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FIRST DESCRIPTION OF THE NEST AND EGGS OF THE ISLAND-ENDEMIC COZUMEL VIREO, *VIREO BAIRDI*

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ABSTRACT.—We report the first description of the nest, eggs, and nesting phenology of the Cozumel Vireo (*Vireo bairdi*), a passerine species endemic to Isla Cozumel, México. We discovered three nests of this species in 2009. These open-cup nests were woven onto branches and hung beneath forks. Clutch size was 2–3 eggs, and eggs were ovate and had a white ground color with reddish-brown flecks. These characteristics of nests and eggs are similar to those of most other *Vireo* spp., including other West Indian members of the *Vireo* subgenus. Breeding activities, including egg-laying, incubation, and nestling and post-fledging provisioning occurred from May to July 2009. We estimated the length of incubation to be ~14 days and length of the nestling stage to be 11–12 days. Much of the Cozumel Vireo's breeding biology remains unknown and further study of this single-island endemic is needed. *Received 25 March 2012. Accepted 6 July 2012.*

The vireos (Vireonidae) comprise 52 species that range from North to South America, including many islands (Brewer and Orenstein 2010). *Vireo,* largest of the family's four genera, contains 31 species with ~61% mostly or wholly restricted to tropical latitudes including the nine species restricted to islands (Raffaele et al. 1998, Brewer and Orenstein 2010). A temperate-zone bias (*cf.* Stutchbury and Morton 2001) characterizes knowledge of the breeding biology of vireos: species nesting in Canada and the United States are overall better known than neotropical and Southern Hemisphere counterparts. The nests and eggs of several vireos breeding in México and Central and South America remain undescribed (Brewer and Orenstein 2010).

Two recognizable groups are distinguishable within *Vireo* on the basis of plumage (Hamilton 1962): (1) species with eye-rings and wing-bars in the subgenus *Vireo*, and (2) species with eye-stripes and lacking wing-bars in the subgenus *Vireosylva*. Johnson et al. (1988) recommended abandoning this dichotomy based on allozyme evidence, but phylogenetic analysis using mitochondrial DNA sequence data (Murray et al. 1994) supported recognition of the two subgenera. The 'eye-ring' group includes eight little-studied species endemic to the West Indies or the adjacent Caribbean Coast of México and Central America; one of the most range-restricted species among these is the Cozumel Vireo (*V. bairdi*).

The Cozumel Vireo is endemic to Isla Cozumel, Quintana Roo, México (Howell and Webb 1995, AOU 1998). The species' breeding biology is wholly unknown (Brewer and Orenstein 2010). Early records described the species as ''very common'' (Griscom 1926:11) and ''more frequently encountered than any other species in woodland and secondary growth'' (Bond 1961:45). The Cozumel Vireo remains abundant (JBL, RLC, and JEMG, pers. obs.) despite the presence of feral cats (*Felis catus*) and dogs (*Canis familiaris*) as well as other recently introduced potential predators, including a snake (*Boa constrictor*, present since the early 1970s; Martínez-Morales and Cuarón 1999, Romero-Nájera et al. 2007) and black rats (*Rattus rattus*; Engstrom et al. 1989). Our objectives are to report the first descriptions of the Cozumel Vireo's nest, eggs, and nesting phenology, and to compare our observations with available data for other 'eye-ring' vireos (*cf.* Hamilton 1962).

METHODS

Study Area.—We observed vireo nests during fieldwork (May–Jul 2009) on Cozumel focused on Black Catbird (*Melanoptila glabrirostris*) breeding biology. Cozumel is in the Caribbean Sea, ~17.5 km off the Yucatán Peninsula's coast, separated from the mainland by a deep channel; it has a land area of ~490 km^2 (BirdLife International 2012). Most of the island's vegetation is semi-deciduous or tropical deciduous forest with

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relatively low canopy height influenced by hurricanes; recent hurricanes that have directly impacted Cozumel include Gilbert (1988), Roxanne (1995), Emily (2005), and Wilma (2005). Our study site was a set of paths leading from an area known locally as Pueblo Fantasma (20° 26′ 54″ N, 86° 57′ 32″ W), an isolated and mostly abandoned residential development (Howell 1999:311) ~6 km south of San Miguel, the island's primary town. This area was easily accessible with vegetation representative of Cozumel's interior forests.

Nest Searching and Monitoring.—JBL discovered three Cozumel Vireo nests while systematically searching for catbird nests. We checked nest contents every 1–3 days (although one nest-check interval lasted 8 days).

Measurements.—We measured nest height from nest bottom and top, tree height, nest circumference, distance to stem, and angled distance to stem using a tape measure. We used calipers to measure nest and egg dimensions.

OBSERVATIONS

Nesting Cycle and Nesting Phenology.—JBL discovered the first Cozumel Vireo nest (#1) on 1 June 2009 (Fig. 1) containing two eggs at 1136 and 1830 hrs (CST). The nest contained three eggs on 2 June 2009 at 1114 hrs. The last day we observed the nest with eggs was 15 June 2009 at 1051 hrs, and we observed two recently-hatched chicks and one un-hatched egg in the nest on 17 June 2009 at 1854 hrs. Incubation lasted ~14 days if we assume incubation began with clutch completion (2 Jun 2009) and the chicks hatched on 16 June 2009, the day between the last observation of three eggs and the first observation of chicks. One chick disappeared from the nest between 1116 hrs on 23 June 2009 and 0731 hrs on 25 June 2009, and the remaining chick disappeared from the nest between 1821 hrs on 27 June 2009 and 1040 hrs on 28 June 2009. We infer this remaining chick's successful fledging based on (1) the sound of a chick calling in the vicinity of the nest, and (2) the unhatched egg being intact, suggesting the nest was not depredated. The nestling stage lasted ~11 days.

A second Cozumel Vireo nest (#2) contained one recently hatched chick and one egg on date of discovery (17 Jun 2009 at 0955 hrs) and two chicks and no eggs at the next nest check (19 Jun 2009 at 1835 hrs). This nest last contained two chicks on 29 June 2009 and was empty on 30 June 2009. We infer successful fledging of at least one chick from this nest based on the presence of an adult Cozumel Vireo persistently scold-calling in the immediate vicinity on 30 June and 1 July 2009. These observations suggest the nestling stage lasted ~12 days if we assume (1) the eggs hatched on the day of nest discovery and (2) at least one chick successfully fledged. The approximate total length of the nesting cycle, including egg-laying, incubation, and nestling stages, is ~27–28 days, combining data from both nests.

A third nest (#3), discovered with two eggs at 1014 hrs on 20 June 2009, yielded incomplete data because of abandonment. We observed a bird incubating at 1712 hrs on 20 June 2009, at 0952 hrs on 21 June 2009, and at 0936 hrs on 23 June 2009. Two eggs were present on 28 June 2009, but a leaf covered both at 0717 hrs on 29 June 2009. The leaf remained on 2 July 2009, which suggests the parents abandoned this nest between 23 June 2009 and 29 June 2009.

JBL observed an adult *V. bairdi* provisioning a well-developed fledgling (i.e., flying with the adult) at 1607 hrs on 22 June 2009 in an area separate from the three vireo nests. This observation suggests at least one successful nest was initiated before the end of May, if we assume a nesting cycle of 27–28 days. Our combined observations indicate that Cozumel Vireos breed from late May through June. If nest #3 had not been abandoned, it likely would have been active at least into the beginning of July, which would extend the known breeding period.

Nest Description.—Each of the three nests hung between two horizontal forks of a lateral branch with the rim woven about the supporting branches (Fig. 1A). Each nest's outer cup comprised plant fibers interwoven with spider silk and well-decomposed leaves, and adorned with bits of lichen, bark, and thin, black rootlets (Fig. 1A). The nest lining consisted of an open network of thin, dried grass fragments (Fig. 1B). Nest dimensions (Table 1) varied because of differences associated with position of the nest rim in relation to the supporting branches.

All three nests were placed low (< 2 m) in relatively short trees (< 2.7 m), at varied distances from the main stem (Table 1). Floral parts necessary for definitive identification were absent, but the plant supporting one nest was identified as a member of the family Myrtaceae (possibly *Eugenia* sp.; Israel Acosta-Rosado, pers. comm.).

FIG. 1. Nest and eggs of the Cozumel Vireo on Isla Cozumel, México (Nest #1). (A) External structure and hanging posture of nest. (B) Eggs and internal nest structure. (Photographs by J. B. LaPergola).

TABLE 1. Measurements of Cozumel Vireo nests and eggs with comparative data for closely related species in the *Vireo* subgenus.

Parameter	Species					
	Cozumel Vireo, *V. bairdi*[a]			Mangrove Vireo, *V. pallens*[b]	San Andres Vireo, *V. caribaeus*[c]	Thick-billed Vireo, *V. crassirostris*[d]
	Nest #1	Nest #2	Nest #3			
Bottom nest height (cm)	162.0	114.0	155.0	100	124 ± 49	91–122
Top nest height (cm)		124.5	163.5			
Nest tree height (cm)	268.0	237.0	201.5		260 ± 138	
Front external nest depth (mm)	53.0	69.6	65.3	68.7[c]	60, 70	63.5
Back external nest depth (mm)	76.4	62.0	64.4	75.6[d]		
Front internal nest depth (mm)	44.0	44.5	38.0	37.1[c]	45, 40	38.1
Back internal nest depth (mm)	54.0	39.0	40.5	50.2[d]		
Widest internal diameter (mm)	47.5	60.3	55.4	50.1	50, 40	57.2
Narrowest internal diameter (mm)	44.3	45.7	55.3	33.1	40, 35	
Widest external diameter (mm)	66.3	70.5	68.1		60, 60	76.2
Narrowest external diameter (mm)	65.4	50.0	65.8		50, 50	
Internal opening circumference (mm)	144.5	152.0	151.0			
Horizontal distance to stem (cm)	13.1	30.0	0.8	140.0	90 ± 113	
Angled distance to stem (cm)		44.0	1.3			
Clutch size	3	≥2	2	3	2 ± 1	2–3
Egg length (mm)	20.2			17.6	19, 18	19.2 ± 0.3
Egg width (mm)	14.4			13.8	12.5, 13	14.5 ± 0.7
Nesting period		May–Jul		May–Jun	Jan–Jun	Mar–Jul
Incubation period (days)		14			17	
Nestling period (days)		11–12			9	
Adult mass (g)[g]		11.2–14.6		8.9–13	8.6–10	11–16.2

[a] This study.
[b] Figueroa and Albanese (2003), $n = 1$ nest and $n = 1$ egg.
[c] Measured from the lower of two horizontal supporting twigs.
[d] Measured from the higher of two horizontal supporting twigs.
[e] Gómez-Montes and Moreno (2008), mean ± SD, $n = 19$ nests for dimensions, $n = 10$ nests for clutch size; Barlow and Nash (1985), individual measurements, $n = 2$ eggs, $n = 2$ nests.
[f] Brudenell-Bruce (1975), nests ''most often'' at heights shown (full range 61–366 cm); Maynard (1893:96), $n = 4$ eggs.
[g] Brewer and Orenstein (2010).

We collected two nests after the chicks fledged. We deposited nest #1 and its remaining egg in the National Collection of Birds (Instituto de Biología de la Universidad Nacional Autónoma de México, accession IBUNAM: CNAV: N029140), and nest #2 in the Museo de Zoología of El Colegio de la Frontera Sur, Chetumal, México.

Description of Eggs, Hatching Success, and Nesting Success.—Clutch size was three eggs in nest #1, at least two eggs in nest #2, and two eggs in nest #3. All observed eggs ($n = 6$) were oval to short oval in shape (Baicich and Harrison 1997) and had white ground color with reddish-brown flecks concentrated toward the broad end (Fig. 1B). The egg we collected measured 20.2 × 14.4 mm (length × width).

Hatching success varied. Two of three eggs in nest #1 hatched; both eggs in nest #2 hatched; and neither egg in nest #3 hatched, likely because the parents abandoned the nest prior to completion of incubation.

Parents at two of the three nests appeared to have fledged young. We inferred fledging success

based on (1) the presence of adult Cozumel Vireos emitting alarm or scold calls close to each nest during the first days we observed them empty, and (2) the highly developed state of nestlings (primaries and secondaries completely lacking sheaths) on the last day observed in nests #1 and #2.

JBL and JGMH candled the eggs in nest #3 on 8 July 2009 using a headlamp. Neither egg showed signs of development, but we returned both to the nest. One egg had broken before we checked the nest on 15 July 2009; we collected the remaining intact egg but it broke in transit.

DISCUSSION

Our observations represent, to our knowledge, the first account of the nest, eggs, and breeding phenology of the Cozumel Vireo. Sample sizes are limited, but available data indicate that several aspects of the species' breeding biology are consistent with those of other 'eye-ring' vireos, including other members of the same superspecies (AOU 1998) within the *Vireo* subgenus: White-eyed Vireo (*V. griseus*) and Mangrove Vireo (*V. pallens*).

Cozumel Vireos, by suspending nests from forked branches of a small tree and by using plant fibers and spider silk for exterior walls and grass fibers for lining, are typical of most Vireonidae (Baicich and Harrison 1997). Incorporation of more varied construction materials by White-eyed Vireos, including use of rootlets and hair in the lining (Hopp et al. 1995), probably reflects more diverse contexts for nest-building across that sister species' wide geographic range. The only described nest of the Mangrove Vireo, from a highland area in Belize, differed by having a lining of pine needles (Figueroa and Albanese 2003), a resource not available on Cozumel. By including prominent dead leaves in exterior walls, Cozumel Vireo nests especially resemble those of the island-endemic San Andres Vireo (*V. caribaeus*) (Barlow and Nash 1985), although lacking the dead leaves that hang from the bottom of San Andres nests.

Measures of nest dimensions permit comparisons with species for which data are available (Table 1). Values from the three Cozumel Vireo nests encompass those for Mangrove Vireo with regard to four parameters, but front internal nest depth and narrowest internal diameter were larger for the slightly heavier Cozumel species. Most Cozumel Vireo nest dimensions were greater than those for the considerably smaller San Andres Vireo, whereas nests of the Thick-billed Vireo (*V. crassirostris*), with body size roughly similar to that of Cozumel Vireo, appear to have smaller interior dimensions but larger exteriors.

Precise data concerning canopy height on Cozumel are not available, but the rather low height of Cozumel Vireo nests ($\sim$ 1.5 m above ground) may reflect use of small shrubs and saplings (2–3 m tall) and not larger trees (up to 15 m) that are present in our study area, as in most of Cozumel's forests (JBL, JEMG, and RLC, pers. obs.). The tendency to place nests relatively low in vegetation is fairly consistent across other 'eye-ring' vireos (e.g., $<$ 1 m nest height in White-eyed Vireo; Hopp et al. 1995), including those on islands (Table 1), although higher nest placement (mean height = 4.9 m) by Puerto Rican Vireos (*V. latimeri*) in montane habitat (Tossas 2008) suggests flexibility within the subgenus. Detection bias favoring low nests may complicate some comparisons.

Cozumel Vireo clutch size appears to reflect broad latitudinal trends (Martin 1996), but its eggs may be comparatively large. Cozumel Vireos produce smaller clutches, at two to three eggs, than most temperate-zone congeners; for example, clutch size in White-eyed Vireos averages four eggs (Hopp et al. 1995). Cozumel Vireo clutch size approximates that of congeners breeding at similar latitudes (Thick-billed and Mangrove vireos), but exceeds that of the more southerly San Andres Vireo (Table 1). The Cozumel Vireo egg we measured was longer than that of the similar-size Thick-billed Vireo and larger overall than eggs of the smaller Mangrove, San Andres, and White-eyed vireos (Table 1; Hopp et al. 1995), but more data are needed to definitively characterize egg dimensions of *V. bairdi*.

Our limited observations regarding breeding success provide a preliminary basis for comparisons. Hatching success (67%) in nest #1, which yielded our most detailed information, was lower than that of eggs in unparasitized Puerto Rican Vireo nests (86%; Woodworth 1997). Our sample suggested relatively high fledging success (67% of nests producing at least one fledgling). Other insular *Vireo* spp. may have higher rates of nest failure; for example, 63% of Puerto Rican Vireo nests were depredated (Tossas 2008).

The observed nesting period of the Cozumel Vireo is somewhat shorter than other insular 'eye-ring' vireos, but the length of its incubation and nestling stages are more typical (Table 1). Limited

duration of fieldwork might account for our relatively brief estimate of the Cozumel Vireo's nesting period (~ 2.5 months) and observation of only one brood per pair. However, we predict that Cozumel Vireos may attempt multiple broods over a protracted season, as do some Caribbean vireos (e.g., Puerto Rican Vireo; Woodworth 1997) and some other passerines in the Yucatán region (e.g., Black Catbird; JBL, unpubl. data). The incubation and nestling stages of the Cozumel Vireo were slightly shorter and longer, respectively, than those of the San Andres Vireo, but were close to those of other 'eye-ring' vireos including, for example, the White-eyed Vireo (incubation: 13–15 days, nestling stage: 9–11 days; Hopp et al. 1995).

The Cozumel Vireo is currently considered a species of Least Concern (BirdLife International 2012), but insular taxa constitute a disproportionately large percentage of threatened bird species with declines frequently attributable to newly arrived predators and parasites (e.g., Blackburn et al. 2004). Vireos and their nests may be vulnerable to predation by boas and introduced mammals on Cozumel, but confirmation is needed. We detected no interspecific brood parasitism in the three Cozumel Vireo nests we observed. However, cowbird parasitism significantly affects several closely related vireos including, for example, Black-capped Vireo (*V. atricapilla*), parasitized by Brown-headed Cowbirds (*Molothrus ater*) (Grzybowski 1995), and Puerto Rican Vireo, parasitized by Shiny Cowbirds (*M. bonariensis*) (Woodworth 1997). Recent expansion of Shiny Cowbirds into the Yucatán represents a potential conservation threat for Cozumel Vireos (Kluza 1998).

Detailed basic natural history data for Cozumel Vireo and other poorly known species will be crucial for management decisions. Practical research issues are raised by similarity between the nest and eggs of *V. bairdi* and those of the sympatric Yucatan Vireo (*V. magister*), but eggs of Cozumel Vireo appear to be more heavily speckled than those of Yucatan Vireo (JBL, pers. obs.). The adults of the two species differ considerably in size (*V. bairdi* = 11.2–14.6 g; *V. m. magister* = 16.7–22.5 g; Brewer and Orenstein 2010) and belong to different subgenera, but more data are needed to develop criteria that can be used to identify nests and eggs of these species in the absence of adults.

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