The Spectrum: A Scholars Day Journal

Volume 2 Article 10

April 2013

High Biodiversity and Endemicism of a Cloud Forest, Exemplified by regional characteristics of Certhiaxis cinnamomea, Qualifies Conservational Priority in Ecuador

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OAP 404
24 January 2012

Introduction

Ecuador is considered a "megadiverse" country. A veritable patchwork of different environmental conditions, per unit of area it contains the greatest variety of ecosystems of any country in the world. Spilling into both the northern and southern hemispheres, Ecuador is geographically comprised of four regions: the highlands (or Andes mountains), the Amazon, the coast, and the Galapagos Islands ("Cloud Forest").

The cloud forest region

The Andean cloud forest occurs between 1400-3500 meters above sea level (MASL), and transitions from tropical "low montane" to "high montane" or "tropical montane cloud forest" (TMCF). At this elevation clouds surround the vegetation creating a phenomenon known as "horizontal precipitation:" water vapor cools and condenses at the vegetative level, blocking UV rays and heat from the forest foliage ("Cloud Forest"). This unique environment allows the growth and germination of flora dependent on a lesser UV index and plentiful atmospheric water: typically epiphytes, mosses, and lichens. As the elevation of the Andean cloud forest region often places TMCFs on a steep portion of the upper mountain, the dense foliage that characterizes cloud forest is essential insurance against the erosion of topsoil ("Cloud Forest"). Tropical Montane Cloud Forests are also major factors in the hydrologic cycle ("Cloud Forest").

Despite the impressive ecological significance of Andean cloud forests, TMCFs face a litany of anthropogenic threats in Ecuador. Disturbance due to the exploitation of forest materials, fragmentation by media-transmission structures, hunting, tourism, and land-clearing by local subsistence farmers all pose a risk to Ecuadorean cloud forests, and they are disappearing at a rate of 1.1 percent per year ("Cloud Forest").

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Species diversity in a TCMF

Tropical montane cloud forests are also characterized by high levels of biodiversity and endemicism, or species particular to one area on Earth as a result of divergent evolution. A correlation can be seen between the environmental capacity for enormous plant diversity in the Andean TMCF and the similarly impressive faunal diversity of the region. Globally, species richness of producers generally reflect the species richness of primary and upper-level consumers (Jetz *et al.* 2009). Plant distribution and speciation in the South American Neotropics, exemplified by disproportionate endemicism on a cloud forest ridge in Centilina, Ecuador, is illustrative of the founder effect: as plant species are distributed further up the mountain, the abrupt change in environment due to elevation and the resulting atmospheric conditions prompts adaptation by the plant species (Gentry, 1992). Globally, plant endemicism often results from a patch of unusual substrate that forces adaptation to a different set of available nutrients (Gentry 1992). However, in a cloud forest, plants are prompted to adapt to the quantity of atmospheric water present past the cloud barrier at a particular elevation. This in turn prompts the coevolution of the consumer species – not only those that eat the adapted plants, but also those that hide, hunt, and nest in them. Thus, the divergent evolution of plants in the cloud forest environment suggests similar speciation of the consumer species that rely on them, creating huge rates of endemicism in TMCFs. Endemicism is also confirmed by upper level consumer species, probably due to numerous non-nutritive assets of local flora such as shelter, ability to harbor prey, and indication of general resource abundance (Jetz *et al.* 2009).

Life history of the Yellow-chinned Spinetail

The Yellow-chinned Spinetail (*Certhiaxis cinnamomea*) is one of South America's most common and widely-ranging bird species, with sightings documented throughout Brazil, Guyana, Paraguay, Uruguay, Venezuela, Suriname, Bolivia, Peru, and Columbia ("Yellow-chinned" 2012). This bird has rufous - or cinnamon-red - back, tail, wings, and uppers, with a creamy belly, throat, and face. Lores are faintly gray, the feathers transition from cream belly to red uppers with a faded gray-brown region between, it has black/dark gray legs, feet, and beak, and is tawny at forehead and crown. Like other members of the Furnariidae, or ovenbird family, *C.cinnamomea* is an insectivore, feeding on a general assortment of local arthropods (Poulin *et al.* 1994). Preferring to breed during the early portion of the wet season (Cruz and Andrews 1989), this species is one of many Furnariidae known for large and intricate stick nests that feature closed, ovate chambers with a funneling projection used as an entrance by parent birds. *C.cinnamomea* is most often seen alone or in pairs. Its call is a harsh "churrrr," growing louder until fading, or a buzzing trill ending in a "chip" (Hilty and Brown 1986). The global population of *C.cinnamomea* is not presently quantified, although it is believed to be declining. Numbers of *C.cinnamomea* are not believed to be approaching thresholds that could classify the species as "vulnerable," but due to its extremely large range it is classified as "of least concern" on the IUCN Red List of Endangered and Threatened Species (2011). This species is typically observed in scrubby, dense lowlands South and East of the Andes, in the immediate vicinity of a body of water (Sibley and Monroe 1990).

La Hesperia Biological Reserve

The reserve on which the data for this study was collected, La Hesperia, is located in the western Andes Mountains at an elevation of 1100-2040 MASL ("Cloud Forest"), which places much of its area within a TMCF region. Birds generally represent the most heavily documented genre of biodiversity, and high rates of endemicism surrounding La Hesperia prompted recognition of the Rio Toachi-Chiriboga Important Bird Area (IBA) in which the reserve is located. This study was done in early January, placing its weeklong duration within the rainy season. The reserve had access to direct sunlight only during the hours of daylight before noon, and steady light precipitation consistently fell for the rest of the day. The reserve contains both densely forested and cleared areas, and included housing structures for both humans and livestock.

In the Western Andes of Ecuador, the yellow-chinned spinetail (*C. cinnamomea*) is poorly documented at best. Any regional variation of a species found so commonly on the South American continent, such as the widely-distributed *C. cinnamomea*, supports the unique demand for the conservation of disappearing Ecuadorian cloud forests.

Materials and Methods

On 7, January 2012, a pair of yellow-chinned spinetails (*C. cinnamomea*) was observed entering a large, ovular twig nest roughly 7 meters from the ground in a high, spare willow tree covered in epiphytes , mosses and parasitic vines. The site was surrounded by an ornamental garden of native palms and aloes, and located near a stone wall and a footpath at the edge of open, cleared property on the La Hesperia Biological Reservation,1100-2040 meters above sea level in the Choco Darien/Tropical Andes bioregion ("Cloud Forest"). From 9, January 2012 to 12, January 2012 – during the beginning of the rainy season in western Ecuador – the nesting parents were observed

twice a day at varying intervals and times. Recorded observations were then compared with published literature concerning the physical and behavioral characteristics of *C. cinnamomea* in its more traditional habitat, generally swamp lowlands in Columbia, Venezuela, and Brazil within roughly 180-700 MASL.

Results

Breeding /territorial behavior

The family of *C. cinnamomea* observed during the four-day study generally complied with recorded standards for this species. Parents were seen departing the nest, foraging on the ground for large invertebrates, and returning to the nest at least twice in any hour of observation. Parents of both sexes participated in the feeding and supervising of offspring. The female can be identified as it is less brightly rufous than the male. At least one parent appeared to be always present in or beside the nest, trading stations with the foraging parent only at the time of the foraging parent's alightment on the nesting branch. Brief sparring was observed twice between one of the nesting parents and a trespassing *C. cinnamomea* on the cleared ground within view of the nesting tree, although the sex of the involved parent was not determined. Offspring was first audible from ~30 meters on the third day of observation.

Nest

The nest was observed only at a distance through binoculars, but assessment at ~10 meters revealed a general twig and stick composition, with an overall shape true to prior studies of breeding *C. cinnamomea* (Sibley and Monroe 1990).

Feeding

Feeding was generally done on the ground, with a few instances of foraging in the mossy branches of short trees.

Call

Both parents issued frequent, high pitched, and unique calls (Table 1), provoked both by intruders of the same species and by the need for communication with the other mate.

Regional variation

When compared with published observations, field observations of *C. cinnamomea* recorded at the la Hesperia Biological reserve show significant regional differentiation between individuals in the TMCF region of western Ecuador and the lowlands of Eastern and Southern South America (Table 1). Individuals from the TMCF region were significantly larger than the average individual recorded in the lowlands. While the documented tendency of the species to occur alone or in pairs (Cruz and Andrews 1989) was consistent with the behavior of *C. cinnamomea* individuals observed in the TMCF, the population appeared to be especially dense at la Hesperia, forcing independent pairs to interact with others of the same species and causing frequent territory disputes. *C. cinnamomea* observed in the Ecuadorean Andes TMCF also had a strikingly different call than that of birds documented during lowland studies; TCMF birds appeared to favor this unique call exclusively.

Table 1: Regional discrepancies between *Certhiaxis cinnamomea* individuals observed on the la Hesperia reserve (1100-2040 meters above sea level) in the Ecuadorian TMFC and those observed in South American lowlands (180-700 MASL).

Environment	Tropical Montane Cloud Forest	Tropical Lowlands
Average length (cm)	~25	~15
Voice	"Pwee, pwee, pa-pa-pa-pa-pah" (high-pitched)	Rattling "Churrrrr-r-r"
Population density	Frequently interact with other *C. cinnamomea*	Seldom interact with other *C. cinnamomea*
Demeanor	Territorial	Timid, unobtrusive

Discussion

Regional development of *C. cinnamomea*

The contradictory behavioral patterns observed between *C. cinnamomea* in the TMCF of the Ecuadorian Andes on the la Hesperia reserve and those recorded by lowlands ornithologists in Venezuela and Columbia may be the product of many environmental factors besides the change in elevation, the presence of excessive atmospheric water, and the characteristic vegetative transition between the lowlands and the cloud forest. Population density appeared to play a major role in the territorial behavior of *C. cinnamomea* in the TMCF. Studies of the lowlands populations of this species seem to suggest that individual pairs were scattered sparsely, allowing each pair a large territory exclusive of other *C. cinnamomea* (Sibley and Monroe 1990). The unique call could conceivably be explained by the constant threat of territorial trespassers. However, the discrepancy in the size between the birds observed on the TCMF reserve and those observed in Venezuela and Columbia suggests that the density of *C. cinnamomea* in the Ecuadorian cloud forest is the direct effect of the elevated level of useful resources available to individuals of that species in the TCMF. Clearly, the la Hesperia reserve was capable of supporting large numbers of *C. cinnamomea*, and at above average size. Indeed, the territorial behavior of the birds in the TMFC suggests that the species' tendency toward a large and private breeding territory is the limiting factor in their population of the Ecuadorian cloud forest.

Error

The duration of the observational period was undoubtedly the greatest threat to the credibility of this study. The observations here are intrinsically limited, as observation

was confined to four full days. The effective familiarization of the character and regional nuance of a species requires observation in diverse conditions over an extended period of time. The birds at la Hesperia were, for example, observed mainly in cleared areas and only during the early rainy season. The first-hand observation of *C. cinnamomea* in several other TMCF regions, as well as in several lowlands locations, would have also made this study much more conclusive in its evaluation of divergent evolution.

Implied significance in conservation

The apparent variability between *C. cinnamomea* individuals observed in the TMCF of Western Ecuador and those observed in the lowlands of South America such as Columbia and Venezuela supports the conservational priority given to the Andean cloud forests. Taking into account the wide species distribution of *C. cinnamomea* throughout South America, the possibility of divergent evolution in response to the unique environment over 1400 MASL is compelling evidence of the degree of adaptive pressure exerted by the Andean cloud forest. As is suggested by the unique size and population density of *C. cinnamomea* living on the la Hesperia reserve, individuals clearly have access to a bounty of nutritional and material resources, making adaptation to the TMCF environment a distinct advantage. The implications for other species are potentially vast: the disappearance of the rare environment offered within the TMCF of Ecuador could eliminate ideal conditions for countless endemic and evolving species, as well as the potential capacity of this environment to preserve biodiversity due to climate change ("Cloud Forest").

Important Bird Areas

Conservation initiatives such as the institution of Important Bird Areas throughout South America are an important aspect of the preservation of global biodiversity. The significance of these designations is elevated by high rate of endemicism in the area, making the TMCF one of South America's greatest biodiversity assets. The IBA program was initiated in by the international non-profit organization, Birdlife International, and implementation is a product of coordination with local NGOs and conservation initiatives in the area. Through the instatement and management of IBAs, Birdlife International attempts to enable the conservation communities of the 21 nations that currently maintain IBAs. The establishment of an IBA is qualified by the presence of one or more globally threatened (as listed by the IUCN Red List), biome-restricted, or range-restricted species, or by the status as a congregation area for migrating species ("The important…" 2012).

Universal benefits of the IBA conservation approach

The main advantage offered by the establishment of such areas as high conservational priority extends beyond the preservation of unique or threatened bird species. The heavy documentation of birds relative to that of other taxa often prompts the use of bird as indicator species. Schulze *et al.* (2003) show a correlation between the biodiversity of multiple taxa in tropical systems, including trees, understory plants, birds, butterflies, and dung beetles, suggesting a possibility that the establishment of IBAs may preserve ecological regions with an overall high level of biodiversity. Sites are evaluated using a set of globally standardized qualifications, allowing for international involvement and awareness of site priority. The IBA program appears to be a universally applicable option, designed to globalize conservation initiative while encouraging the involvement of local, grassroots conservation groups as well as national organizations in

stewardship of their environment. The instatement of Important Bird Areas is underutilized in developing nations; fully industrialized and growing nations such as the United States could benefit enormously from such a program, as a useful means of encouraging NGO and community involvement and protecting quickly-disappearing regions essential to preserving a part of the biodiversity of the Americas.

Conclusion

A nesting family of *C. cinnamomea* were observed during the rainy season on the cleared property of the la Hesperia Biological Reserve, located in the Tropical Montane Cloud Forest in the Andes of Western Ecuador at an elevation of 1100-2040 MASL. *C. cinnamomea* is not well documented in Ecuador or at high elevations, and characteristics observed in birds in the TMCF – including size, voice, population density, and demeanor – differed significantly from accepted characteristics of the same species recorded in the lowlands of South America, including Brazil, Venezuela, and Columbia (Table 1). These regional discrepancies are suggestive of divergent evolution, a common occurrence in the unique environment implied by the elevation of the area and classifying it as a cloud forest. Endemic traits of a common and widespread species such as *C. cinnamomea* supports the high conservational propriety of the Rio Toachi-Chiriboga IBA. The IBA program is currently protecting areas rich in biodiversity in 21 nations, and is a universal application of conservation effort aimed at protecting global species diversity. IBAs are established by Birdlife International, and maintained through the organization's cooperation with and encouragement of local and NGO efforts. The adaptation of *C. cinnamomea* and other local South American fauna to the TCMFs of Ecuador could be more thoroughly studied, presently being

poorly documented; IBAs should continue to be supported in Ecuador and should be considered as a conservation possibility for the United States and other developed nations.

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