

## Western Mexico: a significant centre of avian endemism and challenge for conservation action

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El endemismo de aves en México está concentrado en el oeste del país, pues entre el 40 al 47% de las aves endémicas de México están totalmente restringidas a la región. Presentamos un compendio de estos taxones, tanto siguiendo el concepto biológico de especie como el concepto filogenético de especie, documentando la región como un importante centro de endemismo. Discutimos estrategias de conservación en la región, especialmente la idea de ligar reservas para preservar transectos altitudinales de hábitats continuos, desde las tierras bajas hasta las mayores altitudes, en áreas críticas.

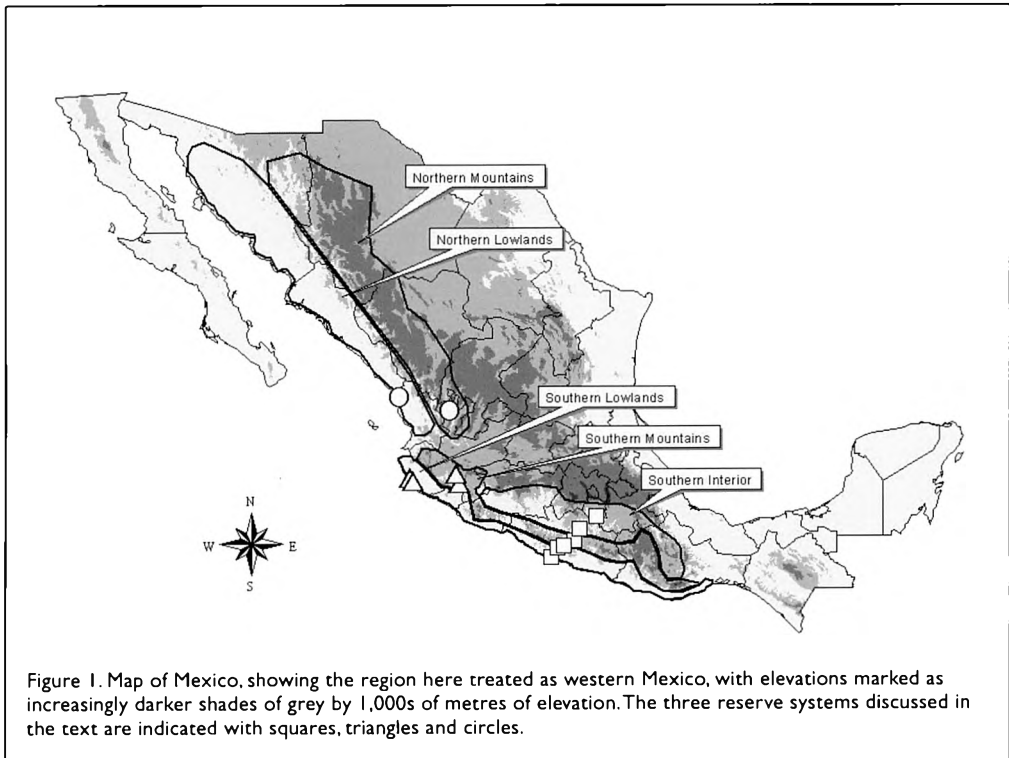
### Introduction

Mexico has been identified as a megadiverse country, with impressive diversity in many taxonomic groups<sup>20</sup>. Efforts to document the country's biological diversity are at varying stages of development in different taxa<sup>17,19,20</sup> but avian studies have benefited from extensive data already accumulated<sup>18</sup> and have been able to advance to more detailed levels of analysis<sup>6,12,17</sup>.

In the only recent countrywide survey of avian diversity and endemism<sup>6</sup>, the south-east lowlands were identified as important foci of avian species richness. In contrast, the Sierra Madre Occidental

and Transvolcanic Belt of central and western Mexico were identified as major concentrations of endemic species. This non-coincidence of diversity and endemism in Mexican biodiversity has since been documented on different spatial scales<sup>13,17</sup> and in additional taxonomic groups<sup>17</sup>.

In prior examinations, however, western Mexico (herein defined as the region from Sonora and Chihuahua south to Oaxaca, including the coastal lowlands, the Sierra Madre Occidental and Sierra Madre del Sur, and Pacific-draining interior basins such as the Balsas Basin) has not been appreciated sufficiently as a centre of endemism. Our ongoing



systematic studies of Mexican birds<sup>3,5,9,14–16</sup>, as well as our re-examination of Mexican bird taxonomy from alternative viewpoints<sup>10</sup>, have led us to appreciate western Mexico as the primary focus of avian endemism in Mesoamerica. Although the region has been mentioned as important by previous authors<sup>4,7</sup>, the purpose of the present contribution is to emphasise the biological uniqueness of the region and to explore the implications of this for conservation strategies.

### Endemism in biological and phylogenetic species

The dominant taxonomic viewpoint for birds has long been the Biological Species Concept<sup>8</sup>, as exemplified in North America by the American Ornithologists' Union's check-list series<sup>2</sup>, and has been the basis for previous examinations of Mexican bird endemism<sup>6</sup>. Under this concept, 101 species are endemic to Mexico, 46 of which are restricted to western Mexico—13 in montane regions, 20 in the lowlands, and 13 in the interior of southern Mexico (Table 1). Eleven of these species are restricted to north-west Mexico (south to Jalisco), whereas 20 occur only in south-west Mexico (Jalisco south to Oaxaca).

Alternative taxonomic viewpoints, such as the Phylogenetic Species Concept and the Evolutionary Species Concept<sup>21</sup>, are beginning to acquire greater significance in ornithology. These concepts emphasise monophyly as a base criterion for identifying potential species taxa. The Phylogenetic Species Concept then focuses on diagnosability—distinct populations that are essentially 100% identifiable and distinguishable from other groups. The Evolutionary Species Concept refers to the idea of identifying populations that have taken independent evolutionary trajectories as species; we have implemented this concept in similar manner as the Phylogenetic Species Concept—evolutionary independence is signalled by the fixation of distinct character states. Hence, we applied the two alternative concepts under a single decision rule: we sought sets of populations that exhibit unique phenotypic character suites that distinguish them from other populations. We detected potential alternative species units via the scientific literature and via inspection of specimens, and checked our hypotheses in at least one additional scientific collection based on an independent series of specimens.

Although these approaches have been applied to several avian clades, they have not yet been applied to an entire region: we are presently preparing a revision under these concepts for Mexican birds<sup>10</sup>. Based on this information, we have been able to assess levels of endemism across the country<sup>11</sup>, and summarise species endemic to western Mexico (Table 1). Under this view, c.250 bird species are

endemic to Mexico, 99 of which are endemic to western Mexico—29 in montane regions, 55 in the lowlands, and 15 in the interior. Twenty-two phylogenetic species are restricted to north-west Mexico, whereas 42 are restricted to south-west Mexico.

Overall, western Mexico supports a substantial portion of Mexican bird diversity. In all, 45% of the 100 endemic biological species and 40% of the 250 endemic phylogenetic species in the country are found only in the west of the country. Indeed, three genera—*Euptilotis*, *Deltarhynchus*, and *Philortyx*—are endemic to the region, as well as two others sometimes considered separate genera (*Neochloe* = *Vireo*, *Aechmolophus* = *Xenotriccus*). Other regions, such as the Sierra Madre Oriental, the Yucatán Peninsula, and the southern tip of Baja California<sup>11</sup>, hold smaller concentrations of endemic species. Patterns of endemism in other taxonomic groups generally appear to parallel those of birds<sup>2,3</sup>, suggesting that the patterns outlined herein may be quite general for Mexican biodiversity.

### Conservation challenges

The enormous concentration of endemic birds in western Mexico represents both a challenge and an opportunity for conservation efforts in Mexico. The challenge results from the paucity of reserves established in the region. Presently, the only large-scale, effective reserves in western Mexico, north to south, are El Carricito del Huichol (mountains of northern Jalisco), Chamela/Cuixmala (coastal lowlands of Jalisco) and the Sierra de Manantlán (mountains of western Jalisco)<sup>1</sup>. Large areas of important habitat rich in endemic species both north and south of this limited zone remain either unprotected or poorly protected.

The western Mexican centre of endemism also represents an opportunity. If biologically unique elements were scattered randomly, without geographic foci, development of cost-effective conservation strategies would be extremely difficult<sup>13</sup>. Rather, given clear concentrations, those same areas can represent priority areas for conservation attention.

In the present case, we recommend three latitudinally separated sets of reserves linked to cross altitudinal gradients in western Mexico. In the north, perhaps in Nayarit and northern Jalisco, linkage of El Carricito del Huichol with coastal slope sites and coastal sites (e.g. Marismas Nacionales in coastal Sinaloa and Nayarit) would be an ideal starting point. A nearby, but more southerly reserve assemblage could link Sierra de Manantlán with the coastal Chamela/Cuixmala complex. The combination of these two mega-reserves would effectively protect habitat appropriate for almost all of the 'northern' species endemic to the region,

**Table 1.** Summary of distributions of 99 bird species endemic to western Mexico, divided by geography. For names representing recognisable phylogenetic species, names of associated biological species taxa recognised by AOU<sup>2</sup> are given in parentheses. Common names are preliminary in nature.

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### Species

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#### Northern Mountains:

Thick-billed Parrot *Rhynchopsitta pachyrhyncha*, Mexican Woodnymph *Thalurania ridgwayi* (*Thalurania colombica*), Eared Quetzal *Euptilotis neoxenus*, Arizona Woodpecker *Picoides arizonae* (*Picoides stricklandii*), Imperial Woodpecker *Campēphilus imperialis*†, Sinaloa Martin *Progne sinaloae*, Tufted Jay *Cyanocorax dickeyi*, Olive Nightingale-thrush *Catharus olivascens* (*Catharus occidentalis*), Moore's Red-warbler *Ergaticus melanauris* (*Ergaticus ruber*), Five-striped Sparrow *Amphispiza quinquestrata*

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#### Northern and Southern Mountains:

White-naped Swift *Streptoprocne semicollaris*, Red-headed Tanager *Piranga erythrocephala*, Flame-colored Tanager *Piranga bidentata* (*Piranga bidentata*)

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#### Southern Mountains:

Salle's Quail *Cyrtonyx salli* (*Cyrtonyx montezumae*), White-fronted Swift *Cypseloides storeri*, White-tailed Hummingbird *Eupherusa polioerca*, Blue-capped Hummingbird *Eupherusa cyanophrys*, Margarita's Hummingbird *Lampornis margaritae* (*Lampornis amethystinus*), Wagler's Toucanet *Aulacorhynchus wagleri* (*Aulacorhynchus prasinus*), Grey-crowned Woodpecker *Piculus auricularis*, Guerrero Woodhewer *Xiphocolaptes omlitemensis* (*Xiphocolaptes promeropirhynchus*), Mexican Antpitta *Grallaria ochraceiventris* (*Grallaria guatemalensis*), Guerrero Jay *Aphelocoma guerrerensis* (*Aphelocoma unicolor*), Sumichrast's Jay *Aphelocoma sumichrasti* (*Aphelocoma coerulescens*), White-throated Jay *Cyanolyca mirabilis*, Guerrero Bush-tanager *Chlorospingus albifrons* (*Chlorospingus ophthalmicus*), Michoacán Towhee *Pipilo nigrescens* (*Pipilo ocai*), Slate-blue Seedeater *Amaurospiza relicta* (*Amaurospiza concolor*), Dickey's Oriole *Icterus dickeyae* (*Icterus gradaucada*)

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#### Northern Lowlands:

Wagler's Chachalaca *Ortalis wagleri* (*Ortalis poliocephala*), Masked Bobwhite *Colinus ridgwayi* (*Colinus virginianus*), Elegant Quail *Callipepla douglasii*, Brewster's Parakeet *Aratinga brewsteri* (*Aratinga holochlora*), Mexican Parrotlet *Forpus cyanopygius*, Sinaloa Crow *Corvus sinaloae* (*Corvus imparatus*), Black-throated Magpie-jay *Calocitta calliei*, Purplish-backed Jay *Cyanocorax beecheii*, Black-capped Gnatcatcher *Poliopitla nigriceps*, Palmer's Thrasher *Toxostoma palmeri* (*Toxostoma curvirostre*), Sinaloa Vireo *Vireo paluster* (*Vireo pallens*)

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#### Northern and Southern Lowlands:

Lilac-crowned Parrot *Amazona finschi*, Mexican Squirrel Cuckoo *Piaya mexicana* (*Piaya cayana*), Colima Pygmy-owl *Glaucidium palmarum* (*Glaucidium minutissimum*), Eared Poorwill *Nyctiphrynus mcleodii*, Hartert's Hermit *Phaethornis mexicanus* (*Phaethornis superciliosus*), Golden-crowned Emerald *Chlorostilbon auriceps* (*Chlorostilbon canivetii*), Citreoline Trogon *Trogon citreolus*, Thick-billed Kingbird *Tyrannus crassirostris*, Flammulated Flycatcher *Deltarhynchus flammulatus*, Pacific Attila *Attila pacificus* (*Attila*

*spadiceus*), White-bellied Becard *Pachyrhamphus albiventris* (*Pachyrhamphus aglaiae*), Sinaloa Becard *Pachyrhamphus uropygialis* (*Pachyrhamphus major*), Western Tityra *Tityra griseiceps* (*Tityra semifasciata*), San Blas Jay *Cyanocorax sanblasianus*, Western Green Jay *Cyanocorax speciosa* (*Cyanocorax yncas*), Happy Wren *Thryothorus felix*, Sinaloa Wren *Thryothorus sinaloa*, Rufous-backed Robin *Turdus rufopalliatu* (*Turdus rufopalliatu*), Golden Vireo *Vireo hypochryseus*, Western Parula *Parula pulchra* (*Parula pitiayumi*), Red-breasted Chat *Granatellus venustus*, Pale-vented Euphonia *Euphonia godmani* (*Euphonia affinis*), Western Ant-tanager *Habia affinis* (*Habia rubica*), Mexican Thrush-tanager *Rhodinocichla schistacea* (*Rhodinocichla rosea*), Western Saltator *Saltator vigorsii* (*Saltator coerulescens*), Yellow Grosbeak *Pheucticus chrysopeplus*, Pacific Bunting *Cyanocmpsa indigotica* (*Cyanocmpsa parellina*), Orange-breasted Bunting *Passerina leclancherii*, Western Olive-sparrow *Arremonops sumichrasti* (*Arremonops rufivirgatus*), Rusty-crowned Ground-sparrow *Melozone kieneri*, Cinnamon-rumped Seedeater *Sporophila torqueola* (*Sporophila torqueola*), Russet-tailed Sparrow *Aimophila acuminata* (*Aimophila ruficauda*), Yellow-winged Cacique *Cacicus melanicterus*, Scarlet-headed Oriole *Icterus pustulatus* (*Icterus pustulatus*)

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#### Southern Lowlands:

West Mexican Chachalaca *Ortalis poliocephala* (*Ortalis poliocephala*), West Mexican Bobwhite *Colinus coyolcos* (*Colinus virginianus*), Lamb's Screech-owl *Otus lambi* (*Otus cooperii*), Cinnamon-sided Hummingbird *Amazilia wagneri* (*Amazilia viridifrons*), Doubleday's Hummingbird *Cyananthus doubledayi* (*Cyananthus latirostris*), Short-crested Coquette *Lophornis brachylopha* (*Lophornis delatitri*), Golden-cheeked Woodpecker *Melanerpes chrysogenys*, Western Wren *Campylorhynchus humilis* (*Campylorhynchus rufinucha*), Colima Wren *Uropsila pacifica* (*Uropsila leucogastra*)

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#### Southern Interior:

Banded Quail *Philortyx fasciatus*, Balsas Screech-owl *Otus seductus*, Balsas Pygmy-owl *Glaucidium griscomi* (*Glaucidium minutissimum*), Green-fronted Hummingbird *Amazilia viridifrons* (*Amazilia viridifrons*), Dusky Hummingbird *Cyananthus sordidus*, Beautiful Hummingbird *Calothorax pulcher*, Grey-breasted Woodpecker *Melanerpes hypopolius*, Pileated Flycatcher *Xenotriccus mexicanus*, Boucard's Wren *Campylorhynchus jocosus*, Slaty Vireo *Vireo brevipennis*, Dwarf Vireo *Vireo nelsoni*, White-throated Towhee *Pipilo albicollis*, Bridled Sparrow *Aimophila mystacalis*, Black-chested Sparrow *Aimophila humeralis*, Oaxaca Sparrow *Aimophila notosticta*

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†extinct.

including habitat critical to the survival of narrow-range endemics such as Mexican Woodnymph *Thalurania ridgwayi*, Sinaloa Martin *Progne sinaloae* and Tufted Jay *Cyanocorax dickeyi*.

Perhaps most important—and least protected—is the southern part of the region. An ideal site would be the coastal and interior slopes of the Sierra Madre del Sur, where the southern faunas are best developed. Here, appropriate and indeed critical habitat is present from near the coast, in the vicinity of Atoyac de Álvarez, up into the Sierra de

Atoyac to Cerro Teotepec (including the paper park Parque Nacional Cerro Teotepec), along the Sierra Madre del Sur to the Parque Ecológico Estatal de Omiltemi, and the interior slopes into the Balsas Basin (Cañon del Zopilote Biosphere Reserve and Reserva Biológica Sierra de Huautla). These areas include the entire geographic distribution of the rare Short-crested Coquette *Lophornis brachylopha* and Guerrero Jay *Aphelocoma guerrerensis*, perhaps the only viable known populations of White-throated Jay *Cyanolyca mirabilis* and White-tailed Hummingbird *Eupherusa poliocerca*, and known populations of rarities such as Balsas Screech-owl *Otus seductus*, Pileated Flycatcher *Xenotriccus mexicanus* and Slaty Vireo *Vireo brevipennis*. This mega-reserve, including at least four linked areas, would effectively protect much of the southern component of the western Mexican endemic avifauna.

The reserve systems outlined above are intended as a framework for bird conservation in western Mexico. Although they include most of the endemic forms in the region, several taxa would remain unprotected, including Masked Bobwhite *Colinus ridgwayi* (Sonora), Brewster's Parakeet *Aratinga brewsteri* (Sonora, Sinaloa and Durango), Blue-capped Hummingbird *Eupherusa cyanophrys* (Sierra de Miahuatlán, Oaxaca), Lamb's Screech-owl *Otus lambi* (coastal Oaxaca), Cinnamon-sided Hummingbird *Amazilia wagneri* (Sierra Madre del Sur, Oaxaca), Balsas Pygmy-owl *Glaucidium griscomi* (upper Balsas Basin), and Oaxaca Sparrow *Aimophila notosticta* (interior Oaxaca). These forms are either located in areas that do not present opportunities for cross-habitat reserve complexes (e.g. Durango), or are in regions too poorly explored to permit ready identification of priority areas.

### Conclusions

Western Mexico, though long an attraction for ornithologists and birdwatchers, has been under-appreciated as a centre of endemism. A significant portion of Mexican bird diversity is represented there and indeed almost half of the bird species unique to the country are restricted to the region. We propose this area as a critical priority for conservation action in the country and suggest that broad strategies for achieving these conservation goals need to be outlined.

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