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RATIOS OF NEOTROPICAL MIGRANT AND NEOTROPICAL RESIDENT BIRDS IN WINTER IN A CITRUS PLANTATION IN CENTRAL BELIZE

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Abstract.—Overwintering migrants composed 61.3% of the individuals and 40.3% of the species mist-netted in a large citrus plantation in central Belize during the winters of 1986–1987 and 1987–1988. The percentage of migrants ranged from 50.0 to 80.6% of the individuals within five individual orange and grapefruit groves. The most frequently captured migrant species were Black-and-white Warbler (*Mniotilta varia*) and Magnolia Warbler (*Dendroica magnolia*), which together composed 36% of the 509 neotropical migrants of 25 species captured during more than 3300 net hours. The Rufous-tailed Hummingbird (*Amazilia tzacatl*) was the most common of the 37 species of neotropical residents that were netted. These numbers and proportions of overwintering migrants are higher than previously reported from any other habitat on the Yucatan peninsula, but citrus plantations are not suitable for all migratory species.

TASA DE MIGRATORIOS Y RESIDENTES NEOTROPICALES PASANDO EL INVIERNO EN UNA PLANTACIÓN DE CITROSAS EN LA PARTE CENTRAL DE BELIZE

Sinopsis.—De los pájaros capturados con redes en una plantación de citrosas de Belize, los migrantes invernales formaron parte del 61.3% de todos los individuos y el 40.3% de todas las especies atrapadas durante el invierno de 1986–1987 y 1987–1988. El porcentaje de migratorios varió de 50 a 80.6% de los individuos en cuatro siembras de chinas y una de toronjas. Los migratorios más frecuentemente capturados resultaron ser *Mniotilta varia* y *Dendroica magnolia*, los cuales compusieron el 36% de los 509 migratorios atrapados pertenecientes a 25 especies, en 3300 hrs. de captura con redes. El zumbador *Amazilia tzacatl* resultó ser el más común de las 37 especies de aves residentes capturadas. Los números y proporciones de migratorios invernales son los más altos de todos los previamente informados de cualquier otro tipo de habitat de la Península de Yucatán, aunque las plantaciones de cítricos no es habitat apropiado para todas las especies migratorias.

Large numbers of migratory landbirds pass through the Yucatan Peninsula during fall (Bossong 1988, Buskirk 1968, Mills and Rogers 1990) and spring (Mills 1989, Rogers et al. 1982, Rogers and Odum 1966),

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and many species and individuals overwinter on the peninsula (Leck 1985, Lynch 1989, Tramer 1974, Waide et al. 1980). Deforestation reduces the number of bird species present in an area (Terborgh 1980), but some replacement habitats may offer refuge for many species. Lynch (1989) found that some migrant species could be found in a variety of habitats on the Yucatan Peninsula, but a number of species (e.g., Common Yellowthroat *Geothlypis trichas,* Indigo Bunting *Passerina cyanea*) were much more common in brushy, second growth, while others (e.g., Black-and-white Warbler *Mniotilta varia,* Kentucky Warbler *Oporonis formosus*) favored mature forest.

Several studies have examined neotropical migrant numbers within such disturbed tropical habitats as lawns and farms (Leck 1985), coconut plantations (Hutto 1980), Maya ruins (Tramer 1974, Waide 1980), and urban areas (Tramer 1974), but few studies (Nickell 1968, Rogers et al. 1982) have examined migrant numbers and species composition within citrus plantations.

Citrus plantations are used extensively by migrating birds during fall and spring (Mills and Rogers 1990, Rogers et al. 1982), but there is little published information concerning the suitability of these habitats for overwintering neotropical migrants. Nickell (1968) found that citrus groves located near second-growth forests were productive mist-netting sites. Here we report on the numbers of neotropical migrant and resident birds found in citrus (orange and grapefruit) orchards in central Belize.

METHODS

We placed 9–15 mist nets (12 × 2.6 m, 36 mm mesh) in citrus orchards in central Belize during two successive winters (22 Nov. 1986–28 Feb. 1987, 27 Dec. 1987–15 Jan. 1988). Four to five nets were placed in 100 m lines between tree rows, and these net lines were about 50 m apart. Mist nets have been used in other regions and habitat types of the Yucatan Peninsula to assess relative numbers of birds (Bossong 1988; Lynch 1989, 1992; Rogers et al. 1982; Tramer 1974; Waide et al. 1980). We recognize that mist nets may overestimate the relative abundance of species that forage at lower levels within a forest, and may fail to capture species that are restricted to the canopy level. We do not believe that our data are significantly influenced by these biases, however, because of the relatively low canopy height within the orchards.

The four orange groves and one grapefruit grove we studied were located within a citrus plantation owned by Belize Groves Management Company Limited, located at 17°10'N, 88°40'W, on the Western Highway, Cayo District. We banded neotropical migrants with U.S. Fish and Wildlife Service bands, and marked residents by clipping a small portion (0.5 cm) of an outer tail feather. Structural characteristics of the citrus groves were measured using the methods of James and Shugart (1970). Tree height and diameter were fairly uniform within a citrus grove because all trees in a given orchard block are planted at the same time. The four orange orchards (14–16 yr old) varied in mean tree height (5.0–

7.6 m), mean trunk diameter (21.0–27.7 cm) and canopy cover (64–76%). The grapefruit orchard was of unknown age, and had a mean tree height of 6.81 m (±0.87 SD), mean trunk diameter of 37.16 cm (±3.34 SD), and an estimated canopy cover of 80%. Tree height was significantly different among the five citrus orchards (One-Way ANOVA, df = 100, $F = 129.23$, $P < 0.001$).

Within the five orchards we studied, we moved the nets every 3–4 d to lessen the problem of net shyness. Due to the open canopy structure of the orchards, we rarely netted after 1200 hours to avoid subjecting the birds to heat stress. Netting efforts (total net hours = 3324.5) for the five study sites are given at the bottom of Table 1.

The study site was situated in the transition zone from pine savannah and hardwood forest, and the type of native vegetation surrounding the plantation has been classified as semi-rainforest (Lundell 1945). The study sites within the plantation were less than 100 m from mature forest. The farm contains dense second-growth, as well as fields planted in vegetables and grains. Winter (November–February) falls during the early portion of the annual dry season in Belize, and the plantation received 676 mm of rainfall during this period in 1986–1987 (B. Sokolsky, pers. comm.). The average annual precipitation in central Belize is about 2500 mm (Wilson 1980). Water for birds and insects is plentiful year-round because the nearby Sibun River does not stop flowing during the dry season.

We sampled arthropods within each citrus grove on four occasions, using a 31.5-cm diameter muslin sweep net (Janzen 1973) between 0800 and 1000 hours in December 1986, and January, February and March 1987. Each 1-d collection consisted of three sets of 50 continuous sweeps made in a straight line, over a total length of 228 m at each site. One set of 50 sweeps was taken over the grass, one in the air and the third by brushing the net against the citrus trees. Each sweep was an arc of 2 m and covered an area of about 1 m^2 (Whittaker 1952). All arthropods that were collected were measured to the nearest 0.25 mm of body length and identified to Order.

RESULTS AND DISCUSSION

We captured 509 overwintering neotropical migrants of 25 species (Table 1), and 321 permanent residents of 37 species (Table 2) during 3324.25 net hours. Neotropical migrants made up 50.0–69.1% of the total avifauna in the four orange groves, and 80.6% in the grapefruit orchard (Table 3). For the five groves combined, neotropical migrants composed 61.3% of the total individuals and 40.3% of the species in our sample. Black-and-white Warbler and Magnolia Warbler (*Dendroica magnolia*) made up 19% and 15.7%, respectively, of the overwintering migrants. The subfamily Parulinae accounted for 69% (351/509) of the overwintering migrants captured and 48% (12/25) of the species. The most frequently netted non-parulines were Indigo Bunting ($n = 32$), Ruby-throated Hummingbird, *Archilochus colubris* ($n = 24$), White-eyed Vireo,

TABLE 1. Overwintering neotropical migrant species and numbers captured in mist nets in citrus orchards in central Belize, Central America.

Species	GF[1]	#2	#2a	#3	#4	Total
Ruby-throated Hummingbird, *Archilochus colubris*	0	4	4	6	10	(*n* = 24)
Eastern Wood-Pewee, *Contopus virens*	0	1	0	0	0	(*n* = 1)
Yellow-bellied Flycatcher, *Empidonax flaviventris*	0	1	1	2	0	(*n* = 4)
Least Flycatcher, *E. minimus*	0	2	3	0	1	(*n* = 6)
Wood Thrush, *Hylocichla mustelina*	2	4	8	6	0	(*n* = 20)
Gray Catbird, *Dumatella carolinensis*	3	2	8	0	4	(*n* = 17)
White-eyed Vireo, *Vireo griseus*	0	8	6	6	3	(*n* = 23)
Blue-Winged Warbler, *Vermivora pinus*	0	2	5	4	1	(*n* = 12)
Tennessee Warbler, *V. peregrina*	0	1	0	1	4	(*n* = 6)
Northern Parula Warbler, *Parula americana*	0	1	0	1	0	(*n* = 2)
Magnolia Warbler, *Dendroica magnolia*	7	27	15	22	9	(*n* = 80)
Yellow-throated Warbler, *D. dominica*	0	1	0	0	0	(*n* = 1)
Black-and-white Warbler, *Mniotilta varia*	9	25	15	27	21	(*n* = 97)
American Redstart, *Setophaga ruticilla*	2	11	13	11	7	(*n* = 44)
Worm-eating Warbler, *Helmitheros vermivorus*	1	2	0	2	1	(*n* = 6)
Ovenbird, *Seiurus aurocapillus*	3	1	1	4	2	(*n* = 11)
Northern Waterthrush, *S. noveboracensis*	16	1	3	3	4	(*n* = 27)
Common Yellowthroat, *Geothlypis trichas*	2	19	8	5	15	(*n* = 49)
Hooded Warbler, *Wilsonia citrina*	5	2	3	4	2	(*n* = 16)
Summer Tanager, *Piranga rubra*	0	1	0	2	4	(*n* = 7)
Rose-breasted Grosbeak, *Pheucticus ludovicianus*	0	0	0	0	1	(*n* = 1)
Blue Grosbeak, *Guiraca caerulea*	0	0	0	0	2	(*n* = 2)
Indigo Bunting, *Passerina cyanea*	0	7	7	8	10	(*n* = 32)
Orchard Oriole, *Icterus spurius*	0	0	1	0	13	(*n* = 14)
Baltimore Oriole, *I. galbula*	0	2	0	0	5	(*n* = 7)

[1] (GF) grapefruit orchard = 9 nets, 3–5 h/d for 8 d (net hours = 254.5). (#2) orange orchard #2 = 9–15 nets, 2–6 h/d for 27 d (net hours = 1423.5). (#2a) orange orchard #2a = 8–11 nets, 2–5 h/d for 13 d (net hours = 475.5). (#3) orange orchard #3 = 10–15 nets, 2–5 h/d for 11 d (net hours = 579.5). (#4) orange orchard #4 = 11 nets, 2–6 h/d for 12 d (net hours = 591.5).

Vireo griseus (*n* = 23), Wood Thrush, *Hylocichla mustelina* (*n* = 20) and Gray Catbird, *Dumatella carolinensis* (*n* = 17).

The most frequently netted neotropical residents were Rufous-tailed Hummingbird (*Amazilia tzactl*), Ochre-Bellied Flycatcher (*Mionectes oleagineus*), Blue-gray Tanager (*Thraupis episcopus*) and Clay-colored Robin (*Turdus grayi*). These species plus six other species of hummingbirds (Long-tailed Hermit, *Phaethornis superciliosus,* Little Hermit, *P. longuemareus,* White-Necked Jacobin, *Florisuga mellivora,* Green-breasted Mango, *Anthracothorax prevostii,* White-bellied Emerald, *Amazilia candida* and Azure-crowned Hummingbird, *A. cyanocephala*) composed 48.6% (156) of the residents. All 10 species are commonly found in disturbed habitats (Peterson and Chalif 1973). This may illustrate the effects of habitat conversion to monoculture.

Based on sweep samples, the potential food supply for insectivores was virtually limited to small insects (3.80–5.39 mm length) at a density of about 0.81 individuals/m^2. Resident neotropical insectivores tend to have

TABLE 2. Neotropical resident species and numbers captured in mist nets in citrus orchards during winter in central Belize, Central America.

Species	GF[1]	#2	#2a	#3	#4	Total
Plain-breasted Ground-Dove, *Columbina minuta*	2	0	0	0	0	(n = 2)
Blue Ground-Dove, *Claravis pretiosa*	1	6	2	6	7	(n = 22)
White-tipped Dove, *Leptotila verreauxi*	0	0	0	0	2	(n = 2)
Gray-chested Dove, *L. cassinii*	0	0	0	1	0	(n = 1)
Ruddy Quail-Dove, *Geotrygon montana*	0	0	0	0	1	(n = 1)
Groove-billed Ani, *Crotophaga sulcirostris*	0	0	0	0	1	(n = 1)
Long-tailed Hermit, *Phaethornis superciliosus*	0	2	1	0	0	(n = 3)
Little Hermit, *P. longuemareus*	0	2	1	0	0	(n = 3)
White-necked Jacobin, *Florisuga mellivora*	0	1	1	2	1	(n = 5)
Green-breasted Mango, *Anthracothroax prevostii*	0	0	1	2	10	(n = 13)
White-bellied Emerald, *Amazilia candida*	0	4	1	2	5	(n = 12)
Azure-crowned Hummingbird, *A. cyanocephala*	0	0	0	0	2	(n = 2)
Rufous-tailed Hummingbird, *A. tzacatl*	0	8	10	12	20	(n = 50)
Collared Aracari, *Pteroglossus torquatus*	0	0	0	3	0	(n = 3)
Golden-fronted Woodpecker, *Melanerpes aurifrons*	2	4	0	2	10	(n = 18)
Golden-olive Woodpecker, *Piculus rubiginosus*	0	1	1	0	0	(n = 2)
Ivory-billed Woodcreeper, *Xiphorhynchus flavigaster*	0	1	2	1	3	(n = 7)
Streak-headed Woodcreeper, *Lepidocolaptes souleyetii*	0	0	0	0	1	(n = 1)
Ochre-bellied Flycatcher, *Mionectes oleagineus*	0	16	3	2	1	(n = 22)
Yellow-olive Flycatcher, *Tolmomyias sulphurescens*	0	1	0	1	1	(n = 3)
Royal Flycatcher, *Onychorhynchus coronatus*	0	3	3	1	1	(n = 8)
Bright-rumped Attila, *Attila spadiceus*	0	1	0	1	0	(n = 2)
Dusky-capped Flycatcher, *Myiarchus tuberculifer*	2	7	5	4	2	(n = 20)
Brown-crested Flycatcher, *M. tyrannulus*	0	4	2	2	2	(n = 10)
Great Kiskadee, *Pitangus sulphuratus*	1	4	2	2	2	(n = 11)
Social Flycatcher, *Myiozetetes similis*	0	2	2	0	0	(n = 4)
Red-capped Manakin, *Pipra mentalis*	0	7	3	1	1	(n = 12)
Brown Jay, *Cyanocorax morio*	0	2	0	0	0	(n = 2)
Clay-colored Robin, *Turdus grayi*	3	5	3	4	14	(n = 29)
Red-legged Honeycreeper, *Cyanerpes cyaneus*	1	6	0	0	0	(n = 7)
Yellow-throated Euphonia, *Euphonia hirundinacea*	0	0	0	0	2	(n = 2)
Blue-gray Tanager, *Thraupis episcopus*	0	2	0	1	24	(n = 27)
Yellow-winged Tanager, *T. abbas*	0	0	0	1	1	(n = 2)
Buff-throated Saltator, *Saltator maximus*	0	0	0	0	2	(n = 2)
White-collared Seedeater, *Sporophila torqueola*	0	3	2	2	0	(n = 7)
Thick-billed Seed-Finch, *Oryzoborus funereus*	0	0	0	0	2	(n = 2)
Melodious Blackbird, *Dives dives*	0	0	0	0	1	(n = 1)

[1] GF = Grapefruit, #2–#4 = Orange orchards #2–#4.

relatively large bills (mean length = 16.0 mm; Schoener 1971), suggesting that they probably do not commonly feed on insects that are smaller than ca. 5 mm in length. Willis (1980) found that small insects (<5 mm in length) formed less than 10% of the diet of resident insectivorous birds in Panama. These small insects are more suitable as food for smaller-billed neotropical migrants (mean bill length = 11.8 mm; Schoener 1971). The decaying fruits in the citrus groves attracted many small insects. We frequently observed several migrant species feeding on these insects, and the tops of the bills of some individuals became caked with orange pulp

TABLE 3. Numbers and percentages of wintering birds captured in mist nets in citrus orchards in Belize, Central America.

Orchard	# migrants	# residents	migrant species	resident species	% migrant individuals	% migrant species	Net hours
Grapefruit	50	12	10	7	80.6	58.0	254.25
Orange 2	125	92	22	23	57.6	48.8	475.50
Orange 2a	101	45	16	18	69.1	47.0	1423.50
Orange 3	114	53	17	21	68.3	44.7	579.50
Orange 4	119	119	20	26	50.0	43.5	591.50

from probing fruit. Conversion of tropical forest to monoculture orchards may decrease the mean size of insects that are available to resident insectivores, but may be more favorable to migrants.

The highest percentage of overwintering neotropical migrants previously reported from mist net data from any habitat in the Yucatan Peninsula is 48% (Waide et al. 1980). Lynch (1989) found 58.2% migrants (seven species) in coastal mangrove forest using point counts. Using a combination of point counts and mist-net surveys, Lynch (1992) estimated that overwintering migrants composed 41% of the individuals in areas of the northern Yucatan Peninsula. Lynch (1989) also found that migrants composed 25–28% of mist net captures in Quintana Roo. Hutto (1980) reported that neotropical migrants composed 70.6% of the species and 51.2% of the individuals captured in mist nets in a coconut plantation in western Mexico. Other migrant percentages reported from mist-net data include Panama, 5–25% (Karr 1976); Hispaniola, 3–46% (Terborgh and Faaborg 1980); and Colombia, 0–24% (Orejuela et al. 1980). Waide et al. (1980) caught more neotropical species and individuals in mist nets in successional areas away from human disturbance, and noted that migrant percentages increased southward and eastward across the Yucatan Peninsula. This trend would predict a greater overwintering migrant percentage in our study area than in Waide et al.'s (1980) study because Belize lies in the southeastern part of the Yucatan Peninsula. Although the citrus plantation we studied is a heavily modified habitat, it is subjected to little day-to-day human activity. Noise from the workers and machinery on the farm did not appear to frighten away migrants. Thus, the combination of geographical location, a local abundance of small insects, a scarcity of large insects that might attract resident insectivores and a low level of local human activity, all may contribute to the unusually large proportion and absolute abundance of neotropical migrants found in these citrus orchards.

Belize devotes about 5000 ha of land (10% of the agricultural land) to citrus production (Hartshorn et al. 1984). As tropical forests are replaced by food crops to support economic development in Central America, some neotropical migrants are likely to decline in abundance. This is especially

true for species that are limited to closed canopy, moist forests (Lynch 1989). Citrus plantations offer refuge for many species of overwintering migrants, however, and may represent an alternative that is preferable to the conversion of forests to pasture or field crops.

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