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TEMPORAL, SPATIAL, AND ANNUAL VARIATION IN THE OCCURRENCE OF MOLT-MIGRANT PASSERINES IN THE MEXICAN MONSOON REGION

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Abstract. Adults of several species of western North American passerines are known to migrate to the Mexican monsoon region to undergo molt from July to October before continuing migration to their wintering grounds in the neotropics, but little is known about the biology and habitat requirements of these birds on their molting grounds. Therefore we established 13 banding stations during the monsoon seasons of 2007 and 2008 in southeastern Arizona, central Sonora, and central Sinaloa. We studied the spatial and temporal occurrence of 10 previously known and 9 new species of molt migrants on the molting grounds. In many of these species most or all individuals appeared to undertake molt migration but in others it appeared to be limited to a small proportion of the population, underscoring that molt migration must be defined at the level of the individual rather than of the population. Our results suggest that during the drier 2007 monsoon season molt migrants sought out riparian habitats, whereas in the wetter 2008 season, when the flush of vegetation was greater, they were more widely distributed in drier habitats. Site fidelity to molting grounds was virtually zero, significantly less than site fidelity to banding stations on breeding and winter grounds. Our results suggest that molt migration to the Mexican monsoon region is a stochastic or plastic process, substantially influenced by individual choices related to variation in weather and the preceding breeding season. Our study also emphasizes the need to conserve a mosaic of habitats in the monsoon region appropriate for molting birds.

Key words: *molt*, *migration*, *monsoon*, *fidelity*, *Lucy's Warbler*, Vermivora luciae.

Variación Temporal, Espacial y Anual en la Presencia de Aves Paseriformes Migratorias durante la Etapa de Muda en la Región Monzónica Mexicana

Resumen. Se sabe que los adultos de varias especies de Paseriformes del oeste de América del Norte migran a la región monzónica de México para mudar desde julio hasta octubre antes de continuar con la migración hacia sus áreas de invernada en el Neotrópico. Sin embargo, se sabe poco sobre la biología y los requerimientos de hábitat de estas aves en sus áreas de muda. Por lo tanto, establecimos 13 estaciones de anillado durante las estaciones monzónicas de 2007 y 2008 en el sudeste de Arizona, centro de Sonora y centro de Sinaloa. Estudiamos la ocurrencia espacial y temporal de 10 especies previamente conocidas y de 9 especies nuevas que mudan en los sitios de muda migratoria. En muchas de estas especies, la mayoría o todos los individuos migran hacia sitios en que comienzan la muda, pero en otras, esta migración hacia los sitios de muda parece estar limitada a una proporción pequeña de la población, enfatizando la necesidad de definir la migración para muda al nivel del individuo más que al de la población. Nuestros resultados sugieren que durante la estación monzónica seca de 2007, los migrantes en muda buscaron hábitats ribereños, mientras que en la estación más húmeda de 2008, cuando la expansión de la vegetación fue mayor, éstos estuvieron más ampliamente distribuidos en los hábitats secos. La fidelidad de sitio a las áreas de

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muda fue cercana a cero y significativamente menor que la fidelidad de sitio a las estaciones de anillado en las áreas de cría e invernada. Nuestros resultados sugieren que la migración hacia los sitios de muda en la región monzónica de México es un proceso estocástico o plástico, influenciado sustancialmente por las elecciones individuales relacionadas a la variación en el clima y en la estación de cría precedente. Nuestro estudio también enfatiza la necesidad de conservar un mosaico de hábitats en la región del monzón apropiado para las aves que mudan.

INTRODUCTION

Most adult landbirds undergo a complete prebasic molt following breeding, but the locations of this molt are not well understood, as it may occur on or near the breeding grounds, on or near the winter grounds, or both (Pyle 1997a, Rohwer et al. 2005). Adults of several species of western North American passerines are now known to follow a unique strategy, migrating after breeding to the monsoon region of the southwestern United States and northwestern Mexico, where they stop and molt between July and October before continuing migration to their wintering grounds in the neotropics (Rohwer et al. 2005, Butler et al. 2006, Rohwer et al. 2007; Fig. 1). These species apparently take advantage of a flush of vegetation that follows the monsoon, providing more nutrients than found in the increasingly drier habitats of the breeding grounds at this time of year.

On the basis of specimens, adults of at least 12 species of passerines undertake molt migration to the Mexican monsoon region. But specimen evidence may not be adequate to document the full geographic and temporal extent of this phenomenon (Rohwer et al. 2007), and it is also possible that other molt-migrant species have yet to be detected (Leu and Thompson 2002, Rohwer et al. 2005). In addition, it has often been assumed that most or all adults of molt-migrant species undergo molt migration, but the possibility exists that only a proportion of a species' population may undertake molt migration in a given year (cf. Young 1991, Butler et al. 2006, Barry et al. 2009), as affected by climate, age, geographic location of breeding and wintering, and/or timing and success of the breeding season. Also, how much site fidelity molt migrants show from year to year is completely unknown. Because molt and its associated physical processes are among the most energy-demanding events of a bird's annual cycle (Murphy and King 1991), the maintenance of high-quality stopover habitat for molt migrants is critical for managing these species' populations (Trejo and Dirzo 2000, Leu and Thompson 2002, Heglund and Skagen 2005, Barry et al. 2009). However, virtually nothing is known about the habitat selection or biology of molt migrants during this important molt-migration period (Rohwer et al. 2005) or of how the strategies of molt migrants vary with annual variation

FIGURE 1. Generalized molt migration strategy of the Lazuli Bunting (below; see also Young 1991) and locations of our 13 study sites (above) within the Mexican monsoon region. Arrows in map below represent migration stages, two in fall and one in spring. Black circles, "wet" stations with perennial water flow; white circles, "dry" stations with ephemeral or no water flow. See Table 1 for more information on the stations.

in rainfall during the monsoon season (cf. Comrie and Glenn 1998, Butler et al. 2002, Hu and Feng 2002).

To investigate the ecology of molt migrants and to begin to identify critical habitat requirements of molt-migration-stopover sites, we established 13 capture stations and conducted area-search surveys during the monsoon seasons of 2007 and 2008 in southeastern Arizona, central Sonora, and central Sinaloa (Fig. 1). Here we report on the temporal, spatial, and annual variation in the distribution of molt migrants as determined through captures, and we assess the occurrence of molt migration in species for which it has not yet been documented. The monsoon season of 2007 was substantially drier than that of 2008, and we interpret results showing annual differences accordingly. We also assess the degree to which molt migrants return to the same location to molt in successive years.

METHODS

We established 13 capture stations at three widely spaced locations within west-central portions of the Mexican monsoon region (Comrie and Glenn 1998; Fig. 1), in southeastern Arizona (7 stations), central Sonora (2 stations), and central Sinaloa (4 stations). We selected stations and net sites in a variety of riparian, mesquite-, oak-, and cottonwood-dominated habitats in an effort to determine habitat preferences for birds in molt. Each station was assessed for habitat and scored as having perennial water flow ("wet station") or ephemeral or no water flow ("dry station"). We classified eight stations as dry and five as wet (Fig.1, Table 1).

Six to 15 mist-net locations were established within a 200-ha area at each station, and each station was operated for 6–13 days per season between 1 July and 9 October in 2007 and between 2 July and 25 September in 2008 (Table 1). All captured birds were banded and measured according to protocols developed for the Monitoring Avian Productivity and Survivorship (MAPS) program (DeSante et al. 2008). Birds were aged as in their first calendar year (HY) or in at least their second calendar year (adult or AHY) by plumage, degree of skull pneumatization, and extent of primary wear (Pyle 1997a). Many AHYs that had not completed the prebasic molt were further separated as in their second calendar year (SY) or in at least their third calendar year (ASY) by molt limits among the secondary coverts and flight feathers (Pyle 1997a, b).

We scored the status of each primary on all birds of all age groups by Young's (1991) system. Old feathers were given a score of 0.0, new feathers 1.0, and composite scores for an individual bird ranged from 0.0 (molt had not commenced) to 9.0 or 10.0 (indicating that 9-primaried and 10-primaried passerines, respectively, had completed molt); we considered birds to be actively molting if composite molt scores for primaries were greater than zero and less than complete. We also scored body molt by the MAPS protocol (DeSante et al. 2008) as absent (0), trace (1), light (2), medium (3), or heavy (4). HYs of certain species that do not replace primaries during the preformative molt were considered in active molt if their body-molt score was 3 or 4.

This study originally focused on species reported in the literature as molt migrants from specimens, but we also

TABLE 1. Capture stations operated during the 2007 and 2008 monsoon seasons; see Figure 1 for locations of each station.

		2007			2008		
Station[a]	Wet or dry[b]	Days	Dates	Net-hours[c]	Days	Dates	Net-hours[c]
Southeastern Arizona							
Tumacacori (TUMA)	Wet	6	7 Jul–8 Sep	219	6	26 Jul–30 Aug	220
Florida Canyon (FLAC)	Dry	7	8 Jul–9 Sep	267	7	2 Jul–31 Aug	174
Birdland (BILA)	Dry	7	14 Jul–13 Sep	300	—	—	
Ramsey Canyon (RAAV)	Dry	6	1 Jul–7 Oct	116	7	4 Jul–1 Sep	264
San Pedro–Pipeline (SPPI)	Dry	13	13 Jul–12 Sep	656	10	20 Jul–1 Sep	573
San Pedro House (SPHO)	Dry	13	5 Jul–3 Oct	575	10	3 Aug–25 Sep	300
San Pedro–Hereford SPHE)	Wet	13	17 Jul–14 Sep	700	11	19 Jul–3 Sep	539
Sonora							
San Jose de la Pima (SJDP)	Wet	7	11 Jul–19 Aug	185	—	—	—
Rancho la Poza (POZA)	Dry	12	10 Jul–29 Aug	300	—	—	—
Sinaloa							
Imala (IMAL)	Dry	9	28 Jul–24 Sep	295	6	14 Aug–4 Sep	135
Floresta (FLST)	Wet	—	—	—	6	2 Aug–19 Sep	285
Jardín Botanico (BCLN)	Wet	12	29 Jul–22 Sep	595	9	8 Aug–18 Sep	440
Cosalá (CSLA)	Dry	8	21 Aug–9 Oct	320	7	29 Aug–18 Sep	161
Total		113	1 Jul–9 Oct	4528	79	2 Jul–25 Sep	3091

[a] Abbreviations correspond to stations mapped in Figure 1.
[b] Wet, perennial water flow; dry, ephemeral or no water flow (see text).
[c] Sum of each 12-m net being operated for 1 hr at a station.

captured adults of other species undergoing molt. Many of these were locally breeding or resident birds reported to molt on the breeding grounds (Pyle 1997a, Rohwer et al. 2005), and we excluded these from further consideration. We also captured apparent molt migrants of additional species outside of core breeding and wintering ranges. We assessed breeding and wintering ranges from Howell and Webb (1995), Corman and Wise-Gervais (2005), *Birds of North America* accounts, and unpublished banding and observation data we recorded from the capture stations and surrounding areas.

RESULTS

The 13 capture stations were operated on 113 days for a total of 4528 net-hours in 2007 and 79 days for a total of 3091 net-hours in 2008 (Table 1). For various logistical reasons (primarily rain, flooding, and access) the numbers of stations, days, and net-hours were fewer in 2008 than in 2007. During this effort we recorded 2755 captures, including 1669 individual AHYs, of which 470 (28.2%) were undergoing active molt, and 749 HYs, of which 298 (39.8%) were undergoing active molt. Recaptures and birds of unknown age account for the remainder of the captures.

OCCURRENCE OF MOLT MIGRANTS

During this study we captured molting AHYs of ten species known to undergo molt migration (Table 2). The occurrence and proportion of molt migrants, although based on variable capture effort at the three locations and small samples sizes in some cases, suggest that AHY Painted Buntings favor the southern portion of our study area to molt whereas AHY Lucy's Warblers, Lazuli Buntings, and Lesser Goldfinches favor the northern portions (see Table 2 for scientific names), in correspondence with specimen-based studies (see below). All nonmolting AHYs of these ten species had primary scores of 0.0, indicating that molt had not commenced, with the exception of 14 Lesser Goldfinches captured in Arizona and two Painted Buntings captured in Sinaloa (with scores of 9.0) that had completed the prebasic molt. Data on the occurrence of HYs of these species were sparser but suggest similar patterns in distributions of molting birds, perhaps with the exception of the Ash-throated Flycatcher, of which a higher proportion of HYs than AHYs captured in Arizona appeared to be molting (see Butler et al. 2006).

Molting AHYs of nine additional species were captured outside of core breeding and wintering ranges, and we assume these individuals to have been molt migrants (Table 2). We

TABLE 2. Adults captured and proportion in molt for known and suspected molt migrants to the Mexican monsoon region.

	Proportion in molt (*n*)[a]					
	AHY			HY		
Species	Arizona	Sonora	Sinaloa	Arizona	Sonora	Sinaloa
Known molt migrants[b]						
Western Kingbird, *Tyrannus verticalis*	0.00 (1)	1.00 (1)	— (0)	— (0)	0.00 (1)	— (0)
Ash-throated Flycatcher, *Myiarchus cinerascens*	0.10 (20)	0.00 (1)	0.75 (4)	0.75 (4)	— (0)	— (0)
Warbling Vireo. *Vireo gilvus*[c]	0.20 (10)	— (0)	0.00 (1)	— (0)	— (0)	— (0)
Lucy's Warbler, *Vermivora luciae*	0.96 (47)	0.50 (2)	— (0)	0.73 (15)	0.40 (5)	— (0)
Western Tanager, *Piranga ludoviciana*[c]	0.47 (9)	— (0)	1.00 (1)	0.13 (8)	— (0)	— (0)
Black-headed Grosbeak, *Pheucticus melanocephalus*[c]	0.15 (41)	— (0)	0.00 (1)	0.16 (19)	— (0)	— (0)
Lazuli Bunting, *Passerina amoena*	0.38 (151)	1.00 (1)	— (0)	0.12 (52)	— (0)	0.00 (1)
Painted Bunting, *Passerina ciris*	0.00 (3)	0.33 (3)	0.56 (32)	0.50 (2)	— (0)	0.70 (10)
Bullock's Oriole, *Icterus bullockii*	1.00 (2)	1.00 (1)	1.00 (2)	0.00 (5)	— (0)	— (0)
Lesser Goldfinch, *Carduelis psaltria*	0.31 (72)	— (0)	0.00 (7)	0.40 (15)	— (0)	— (0)
Additional evidence for molt migration[d]						
Yellow-green Vireo, *Vireo flavoviridis*[c]	— (0)	— (0)	0.17 (29)	— (0)	— (0)	0.00 (6)
Phainopepla, *Phainopepla nitens*	0.50 (2)	1.00 (2)	— (0)	1.00 (2)	1.00 (4)	— (0)
Nashville Warbler, *Vermivora ruficapilla*[c]	0.40 (5)	— (0)	— (0)	0.00 (4)	— (0)	— (0)
Green-tailed Towhee, *Pipilo chlorurus*[c]	0.07 (14)	— (0)	— (0)	0.17 (6)	— (0)	— (0)
Chipping Sparrow, *Spizella passerina*[c]	0.82 (11)	— (0)	— (0)	0.42 (7)	— (0)	— (0)
Lark Sparrow, *Chondestes grammacus*	0.00 (4)	— (0)	1.00 (2)	0.33 (3)	— (0)	— (0)
Indigo Bunting, *Passerina cyanea*	0.33 (6)	1.00 (1)	— (0)	0.00 (1)	— (0)	— (0)
Orchard Oriole, *Icterus spurius*	— (0)	— (0)	0.50 (2)	— (0)	— (0)	1.00 (1)
Streak-backed Oriole, *Icterus pustulatus*	— (0)	— (0)	0.30 (20)	— (0)	— (0)	1.00 (3)

[a] Number of individual adults captured and the proportion undergoing active flight-feather molt.
[b] Species known as molt migrants from evidence presented by Rohwer and Manning (1990), Thompson (1991), Young (1991), Voelker and Rohwer (1998), Butler et al. (2002, 2006), Rohwer et al. (2005, 2007), and Barry et al. (2009).
[c] Active molt in HYs defined as moderate to heavy body molt, as in this species flight feathers are not typically replaced during the preformative molt.
[d] Species captured in active molt outside of core breeding and wintering ranges (see text).

captured at least two molting AHYs of each of these species except the Green-tailed Towhee and Orchard Oriole; of the Green-tailed Towhee two additional migrants were captured in molt at the Florida Canyon station in September and October 2004, outside of this study, and one was captured in 2007 with worn primaries (molt score 0.0), suggesting that the single molting AHY captured during this study was not anomalous. AHYs of these species not in active molt had primary-molt scores of 0.0 in all cases except for eight of 12 Yellow-green Vireos in Sinaloa, all three Nashville Warblers in Arizona, 12 of 13 Green-tailed Towhees in Arizona, and five of 14 Streak-backed Orioles in Sinaloa that had been captured after molt had completed (primary-molt scores 10.0 or 9.0). Data on HYs are again sparser but suggest that at least some Phainopeplas, Green-tailed Towhees, Chipping Sparrows, and Lark Sparrows can undergo the preformative molt at stopover sites, although the dynamics of molt in HYs are not necessarily consistent with those of AHYs.

Among 490 AHYs of the 19 molt-migrant species, 145 were aged as SY and 189 were aged as ASY. Sixty-nine of the 145 SYs were in active molt (47.6%), whereas 49 of the 189 ASYs were in molt (25.9%), a significant difference (logistic regression, $P < 0.01$). Within a species this ratio was generally similar, although all 8 AHY Western Tanagers undergoing active molt in Arizona were SYs.

Five additional migratory taxa of which at least 10 AHYs were captured showed no active molt or evidence for molt migration. These were the Willow Flycatcher (*Empidonax traillii*; $n = 10$ AHYs, mean primary score = 0.0), Western Flycatcher (*Empidonax difficilis/occidentalis*; 30, 0.0), MacGillivray's Warbler (*Oporornis tolmiei*; 137, 9.0), Wilson's Warbler (*Wilsonia pusilla*; 54, 9.0), and Blue Grosbeak (*Passerina caerulea*; 46, 0.0). Thus our study confirms previous suggestions that most or all Willow and Western flycatchers and Blue Grosbeaks molt on the winter grounds, whereas MacGillivray's and Wilson's warblers molt on the summer grounds.

ANNUAL VARIATION IN MOLT-MIGRATION DYNAMICS

On the basis of the nine stations operated in both years, AHYs of the 19 molt-migrant species (Table 2) combined were captured at slightly but not significantly higher rates in 2008 than in 2007 (Table 3). Proportions of AHYs in molt were higher in 2007 than in 2008 for 16 of 19 species, with only Lucy's Warbler, Lazuli Bunting, and Green-tailed Towhee showing higher proportions of molting birds in 2008. For all 19 molt-migrant species combined the proportion was significantly higher in 2007 than in 2008 (Table 3, Fig. 2).

When data from both years and all 13 stations were combined, 94 of 335 (28.1%) molt-migrant AHYs captured at dry stations were molting and 112 of 185 (60.5%) AHYs captured at wet stations were molting, a significant difference (logistic regression, $P < 0.001$). On the basis of data from the nine stations operated in both 2007 and 2008, the proportion of molting AHYs at dry stations was slightly but not significantly higher in 2007 than in 2008, whereas at wet stations the proportion was significantly higher in 2007 than in 2008 (Fig. 2).

TABLE 3. Annual variation in capture rates and proportion of molting AHY birds recorded at stations monitoring molt migration.

	Captures per 600 net-hr[a]		Percentage in molt	
Species	2007	2008	2007	2008
Ash-throated Flycatcher	0.64	2.14	0.50	0.10
Warbling Vireo	0.80	1.28	0.20	0.17
Lucy's Warbler	5.77	2.32	0.94	1.00
Western Tanager	1.60	1.92	0.60	0.44
Black-headed Grosbeak	1.73	5.77	0.36	0.04
Lazuli Bunting	11.06	17.53	0.30	0.44
Painted Bunting	2.56	0.64	0.19	0.00
Bullock's Oriole	0.64	0.00	1.00	—
Lesser Goldfinch	8.82	5.13	0.31	0.21
Total[b]	41.36	45.82	0.42	0.29

[a] According to standard MAPS analytical protocols (DeSante et al. 2008).
[b] Total includes all 19 species of molt migrants (Table 2); the proportion of molting birds was significantly higher in 2007 than in 2008 (logistic regression, $P < 0.01$).

SITE FIDELITY TO MOLTING GROUNDS

Among 248 AHY molt migrants captured in 2007 at stations that operated in both 2007 and 2008, only one Lazuli Bunting was captured in both years (Table 4). It was an ASY female captured on 16 August 2007 and again on 30 August 2008, in active molt each year, at the San Pedro Hereford Station, Arizona. The fidelity rates of 15 species of molt migrants captured

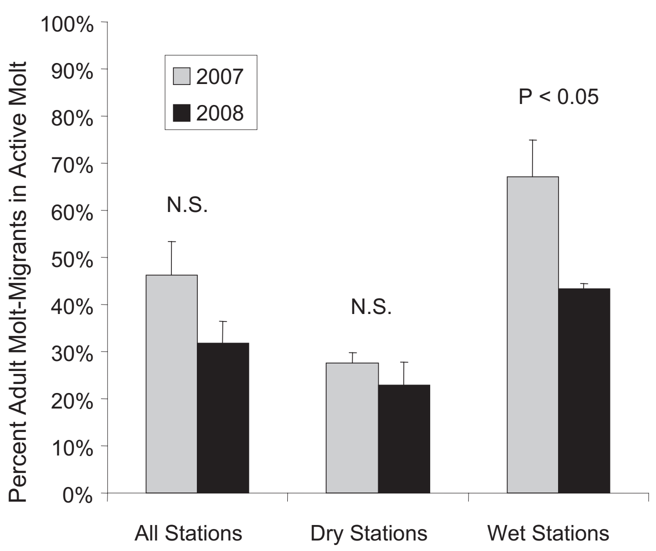

FIGURE 2. Proportion of AHY (adult) molt migrants captured at stations monitoring molt migration, showing variation between 2007 (a dry monsoon year) and 2008 (a wet monsoon year), significant for wet stations and not significant for all stations combined and dry stations, on the basis of logistic regression. Bars represent standard errors.

TABLE 4. Site fidelity of molt migrants on molting, breeding, and winter grounds.

Species	Proportion of adults returning (n)[a]		
	Migration (2007–2008)	Breeding season (1989–2003)[b]	Winter (2002–2007)[c]
Ash-throated Flycatcher	0.00 (4)	0.11 (910)	0.03 (69)
Warbling Vireo	0.00 (5)	0.12 (6417)	0.03 (202)
Lucy's Warbler	0.00 (36)	0.10 (385)	0.00 (1)
Western Tanager	0.00 (10)	0.08 (2037)	0.01 (211)
Black-headed Grosbeak	0.00 (11)	0.13 (4371)	0.02 (132)
Lazuli Bunting	0.01 (69)	0.09 (2158)	0.08 (13)
Painted Bunting	0.00 (16)	0.14 (1576)	0.01 (517)
Bullock's Oriole	0.00 (4)	0.15 (1544)	0.06 (60)
Lesser Goldfinch	0.00 (55)	0.07 (1532)	0.00 (118)
Total[a,d]	0.004 (230)	0.12 (27 207)	0.02 (2739)

[a]Total includes 15 species of western North American molt migrants (migration data from Table 2, the Yellow-green Vireo, Indigo Bunting, Orchard Oriole, and Streak-backed Oriole excluded).
[b]Data from MAPS stations (DeSante et al. 2005, 2008).
[c]Data from Monitoreo de Sobrevivencia Invernal stations (Saracco et al. 2008).
[d]For total, the analysis included species as a term in the model, to control for interspecific variation in fidelity rates.

in 2007 were therefore lower than those recorded by similar methods at MAPS stations on the breeding grounds and lower than or equal to those recorded at Monitoreo de Sobrevivencia Invernal (see Saracco et al. 2008) stations on these species' winter grounds (Table 4).

DISCUSSION

Despite small sample sizes in several cases, our results for known molt-migrant species are consistent with and contribute to those reported in the literature for the Western Kingbird (Barry et al. 2009), Ash-throated Flycatcher (Butler et al. 2006), Warbling Vireo (Voelker and Rohwer 1998), Western Tanager (Butler et al. 2002), Black-headed Grosbeak (Rohwer et al. 2005), Lazuli Bunting (Young 1991), Painted Bunting (Thompson 1991), Bullock's Oriole (Rohwer and Manning 1990), and Lesser Goldfinch (Rohwer et al. 2005). Some of these species may have breeding or wintering ranges that overlap our study area, but the lack of site fidelity at our study sites suggests that they were not breeding or winter residents there. For Lucy's Warbler, Rohwer et al. (2007) found that at least some individuals of both adults (AHY) and young (HY) move south of the United States to molt, and our data suggest that at least some of both age groups also molt in Arizona. This species breeds in the vicinity of our capture stations in Arizona; however, in the second year of the study we recaptured no Lucy's Warblers in Arizona, unlike some other locally breeding migrants such as Bell's Vireo (*Vireo bellii*) and the Yellow-breasted Chat (*Icteria virens*). The capture rates in 2007 being higher than in 2008 suggest a local influx for molting related to seasonal weather patterns (see below). In addition, Leitner's several years of capture data indicate that Lucy's Warblers depart the canyon-oak habitat at the Florida Canyon station before molting but that there is an influx of adults to molt in mesquite and cottonwood-riparian habitats at the Tumacacori station, suggesting that in this species molt migration may be as much between habitats as between geographic locations.

As predicted by Leu and Thompson (2002) and Rohwer et al. (2005) we documented apparent molt migrants of nine additional species breeding in western North America and of two species, the Indigo Bunting and Orchard Oriole, that breed primarily in eastern North America but regularly migrate through the monsoon area to wintering grounds and are thus logical candidates for molt migrants to this area. The Orchard Oriole is supposed to molt on the winter grounds, but documentation on precise molting localities is sparse, and there is no reason to assume that all individuals proceed to winter grounds to molt. The location of the Indigo Bunting's molt is poorly documented (Pyle 1997a). Our results underscore how little we know about the precise locations of prebasic molts relative to breeding and wintering grounds in common and well-studied species of North American passerines.

Among western taxa, the Phainopepla, Western Chipping Sparrow (*Spizella passerina arizonae*), and Lark Sparrow (see also Rohwer et al. 2005) breed in drier areas where resources become limited in late summer, so these species should benefit by moving to the monsoon region to molt. The majority of individuals of two species, the Nashville Warbler and Green-tailed Towhee, were captured with fresh primaries, suggesting that they had molted on or near breeding grounds, as has been presumed for these species (Pyle 1997a, Rohwer et al. 2005). Evidently only a proportion of these species undertakes molt migration, and we suggest that this inconsistency may have been based on individuals' choices related to climate, nutrient availability, and/or their breeding-season dynamics. That we found significantly more SYs than ASYs molting can perhaps be explained by the fact that first-time breeding SYs are less likely to have bred successfully and may thus have chosen to depart the breeding grounds early to molt in the monsoon region.

Molting adults of two tropical species, the Yellow-green Vireo and Streak-backed Oriole, were also captured away from known breeding and wintering locations in Sinaloa, suggesting that adults may migrate from breeding locations in Mexico to the monsoon region to molt. Species with similar distributions that may undergo molt migration (not detected in our capture data) include Nutting's Flycatcher (*Myiarchus nuttingi*), Tropical Kingbird (*Tyrannus melancholicus*), and Thick-billed Kingbird (*T. crassirostris*). That Yellow-green Vireos were molting in the monsoon region is especially interesting given that they have been presumed, like the closely related Red-eyed Vireo (*Vireo olivaceus*), to molt in South America (Pyle 1997a). Patterns of molt in the Red-eyed Vireo complex in North and South America are an interesting topic for further study.

National Weather Service data indicate that in Arizona the 2007 monsoon season was the fifth driest and that the 2008 season was the tenth wettest from 1896 to 2008 (http://www.wrh.noaa.gov/twc/monsoon/monsoon_phx.php), and throughout the monsoon region rainfall totals were substantially higher in 2008 than in 2007 (http://www.climas.arizona.edu/forecasts/BorderClimateSummary_Oct08.pdf). We captured higher proportions of molting AHYs in 2007 than in 2008, and this difference was most substantial at stations with perennial water flow. We suggest that molt migrants were forced to seek out riparian habitats during the drier 2007 monsoon season, when surrounding habitats may not have held the resources necessary for molt, whereas in 2008 molt migrants had more choices among drier habitats that presumably experienced a greater vegetational flush in 2008 than in 2007. Molting birds may also seek out more cover, and increased cover related to flushes of vegetation in dry habitats during wetter years could also help explain these results. Molt migrants' virtual lack of site fidelity at our stations between 2007 and 2008 may reflect this seasonal contrast, or it may indicate that site fidelity is not part of molt-migration strategy.

Overall, the results of our study suggest that molt migration to the Mexican monsoon region is a stochastic or plastic process, substantially influenced by individual rather than species-wide choices and related to proximal dynamics of climate and the breeding season. It should thus be defined at the level of the individual rather than of the species. We predict that the proportion of individuals undertaking molt migration within these species varies annually with the quality of the breeding season and the availability of nutrients on the breeding grounds, molting route, and winter grounds during the molting period. During wetter breeding seasons or when nutrients are more abundant on the breeding grounds, more individuals may opt to molt on or near breeding territories. Similarly, during drier monsoon seasons (such as 2007) more individuals may opt to continue on to the winter grounds to molt, as Young (1991) found for a proportion of Lazuli Buntings. Our study also emphasizes the need to conserve appropriate habitats in the monsoon region for molting birds but that pinpointing optimal habitats may be difficult given the variability of molt migration (see also Butler et al. 2002). Molt migrants' apparent need for riparian habitats for molt during drier monsoon seasons underscores the need to protect such habitats in the Mexican monsoon region.

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