds is not surprising considering the management practices in cacao plantations. Natural regrowth on disturbed lands consists of an abundance of plants with bird-dispersed fruits (Martin, 1985). Tabascan cacao farmers remove many of these weedy perennials. The understory of cacao plantations is managed for a single mammal-dispersed and human harvested species (cacao) and most of the dominant shade trees are not bird dispersed. Based on our tree counts, we estimated that 4% of the total trees and 23% of the non-cacao trees produced bird-dispersed fruit. Bird abundance and diversity would probably be enhanced by a greater incorporation of plants with bird dispersed fruits into the shade tree flora. However, if there is a perception on the part of farmers that birds damage pods and make no positive contribution to the health of cacao plants (Weiss, 1985), then it may be difficult to encourage the use of bird-attracting plants

Planted versus rustic cacao

A few other studies have found a good representation of forest avifauna in cacao plantations – with varying reductions in species richness and abundance of forest specialists (Alves, 1990; Estrada et *al*., 1997; Parrish *et al*., 1998; Power & Fletcher 1998). We also found that the rustic cacao plantation that we surveyed in Chajul supported a diversity of birds that was only slightly lower than undisturbed forest (150 versus 180 species in 35 transect surveys). In this rustic plantation, we observed a 15% reduction in forest specialist species compared to old-growth forest, but a 70% decline in their abundance.

These studies suggest that cacao grown under managed rain forest trees contrasts with the planted shade plantations of this study. However, most of the sites in these rustic cacao studies were in close proximity to forest or forest patches. Alves (1990) showed that similar cacao plantations close to forest patches support a higher diversity of birds and Parrish & Petit (1996) found the same effect for shaded coffee plantations. It is difficult to assess how much of the reduced diversity of forest birds in the Tabasco plantations is a result of shade management and how much is related to differences in proximity and connectivity to forest.

The extent of cacao plantations in Mexico and northern Latin America

Shaded cacao provides habitat for several forest-adapted migratory species. Along with shade coffee farms, cacao plantations support far greater numbers of these birds than most other agricultural habitats. Shaded cacao and coffee farms tend to replace each other altitudinally, and together could form transects that protect many species along an elevational gradient. However, at present cacao plantations are of limited extent in Mexico and northern Latin America as a whole. Cacao farms cover approximately 70 000 ha of land in Mexico, in contrast to over 700 000 ha in coffee plantation (FAO, 1997). For Latin America and the Caribbean north of Colombia, cacao plantations cover approximately 360 000 ha compared to 2.7 million ha of coffee (FAO, 1997). The relative importance of northern Latin America to world cocoa production has declined over the last half century because of persistent disease problems (Wood & Lass, 1985). Until barriers to production are overcome, cacao farms in the Neotropics will remain only a locally important land use and of minor importance to the conservation of migratory birds.

CONCLUSIONS

The cacao plantations of Tabasco, with their relatively diverse planted shade and absence of large tracts of nearby forest, support a resident avifauna that is typical of any small patch of trees maintained in the tropical landscape of the region (Warkentin *et al.*, 1995; Greenberg, 1996). These cacao farms in no way maintain a typical or even a reasonably depauperate forest avifauna. However, forest and woodland migrants are relatively diverse and common. The maintenance of shade-grown cacao under these conditions could contribute significantly to the conservation of migratory songbirds in the face of continued deforestation, particularly if disease problems are overcome and northern Latin America becomes a more significant producer of cocoa. The lack of small omnivorous and frugivorous birds, both migrant and resident, is probably a result of farm management that favours plants with mammal- or wind-dispersed seeds. There is clearly an opportunity for conservation biologists to collaborate with agronomists to develop a set of trees that would increase resources for birds and other wildlife and serve the needs of the cacao farmer as well (see Parrish *et al*., 1998). However, given the concern that some farmers have about damage caused by birds to cacao pods, there may be some resistance to increasing bird populations. As suggested by Weiss (1985), we need more quantitative studies of the cost (damage to pods – primarily by woodpeckers) and benefits (insect control) of birds in cacao farms. More importantly, there needs to be greater effort to communicate information on the value of biological diversity to cacao producers.

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