VARIABILITY PROFILES FOR LINE TRANSECT BIRD CENSUSES IN A TROPICAL DRY FOREST IN MEXICO[1]

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Abstract. Seasonal and temporal patterns of species diversity and abundance in the avifauna of Chamela, Jalisco, Mexico, were studied in different habitats in the coastal tropical dry forest. Species richness did not differ among three different transects. The number of species was temporally homogeneous. Species diversity was similar for all three transects, but it changed to higher values during the rainy season at arroyo habitats and during the dry season (winter) at disturbed habitats. Population fluctuations observed in the second year of the study suggest that stochastic events such as droughts in this region may influence local population dynamics. Patterns of population fluctuation of resident species are discussed with regard to censusing methods and conservation priorities.

Key words: *Species diversity; variability profiles; Jalisco; Mexico; population fluctuations; conservation.*

Resúmen. Se estudiaron los patrones estacionales y temporales de diversidad y abundancia de la avifauna de Chamela, Jalisco, México en distintos habitats de la selva baja caducifolia de la costa. La riqueza de especies no difiere entre transectos y es homogénea temporalmente. La diversidad de especies es similar entre transectos, pero el valor del índice aumenta durante la época húmeda a lo largo de los arroyos y durante la época de secas (invierno) en las zonas perturbadas. Las fluctuaciones en el tamaño de las poblaciones observadas durante el segundo año del estudio sugieren que eventos estocásticos como las sequías en la región pueden afectar la dinámica de las poblaciones a nivel local. Los patrones de fluctuaciones de las poblaciones de especies residentes son discutidos en términos de la metodología usada para censar y en cuanto a su prioridad de conservación.

Palabras clave: *Diversidad de especies; perfiles de variabilidad; Jalisco; México; fluctuaciones de poblaciones; conservación.*

INTRODUCTION

Monitoring temporal changes of avifaunas can provide invaluable information about factors influencing population dynamics, interactions, community structure, and conservation. Seasonal changes in density and number of species have been studied in several temperate avian communities (e.g., Best 1981, Anderson et al. 1981; for a review see Ralph and Scott 1981), but rarely in tropical regions (see Karr 1981 and Blake 1992).

We were interested in determining what factors modify avian behavior, producing fluctuation in diversity and density of each species throughout time. In this study, we examined variation in avian numbers and species richness over two years at specific sites in a tropical dry forest in western Mexico, and investigate the factors that account for variation. Our study of two of the driest years recorded (Márquez-Valdelamar 1987) suggests that: (1) forest resident species, as opposed to wintering species which are
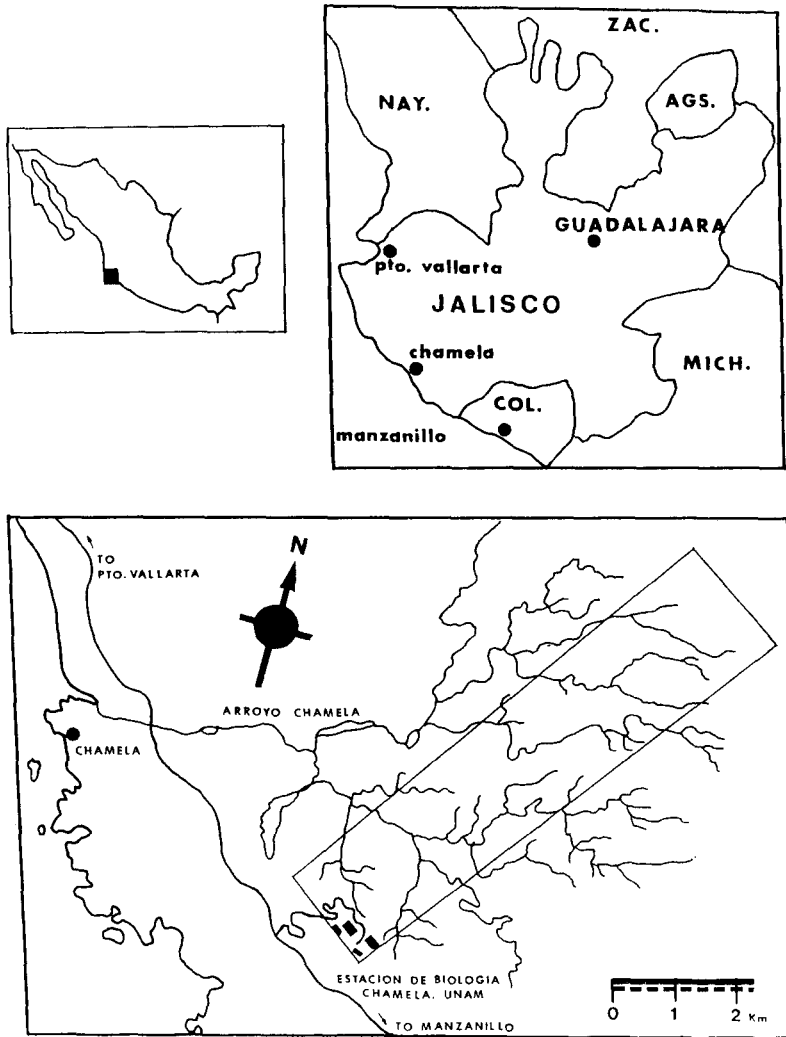
FIGURE 1.   Geographic location of study site. Enclosed area in the bottom figure indicates current extent that belongs to the Estación de Biología Chamela, UNAM.

habitat generalists in this area (Hutto 1980; this study), are more sensitive to drier years; (2) seasonal diversity changes of the Chamela avian community were obscured by the use of an index of diversity; and (3) the higher diversity expected in the most diverse habitat (arroyos) was not found in this study.

STUDY AREA

The study was conducted in the Estación de Biología "Chamela" (105°05′W, 19°33′N) between January 1985 and December 1986. The station belongs to the Instituto de Biología, Universidad Nacional Autónoma de México (UNAM). It is

located on the Pacific Coast of Jalisco (Fig. 1), at km 59 on federal road 200 (Barra de Navidad-Puerto Vallarta) at Municipio La Huerta. The area includes 1,585 ha; elevation varies from 10 to 500 m above sea level. Mean annual rainfall is 748 mm (CV = 16% for eight years; Bullock 1986) with a long dry season extending from November into June, and a mean annual temperature of 24.9°C (details on climate are given by Bullock 1986).

The station contains areas of tropical dry deciduous forest with some patches of tropical semi-deciduous forest along the arroyos (Lott et al. 1987). This area exceeds other similar tropical

areas in Central America in number of plant species (Lott et al. 1987). Some species common to tropical dry forest are *Cordia alliodora, Croton pseudoniveus, Croton* sp. nov., *Lonchocarpus lanceolatus, Trichilia trifolia, Thouinia parvidentata, Caesalpinia eriostachys* and *Rhandia thurberi.* The tropical semideciduous forest has as its most common species *Thovinidium decandrum, Brosimum alicastrum* and *Lideroxylum capiri.* (A complete vegetation description is given by Lott et al. 1987.)

METHODS

We collected natural history data (e.g., on foraging, reproduction, and molting) for the most common resident species by direct observations and mist-netting in the study area every month. Every month for several days we placed at different areas of the station a total of 10 mist-nets to collect physiological and mensural data. From every captured bird, we obtained the following measurements: total body length, wing chord, exposed culmen, tail length, and body mass. We also recorded whether the bird was molting and whether there was any indication of breeding (e.g., cloacal enlargement, incubation patch).

We used Emlen's (1971, 1977) method to conduct monthly censuses for two years (1985 and 1986) at each transect. Three permanent transects (2 km long and 100 m wide; 20 ha) were used to determine differences on species composition between them.

For the purposes of this study, we chose the longest three trails at the station where we could have transects that differed from one another in vegetation composition. (1) El Tejón (on the hillsides of the station) is mostly tropical dry deciduous forest, (2) Eje Central (parallel to arroyo Colorado) is tropical semideciduous forest, and (3) La Virgencita (at 2 km north of station) is a disturbed cultivated area with patches of tropical dry forest and a small population of *Acacia* sp. These transects do not differ in total plant species number, but Eje Central has twice as many species of vine species and a greater number of large trees than the uplands (e.g., El Tejón; Lott et al. 1987).

Each transect was divided longitudinally into seven parallel strips to decrease error when estimating lateral distance (five of 3 m wide, one of 10 m wide, and one of 25 m wide) for each side of the transect line. Each bird detected was assigned into the corresponding lateral strip. We

spent an average of 100 min per census ($\bar{x} = 99.9$, SD = 19.3), but it varied among transects because of topographic differences among them (El Tejón, $\bar{x} = 113.6$, SD = 33.8; Eje Central, $\bar{x} = 113.5$, SD = 24.4; La Virgencita, $\bar{x} = 72.5$, SD = 27.5). Topographical differences among transects could have influenced bird species composition as well as our ability to detect birds and estimate lateral distances (Dawson 1981). However, we were restricted by the length of the trails at the station, and were very familiar with the rugged terrain of this area. We always censused in mornings 30 min after first light, under similar meteorological conditions. Recommendations made by Emlen (1971, 1977) and Skirvin (1981) for conducting censuses were followed by the observers.

Seventy-two censuses were performed over 24 months (130 hr). However, to acquire confidence on bird identification, we dedicated the first five months of our study to familiarizing the observers with local avifauna. The data collected in those months were eliminated, and only data from the last 57 censuses were used for our analysis.

We derived coefficients of detectability (CD) for every species detected in our censuses. CD values were estimated following Emlen's steps (1971; p. 331). Estimations of CD values were based on the assumption that the observer detects nearly 100% of the individuals in the first lateral strips (i.e., 0–3 m on each side of the transect). If birds were not detected at a given strip for a particular species, we used as a value the expected number of birds that one would detect at that particular lateral distance under the assumption described earlier.

The translation of a transect count for a given species into a population estimate or density (D) was effected by dividing the count by the appropriate CD value of the species. Thus, if 10 Cinnamon Hummingbirds were found along 2 km (20 ha) of transect through El Tejón in May, and a CD value of 0.25 was established for that particular period of time, then the derived estimate per hectare would be two Cinnamon Hummingbirds per hectare (for details on calculations see Emlen 1971; p. 332). Density values were obtained to estimate changes in diversity (Shannon-Wiener index; Shannon 1948) and the degree of similarity of similarity between transects (Sorensen's index; Feinsinger et al. 1981).

Seasonal variation in density among transects

was explored using analysis of variance (ANO-VA). We sorted density data for all detected species into four seasons (spring: from March to May, summer: from June to August, fall: from September to November, and winter: from December to February). All ANOVA were carried out with the same density values we used in the other analyses.

We also performed an analysis of concordance among variability profiles (after Sokal and Braumann 1980). The variation in density values for each species among transects was plotted against a horizontal axis representing the species as a character for each transect (Sokal and Braumann 1980). For this purpose, mean density values were calculated for each species on each transect. If one species was not detected in one transect for any particular census (e.g., missing values), we assigned a zero density value to balance out our data (by definition). Mean density values per species per transect were then ranked, and overall concordance of the profiles was tested using the non-parametric Friedman's test. This analysis assumes normality; therefore, we log-transformed the density values to approximate normality (Sokal and Rohlf 1981). Then we calculated the modified coefficient of variation (V^*) (see Sokal and Braumann 1980 for details in calculations) for density values for all species in our censuses. This correction factor suppresses biases when the data are not normally distributed.

Because it was crucial to determine what factors, if any, contribute to variation, we evaluated a model formed by the factors TRANSECT, MONTH, and SPECIES by Three-way Contingency Table Analysis (GLIM, version 3.77) using the same basic data. From this analysis, we determined the percentage of information explained by each factor and the interactions among them. Other statistical routines were performed using SAS (version 6.03) procedures.

RESULTS

A total of 153 species was recorded at the station during this study, but only 104 were detected during censusing. Arizmendi et al. (1990) reported 270 species for the Chamela region, including species found in coastal habitats and seabirds along the Pacific Coast. Of species recorded during this study (153), 61% were resident, 31.6% were latitudinal migrants (including summer and winter migrants), 3.3% were vagrants, and 1.1% were of unknown status.
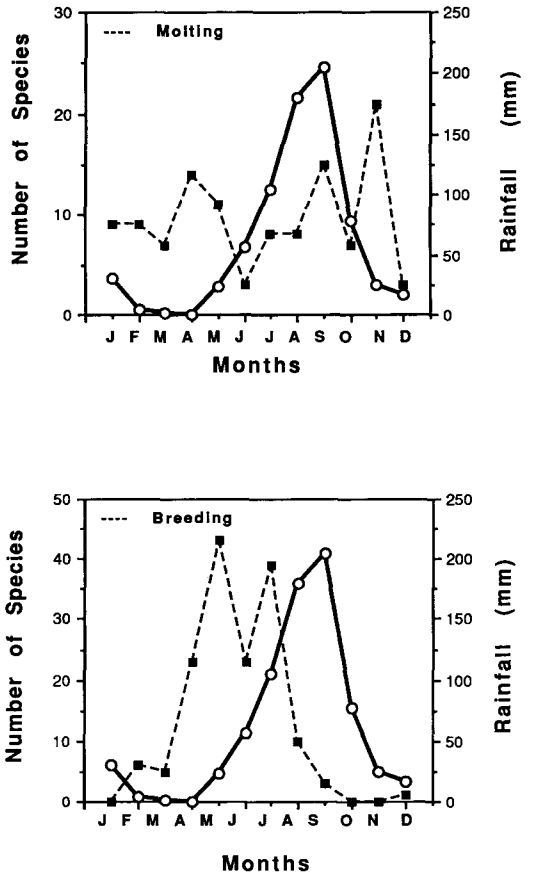

FIGURE 2.   Molting and breeding patterns of the avian community at Chamela, Jalisco, México. These seasonal patterns are contrasted against rainfall. Rainfall data represent mean values for a period of ten years (after Bullock 1986).

Most species for which we collected data by direct observations or mist-netting molt either before or after the rainy season (July–October; see Fig. 2). There are three peaks of bird reproduction at the station. The first is in winter (dry season; the peak of floral resources, Arizmendi and Ornelas 1990) when hummingbirds (e.g., *Heliomaster constantii*), parrots (e.g., *Amazona finschi* and *Aratinga canicularis*) and raptors (e.g., *Buteo nitidus*) breed (see Appendix). The second peak is at the end of the dry season (April–June), when species such as *Leptotila verreauxi*, *Aratinga canicularis*, *Columbina passerina*, *Chlorostilbon canivetii*, *Thryothorus sinaloa*, *Uropsila leucogastra*, *Parula pitiayumi*, *Saltator coerulescens*, *Cyanocompsa parellina*, and *Arremonops rufivirgatus* breed. Lastly, a third peak occurs in
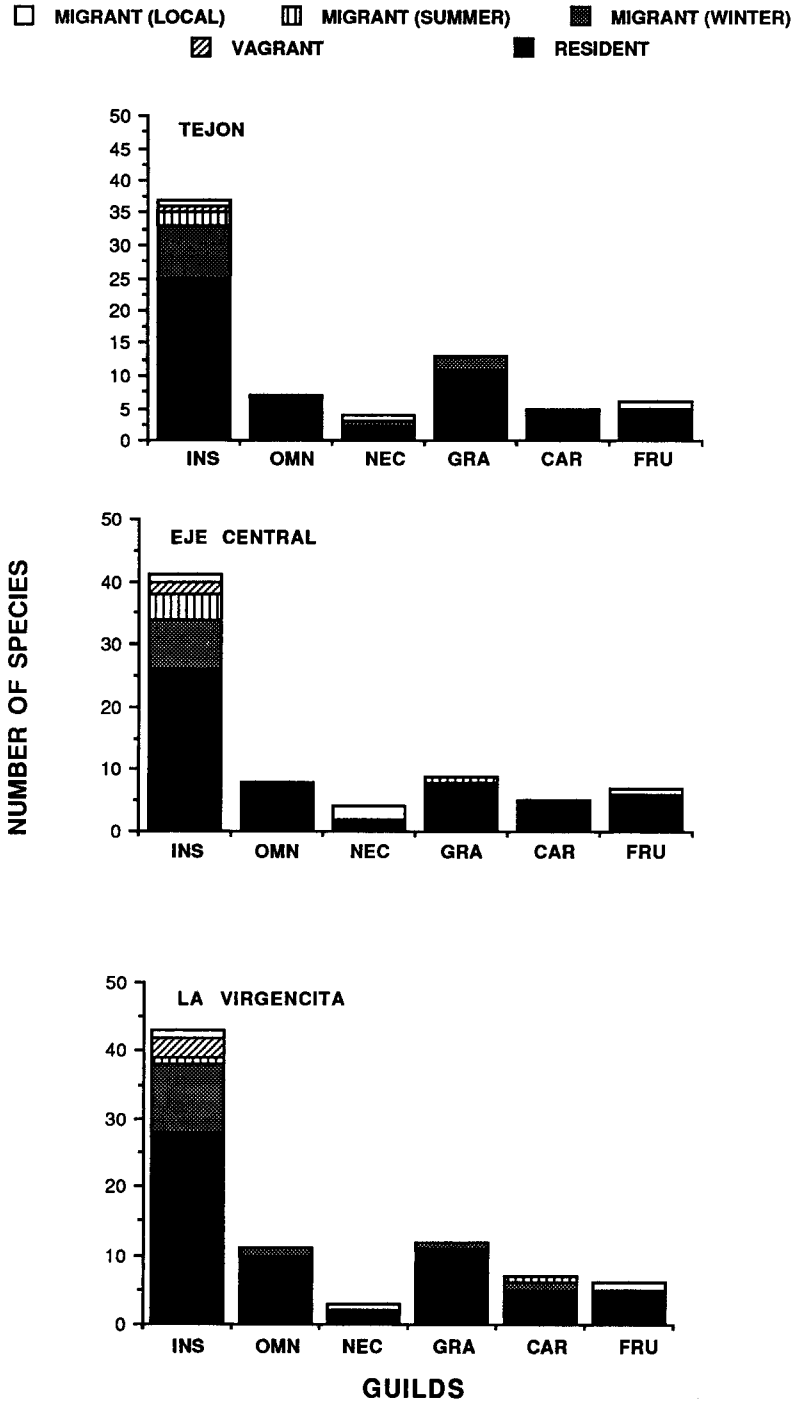
FIGURE 3. Comparison among transects of the guilds' distribution. Species were classified based on local status. INS = insectivores, OMN = omnivores, NEC = nectarivores, GRA = granivores, CAR = carnivores, and FRU = frugivores.

the rainy season (July–October), when insects and fruits are most abundant (Bullock, pers. comm.; Berlanga 1991). During this period species such as *Ortalis poliocephala, Trogon citreolus, Campephilus guatemalensis, Pachyramphus aglaiae, Melanotis caerulescens,* and *Vireo olivaceus* breed (see Appendix).

The guild with the most species at Chamela was carnivores (Falconiformes and Strigiformes; 35.7%) (Fig. 3) as in other similar neotropical areas (see Table 1). Guild seasonal changes in number of species were as follows: (1) nectarivores were more abundant at the end of the dry season than in other seasons, and (2) insectivores and frugivores were more abundant in the winter at all three transects than any other season because of overwintering species (Fig. 3).

Detectability coefficients were higher for most resident species during the breeding season (Fig. 4). CD values for individual species detected during censusing are available from the authors.

Figures 5–9 present annual variation in density for the most common resident and migratory species. In some cases, seasonal patterns were not obvious (e.g., *Trogon citreolus*) (Fig. 5). However, for most resident species, density values seemed to decrease in 1986 (e.g., *Ortalis poliocephala, Leptotila verreauxi, Amazilia rutila, Myiarchus tuberculifer, Uropsila leucogastra, Vireo olivaceus, Cacicus melanicterus*) (Figs. 5–8). Winter migrants seemed to increase in density the second year (e.g., *Vermivora ruficapilla, Mniotilta varia,* and *Wilsonia pusilla.*) (Fig. 9). These patterns were not tested statistically because of small sample sizes, but observed fluctuations could be associated with differences in rainfall between 1985 and 1986. Density differed among transects in *Xiphorhynchus flavigaster* (Friedman's test, $\chi^2 = 8.029$, df = 2, $P < 0.05$).

Density variability among transects was also not significant (Friedman's Test, $\chi^2 = 1.222$, $P > 0.05$). The overall concordance of the variability profile was homogeneous (Fig. 10).

All analyses showed that all three transects were very similar in species composition throughout time. The number of species detected in each census ranged from 18 to 38 (Fig. 11), but species richness did not differ among transects or seasons ($\chi^2 = 0.705$, df = 6, $P > 0.995$). Proportional similarity (Sorensen's index; range from 0.87 to 1.0) among transects and seasons did not differ ($\chi^2 = 0.027$, df = 6, $P > 0.995$). All transects were more similar in species com-

TABLE 1. Avifaunal comparison between Chamela and other Central American areas (Stiles 1983, Arizmendi et al. 1990).

| | Tropical rain forest | | | |
| | Mexico | | Costa Rica La Selva | Panama Barro Colorado |
Family	Chamela	Los Tuxtlas		
Emberizidae	57	88	83	43
Tyrannidae	23	37	54	33
Accipitridae	14	21	25	16
Trochilidae	9	11	22	12
Formicariidae	0	4	20	13
Total	270	315	324	369

| | Tropical dry forest | | |
| | Jalisco, Mexico Chamela | Guanacaste, Costa Rica | |
Family		Palo Verde	Santa Rosa
Emberizidae	57	43	48
Tyrannidae	23	33	34
Accipitridae	14	13	14
Columbidae	7	7	8
Trochilidae	9	10	11
Vireonidae	7	8	5
Total	270	262	267

position in the wet season, and Eje Central differed the most during the dry season.

Diversity values ranged from 0.9 at La Virgencita to 1.45 at Eje Central (Fig. 12). At El Tejón, the lowest value (1.09) corresponded to July and the highest (1.4) to September and May. At Eje Central, the lowest (1.02) was for April and the highest (1.45) for November. Lastly, at La Virgencita the lowest (0.9) was for March and the highest (1.4) for December and May (Fig. 12). However, we found that the values of the Shannon-Wiener index for the three transects were seasonally similar ($\chi^2 = 0.007$, df = 6, $P > 0.999$), with highest diversity during the wet season. Transect La Virgencita (a disturbed area) was more diverse during the dry season (winter), whereas other transects showed changes to higher diversity values during the rainy season.

There were, however, significant seasonal changes in diversity within transects. At Eje Central (parallel to arroyo Colorado), we found fall-winter (dry season) more diverse (ANOVA, $F_{3,17} = 7.19$, $P < 0.05$). At El Tejón, seasonal changes in diversity were not significant (ANOVA, $F_{3,17} = 0.409$, $P > 0.1$). Lastly, at La Virgencita diversity did not differ (ANOVA, $F_{3,17} = 2.076$, $P \gg 0.05$).
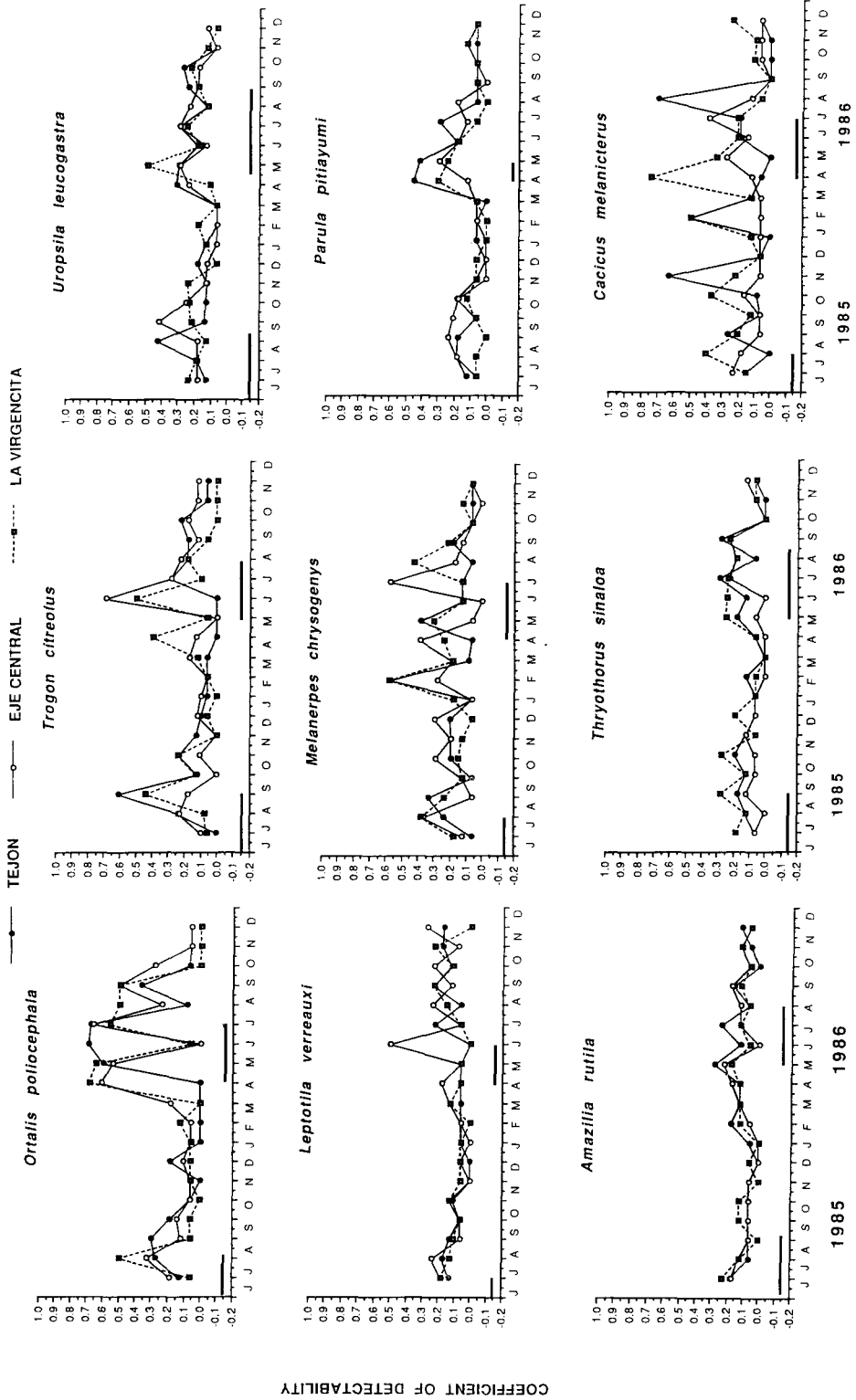
The model we used explained 25% of the vari-

FIGURE 4.   Variation in detectability (CD) of the most common resident species. Horizontal bars represent the breeding season for comparison.
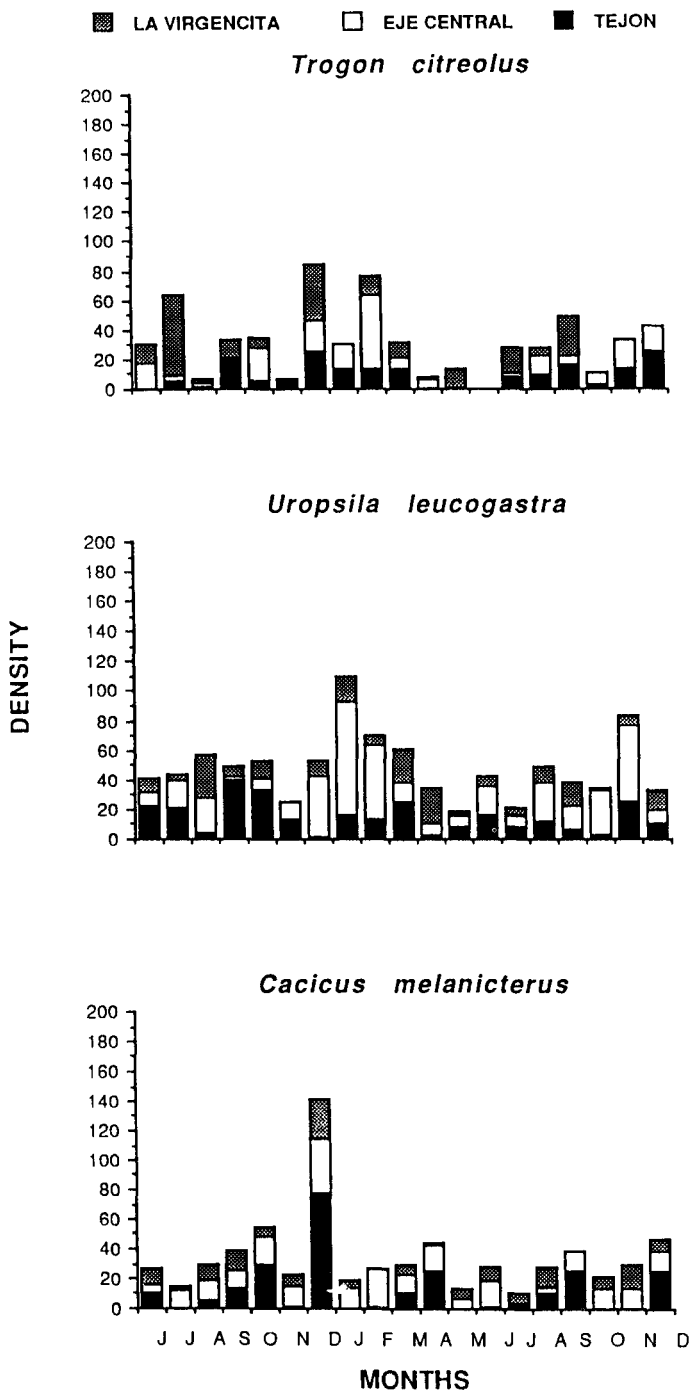
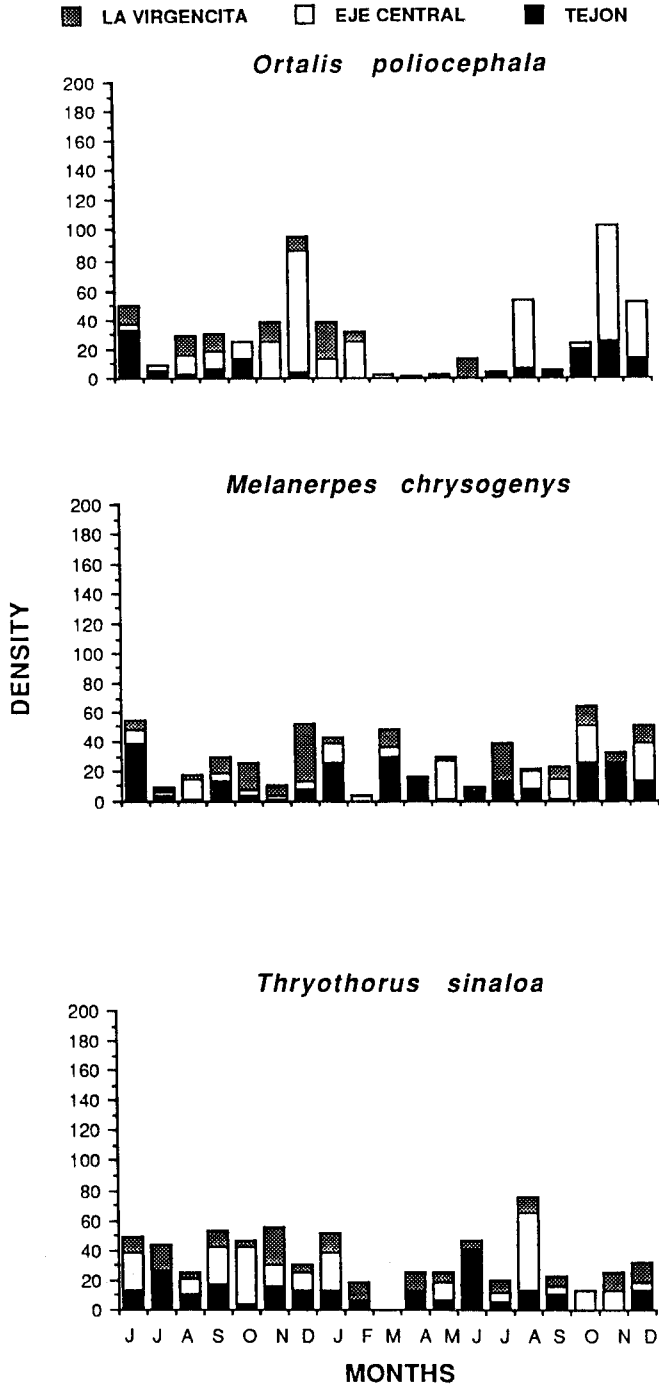FIGURE 5.   Inter-annual density variation for three common species at Chamela.

FIGURE 6.   Inter-annual density variation for three common species at Chamela.
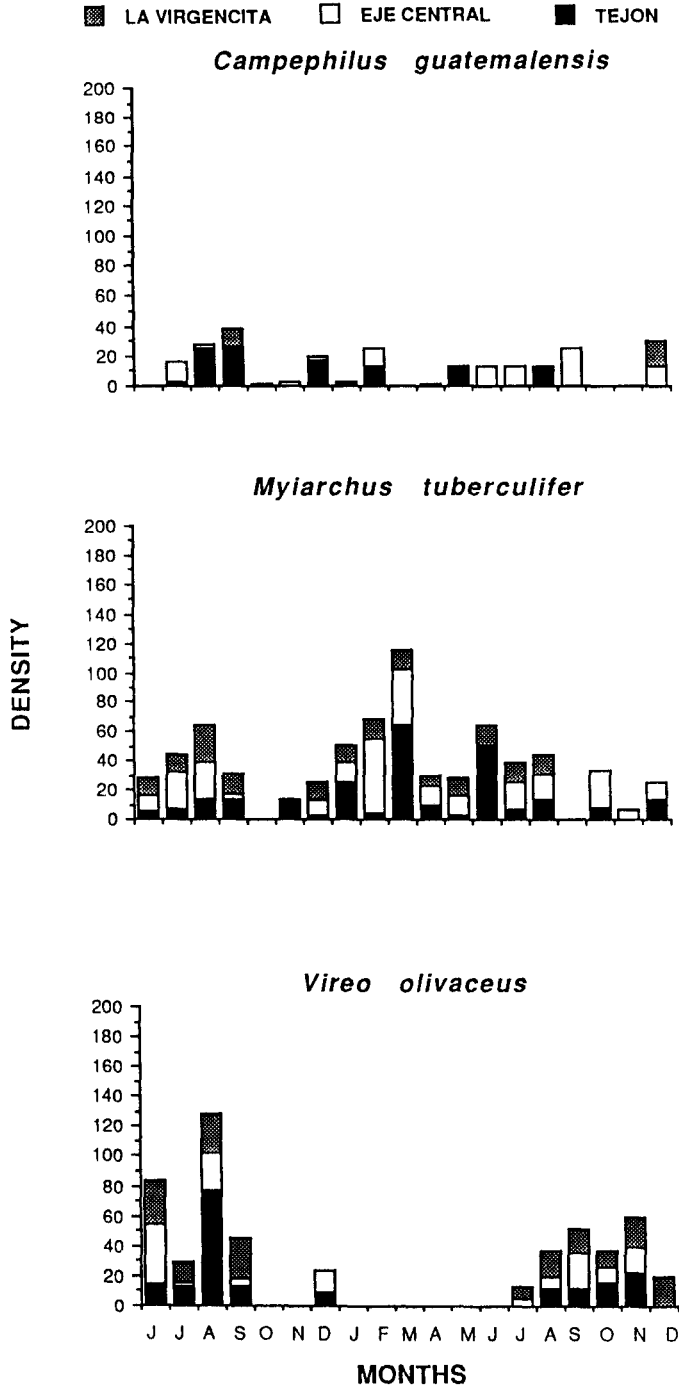
FIGURE 7.   Inter-annual density variation for three common species at Chamela.
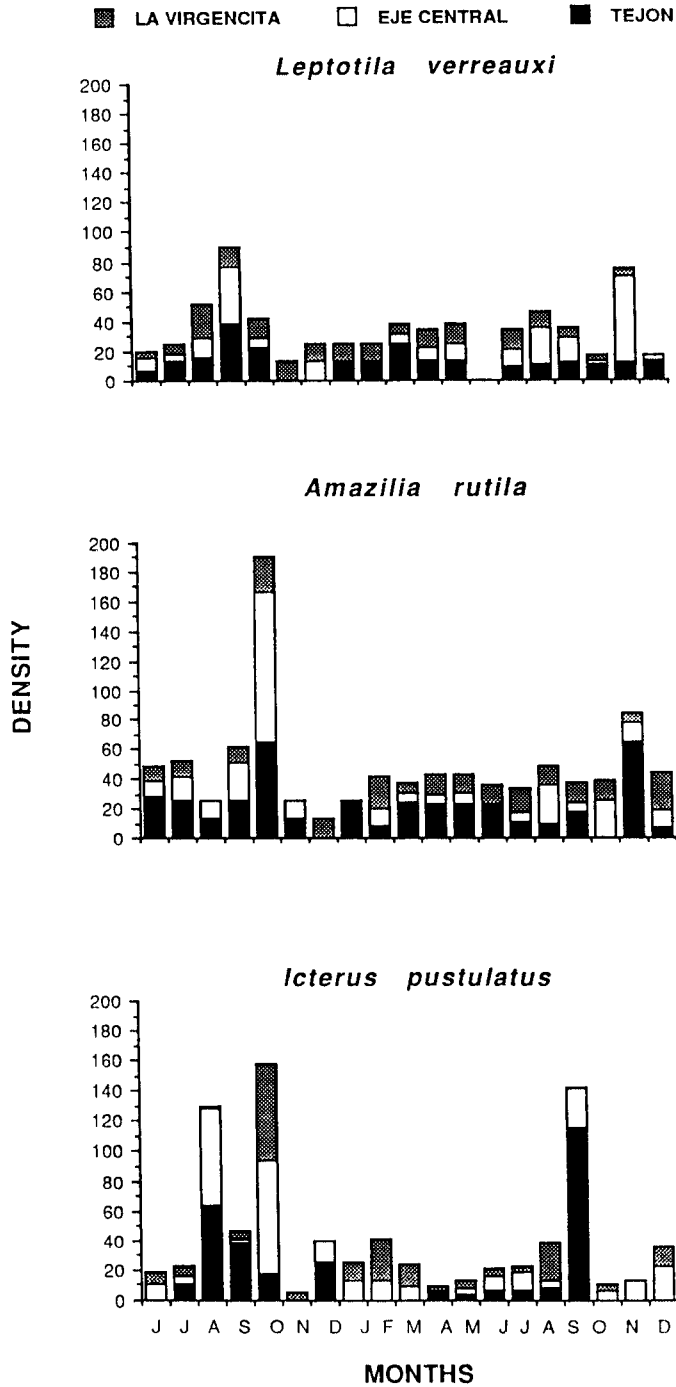
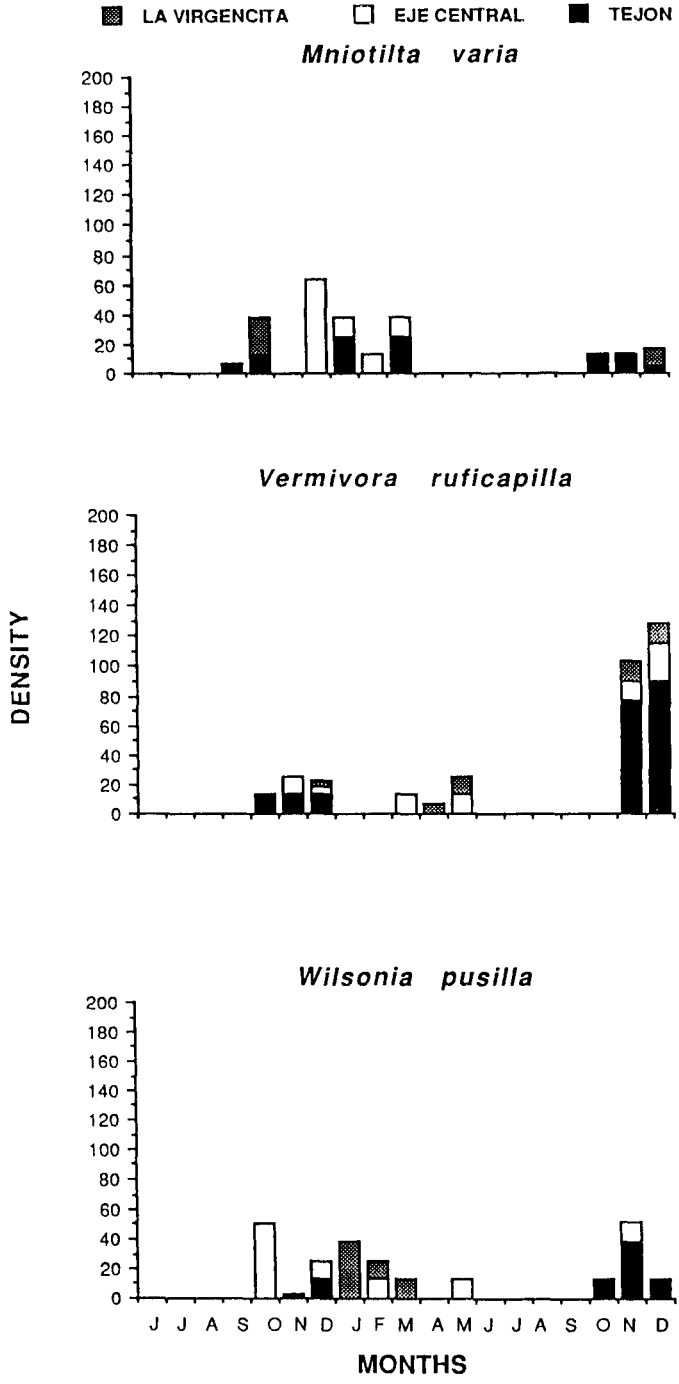FIGURE 8. Inter-annual density variation for three common species at Chamela.

FIGURE 9.   Inter-annual density variation for three common species at Chamela.
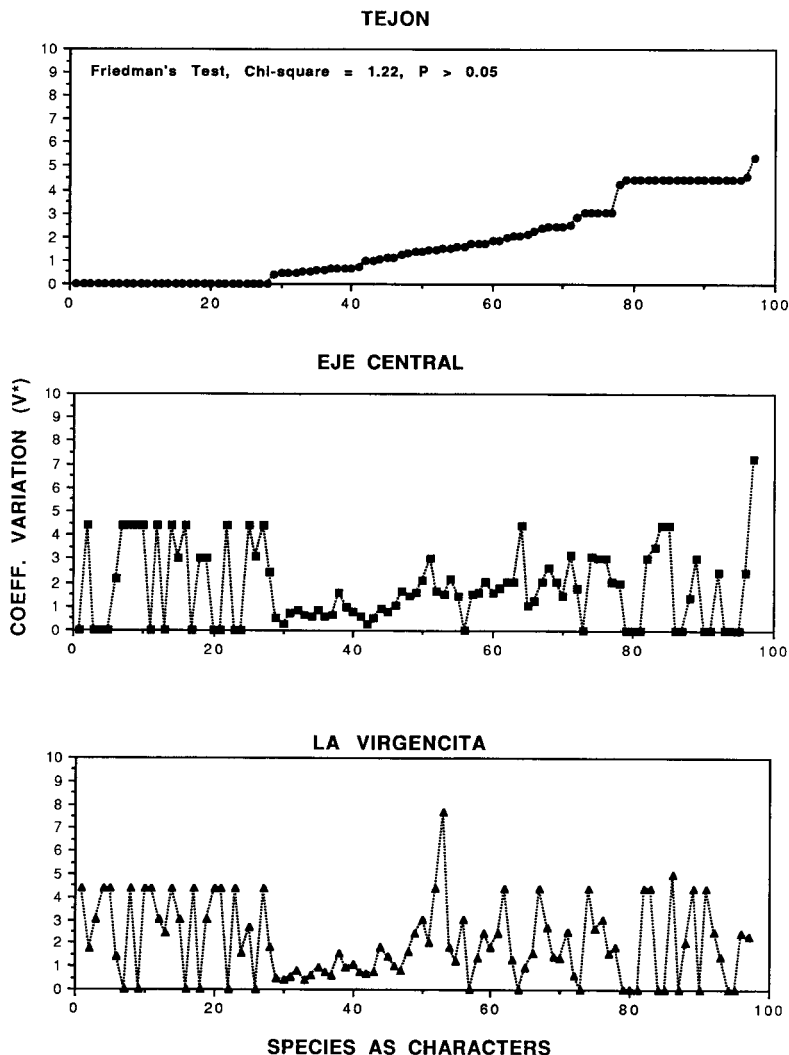
TEJON

EJE CENTRAL

LA VIRGENCITA

SPECIES AS CHARACTERS

FIGURE 10.   Analysis of overall concordance among variability profiles (transects; after Sokal and Braumann 1980). The variation (V*) in density values for each species among transects was plotted against a horizontal axis representing the species as a character for each transect.

ance, which mostly was accounted for by the factors SPECIES and MONTHS. Factor TRAN-SECT and the interactions among factors were less important (Table 2).

DISCUSSION

General patterns at Chamela. The avifauna in the Chamela region is as species-rich as other similar tropical dry-forested areas in Central America (see Table 1), but with more North American wintering species. Moreover, many species (53%) are associated with the tropical

dry-forest corridor and have continuous distri-butions from northern Sonora, Mexico, to Pan-ama in Central America (e.g., Chamela and Guanacaste, Costa Rica share 140 species; Ariz-mendi et al. 1990).

Nine species encountered in our study had not been recorded previously for the Chamela re-gion: *Puffinus griseus, Phaethon auricularis, P. aethereus, Phalaropus tricolor, Larus philadel-phia, Amazilia violiceps, Archilochus alexandri, Agelaius phoeniceus* and *Icterus galbula.* Two were new for the state of Jalisco: *Uropsila leu-*
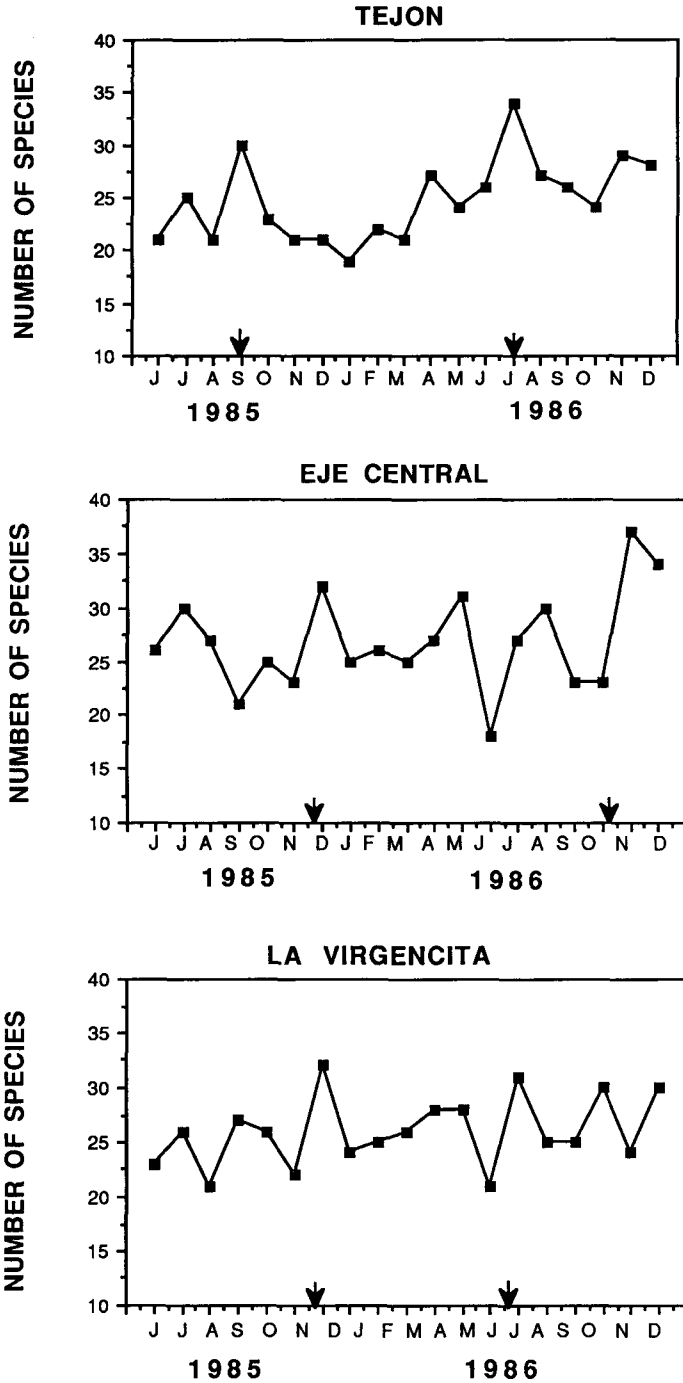
FIGURE 11.   Patterns of species richness in the study site. In both, Eje Central (semideciduous tropical forest) and La Virgencita (disturbed area), species richness was higher during the winter. At El Tejón, a deciduous tropical forest, species richness was higher during wet season. Arrows indicate the two months with highest number of species.

FIGURE 12.   Transect comparison of bird species diversity (H') over time. Arrows indicate the two months with highest diversity.

cogastra and *Oporornis formosus* (Gaviño 1978; Grant 1964; Hutto 1980; Hutto et al. 1986; McWhirter 1976; Schaldach 1963, 1969; Selander and Guiller 1959; Zimmerman and Harry 1951). Distributional implications of these records are discussed elsewhere (Arizmendi 1987, Arizmendi et al. 1990, Arizmendi and Ornelas 1990, Márquez-Valdelamar 1987, Berlanga 1991).

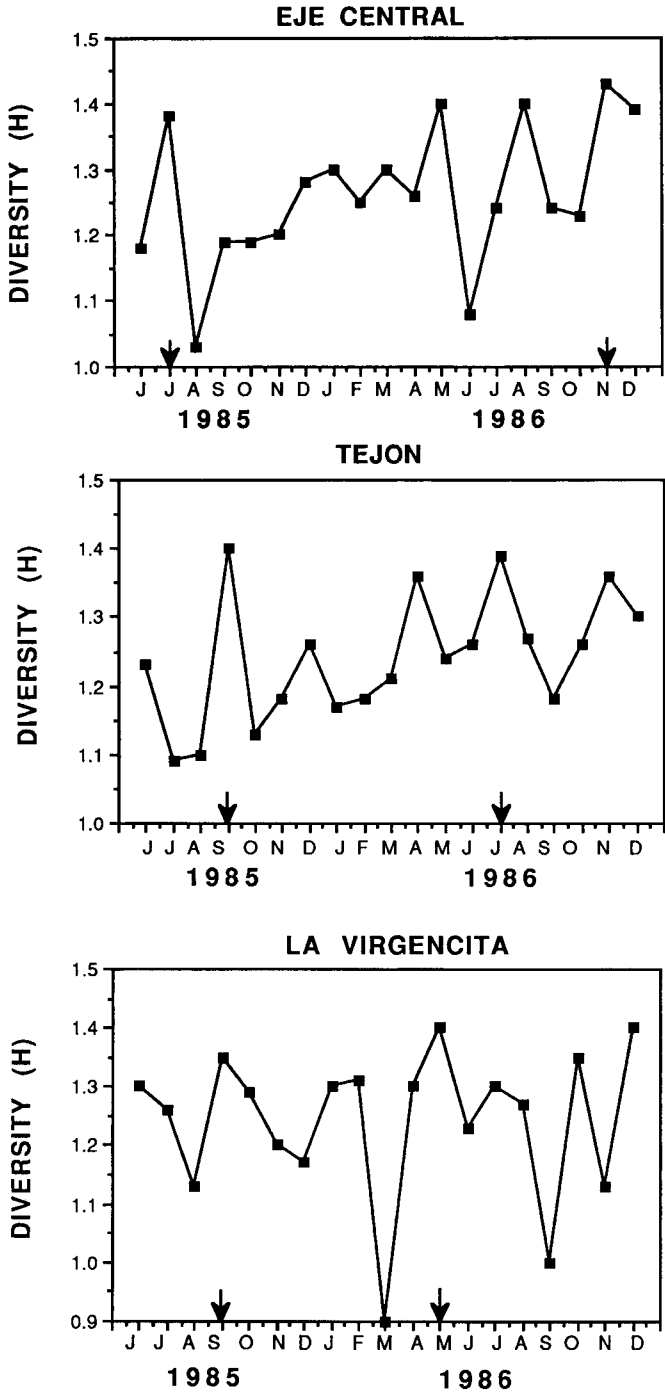*Censusing technique.* There are several potential problems with Emlen's method (e.g., Hutto and Mosconi 1981). First, individual behavioral differences among species are very large (e.g., lekking, flocking, local movements, rarity), which can have major effects on their detectability (Diehl 1981, Karr 1981, Terborgh et al. 1990). Second, accurate estimating species composition and abundances is often difficult in tropical regions where avifaunas are more species-rich and composed of many rare species. Rarity associated with body size introduces problems in understanding population fluctuations (Arita et al. 1990). Third, many biological peculiarities of bird species diverge from the norm of temperate avifaunas (e.g., territory size and body size relationships; Karr 1981, Terborgh et al. 1990), weakening biological assumptions made for birds living in temperate regions. Lastly, environmental conditions (e.g., topographic irregularity, noise, dense ground-level vegetation, patchiness, edge effects, and darkness) might complicate censusing in the tropics (Karr 1981, Dawson 1981). For instance, the rate of travel along transects in this study was slowed because of terrain. This increased the time the observer is exposed to each bird (Dawson 1981), and biased the number of species and individuals detected. However, we corrected possible bias when these numbers were converted to density values by avoiding double-recording of individuals during censusing.

We selected Emlen's method because it allowed us to explore temporal patterns. Alternatively, density values should be interpreted carefully because they are calculated from coefficients of detectability, which vary temporally. Overestimation of the abundance of highly gregarious species (e.g., *Ortalis poliocephala* and *Cacicus melanicterus*) or breeding species (e.g., *Vireo olivaceus* in the rainy season) are possible. Rarity and habitat patchiness are also problems that need to be considered in density interpretation. Resident species such as *Morococcyx erythropygius, Picoides scalaris, Tityra semifasciata, Pachyramphus aglaiae, P. major, Delta-*

TABLE 2. Analysis of a three-way contingency table using a log-linear model (GLIM 3.7). The analysis includes 21 months, 3 transects, and 104 species. The model explains only 24.3% of the deviance.

Source	Deviance	df	% Total deviance	P<
Total	18,238	1,492		
Month	1,534	20	8.41	0.005
Species	2,770	104	15.18	0.005
Transect	24	2	0.13	0.005
Species·Month	22	1	0.12	0.005
Species·Transect	10	1	0.05	0.005
Month·Transect	73	1	0.40	0.005

rhynchus flammulatus, Granatellus venustus, and *Rhodinocichla rosea* were detected only one or two times when censusing either because they are rare or because they prefer habitats not included in our transects, such as a more humid corridor. Despite the problems described earlier, we conclude the technique was appropriate to our field study purposes.

Temporal homogeneity in species richness and diversity index values in all transects indicates ecological similarity. Based on differences in plant composition among transects (e.g., more lianas and larger semideciduous trees at Eje Central; Lott et al. 1987), we expected higher bird diversity in a more diverse habitat, but our results contradict our expectations.

However, the significant seasonal variation in species richness and densities at El Tejón supported our predictions. El Tejón is a trail covered mostly by deciduous tropical forest (as opposed to Eje Central which is mostly semideciduous), in which seasonal changes in the bird community structure might be correlated with seasonality in the landscape. For instance, the number of insectivorous species was relatively constant throughout the study. This suggests that migratory species that feed on insects did not prefer this habitat, as they did in the disturbed habitat (La Virgencita). A similar pattern has been documented previously for migratory species by Hutto (1980). He found that insect-gleaners species prefer disturbed areas or forest clearings in the tropical lowlands, as we found in this study. Moreover, densities of small flocking-species such as resident warblers (*Parula pitiayumi* and *Granatellus venustus*) could be dependent on the availability and density of flocks rather than the availability of food resources (Powell 1989). Ber-

langa (1991) observed mixed-species groups formed by *Campephilus guatemalensis, Melanerpes chrysogenys, Cyanocorax sanblasianus, Cacicus melanicterus,* and *Icterus pustulatus* foraging on insects. However, we did not encounter many flocks during censusing.

Chamela's avian community and conservation. Our data suggest that there are not seasonal differences in avian composition along the transects. However, we detected some bird species exclusive to one habitat. Bird species associated with open and disturbed areas included *Aimophila humeralis, A. ruficauda, Accipiter striatus, Buteogallus urubitinga, Hirundo rustica, Icteria virens, Megarhynchus pitangua, Pipilo fuscus, Pyrocephalus rubinus,* and *Pitangus sulphuratus.* Such species were not found during censuses in the interior of the forest. On the other hand, *Chlorostilbon canivetii, Geothlypis trichas,* and *Lepidocolaptes leucogaster* were not recorded in disturbed habitat (La Virgencita). We found several species exclusively along Eje Central, a trail of semideciduous tropical forest. Species such as *Dendroica coronata, Euthlypis lachrymosa, Morococcyx erythropygius, Oporornis tolmiei, Pheucticus melanocephalus,* and *Turdus assimilis* were recorded exclusively along the arroyo habitat in this trail. This suggests that the arroyo habitat in this area could represent important refugia during the dry season, when the resources in the uplands are scarce. This phenomenon has been documented locally only for *Uropsila leucogastra* (Márquez-Valdelamar 1987). Corridor zones such as arroyos in Chamela have been shown to be essential for movement from one refuge to another (e.g., Willis 1974, Recher and Serventy 1991). On the other hand, it is possible that the scale we used to explore the existence of the pattern was not appropriate.

Considering the patterns of population fluctuations found in this study, it appears that resident species are more susceptible to droughts (e.g., 1985–1986 drought at Chamela; Redford et al. 1990) than overwintering species, and might have fluctuated in the past due to undocumented droughts. We suggest that resident species to the tropical dry forest are more appropriate to utilize when we want to understand the fluctuations due to climatic changes.

Tropical dry forest in the Chamela region apparently is more susceptible to alteration by man (e.g., agriculture and tourism). Tropical dry forests along the Pacific coast in Mexico have been cut for tourist development at an alarming rate

in the last two decades. Bird species endemic to the tropical dry forest (e.g., *Ortalis poliocephala, Forpus cyanopygius, Trogon citreolus, Deltarhynchus flammulatus, Cyanocorax sanblasianus, Granatellus venustus, Passerina leclancherii,* and *Cacicus melanicterus*; Ornelas and Arizmendi, unpubl.) could be in danger of extinction.

The addition of species-rich arroyo habitats into any local attempt to preserve the area in a sustainable fashion should be consistent with land use and tourism plans. A convincing argument to implement the conservation of the arroyo habitats in the tropical dry forests in western Mexico has to include evaluations of temporal population fluctuations of key resident species. Bird species that have an economical (e.g., *Ara militaris, Forpus cyanopygius,* and *Ortalis poliocephala*), biological (e.g., rare or endemic forms), or aesthetic appeal (e.g., *Campephilus guatemalensis*) could be used in monitoring temporal changes on population fluctuations.

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APPENDIX.   Breeding and molting seasons of birds species at Chamela. Data were collected during two years by direct observation, mist-netting, and from the literature. 1 = Molting, 2 = Breeding.

Species	J	F	M	A	M	J	J	A	S	O	N	D
Aimophila humeralis					2							
Aimophila ruficauda	1	1			2	2						
Amazilia rutila		1	1	2	2	2	2		2		1	
Amazona finschi		2										
Aratinga canicularis	1	2	2	2								
Archilochus alexandri	1											
Arremonops rufivirgatus						2		2				
Attila spadiceus									1	1		
Buteo magnirostris							2					
Buteo nitidus				2	2	2						
Cacicus melanicterus				2	2	2	2					
Campephilus guatemalensis				1			2					2
Camptostoma imberbe		2	2	2							1	
Caprimulgus ridgwayi					2	2						
Ceryle alcyon	1											
Chloroceryle americana		1					2					
Chlorostilbon canivetii			1		2							
Chordeiles minor					2							
Columba flavirostris		2										
Columbina inca					2		2					
Columbina passerina					2	2	1					
Columbina talpacoti					2							
Coccyzus minor						2		2	1			
Crotophaga sulcirostris	1			1			2					
Cyanocompsa parellina				2	2	2	1	1	1		1	
Cyanocorax sanblasianus						2	2					
Cynanthus latirostris					1		2		2			
Deltarhynchus flammulatus							2			1		
Dendroica petechia				1								
Dryocopus lineatus	1			2								
Empidonax affinis											1	
Empidonax difficilis											1	
Empidonax minimus				1				1				
Forpus cyanopygius				2								
Geococcyx velox					2							
Geothlypis trichas				1								
Glaucidium brasilianum					2							
Glaucidium gnoma							2					
Granatellus venustus						2						
Habia rubica				2	2							
Heliomaster constantii		2	2		1							
Icteria virens											1	
Icterus pustulatus					2	2	2				1	
Leptotila verreauxi	1		1	2	2		2	2			1	
Melanerpes chrysogenys			1	2	2	2	2					
Melanotis caerulescens			1		2		2					
Molothrus aeneus					2		2					
Molothrus ater							2					
Momotus mexicanus					2	2						
Morococcyx erythropygus							2					
Mniotilta varia		1										
Myarchus cinerascens		1			2					1		
Myarchus crinitus							2					
Myarchus tuberculifer		2		2		2	2				1	
Myarchus tyrannulus				2	2		1		1	1		
Myiodynastes luteiventris					2							
Myozetetes similis									1		1	
Nyctidromus albicollis					2	2	2				1	
Ortalis poliocephala				2	2	2	2					

APPENDIX. Continued.

Species	J	F	M	A	M	J	J	A	S	O	N	D
Pachyramphus aglaiae				2								
Parula pitiayumi				2	2		2					
Passerina ciris											1	
Passerina leclancherii			1	2	2	2	2				1	
Passerina versicolor				2			2					
Pheucticus chrysopeplus				2								
Pheucticus melanocephalus							2					
Piaya cayana						2	2		2			
Pitangus sulphuratus		1		1	2		2				1	1
Polioptila caerulea	1			1								
Polioptila nigriceps					2	2						
Rhodinocichla rosea						2	2					
Saltator coerulescens			1	2		1	1	1	1			
Sayornis nigricans				2								
Sporophila torqueola			1									
Stelgidopteryx serripennis		1										
Thryothorus felix				2				1				
Thryothorus sinaloa				2	2	2	2	1	1			
Trogon citreolus			1	1	2	2	2	2				
Turdus assimilis			2			2						
Turdus rufopalliatus			1			2						
Tyrannus crassirostris	1					2						
Tyrannus melancholichus				2		2				1		
Tyrannus vociferans				2								
Uropsila leucogastra					1	1	2	2	2		1	
Vermivora ruficapilla	1	1									1	
Vireo gilvus			1								1	
Vireo hypochryseus					2						1	
Vireo olivaceus					2	2	2	2	1	1		
Volatinia jacarina											1	
Xiphorhynchus flavigaster					2		2	2	1			
Zenaida asiatica					2	2						