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OBSERVATIONS ON HUMMINGBIRDS AND THEIR NECTAR RESOURCES AT THE CLOUD FOREST OF MANU ROAD, PERU

OBSERVACIONES DE LOS COLIBRIES Y SUS RECURSOS DE NECTAR EN EL BOSQUE NUBLADO DE LA CARRETERA A MANU, PERU

Oscar González[1] & Susan Wethington[2]

[1] School of Natural Resources and Environment, University of Florida. 103 Black Hall Gainesville Fl 32611, USA and Grupo Aves del Peru, Gómez del Carpio 135, Lima 34 Peru
[2] Hummingbird Monitoring Network, PO Box 115 Patagonia, AZ 85624 USA

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ABSTRACT

We studied hummingbird ecology in the cloud forest of southeastern Peru, using mist nets and direct observations. This study was done in one area of the cloud forest of Manu road (Cuzco, Peru) at the beginning of the rainy season of 2011. We give a list of the hummingbirds (14 species) and the flowering plants that they use as nectar resources (~20 taxa in 11 families). We also comment on the abundance, distribution and importance of the hummingbird's role in the cloud forest ecosystem.

Keywords: Cloud Forest, Hummingbirds, Manu road, Plant-Animal Interactions.

RESUMEN

Realizamos un estudio de la ecología de los colibríes en el bosque nublado del sureste peruano, mediante observaciones directas y capturas con redes. El estudio se realizó en un área del bosque nublado de la carretera a Manu (Cuzco, Perú) al inicio de la época de lluvias del 2011. Como resultado damos una lista de los colibríes (14 especies) y las plantas con flores que utilizan como recursos de néctar (~20 taxa en 11 familias) y comentamos sobre la abundancia, distribución e importancia de los colibríes en el ecosistema del bosque nublado.

Palabras clave: Bosque nublado, Colibríes, Interacciones planta-animal, Manu.

INTRODUCTION

Hummingbirds are the second most diverse family of birds in the Americas and live in a variety of environments, from dry, warm lowlands to cold, wet highlands, in habitats ranging from scrubby vegetation to tall, dense forest (Stotz *et al.* 1996). About 80% of hummingbird species are dependent upon forest vegetation for at least one stage of their life history (Wethington *et al.* 2009, 2010). They are the world's most specialized avian nectar feeders with morphological, ecological, behavioral and physiological adaptations for this diet, and serve as pollinators for a wide array of native plants (Brown & Bowers 1985, Stiles 1988, 2008). They depend mainly upon nectar for the energy required for breeding, molt and migration, but they also require insects and spiders for their nutrition and reproductive success (Stiles 1995, Altshuer *et al.* 2004, Gegear & Burns 2007).

Perhaps the greatest potential threat to hummingbird survival is the effect of changing climates on flowering phenology. Even minor changes in climate can produce large changes in blooming seasonality that might decouple local co-adaptations between the annual cycles of hummingbirds and the plants they pollinate, well before extinctions occur (Memmott *et al.* 2007). Therefore, it is critical to monitor nectar availability and plant phenology in concert with hummingbird populations (Garrison & Gass 1999, Wethington *et al.* 2010). In turn, changes in hummingbird abundance and distribution may affect plant distributions by changing the pattern of pollination (Temeles & Kress 2003).

We organized a workshop entitled "Curso teorico-practico, monitoreo de picaflores" in a location of the cloud forest of Manu Road (Cuzco, Peru) after the XI Neotropical Ornithological Conference hummingbird symposium titled: "Ecología y Evolución de Colibríes y las Implicaciones del Cambio Climático" (Hummingbird Ecology and Evolution and Implications of Climate Change; see Lara *et al.* 2012, Arizmendi & Rodríguez-Flores 2012, Hernández-Banos *et al.* 2012, Rodríguez-Flores *et al.* 2012, Schondube 2012). This event was held between November 15 and 19, 2011 and the primary objectives of the workshop were to provide an overview of field techniques used in the study of hummingbirds, including techniques for studying hummingbird-flower interactions and banding techniques for hummingbirds. Additionally discussions were held to investigate solutions for hummingbird conservation issues (Kearns & Inouye 1983, Russell & Russell 2001). In the following section, we present a list of hummingbirds found during our study, along with the flowering plants they used as nectar sources.

MATERIALS AND METHODS

Field activities took place on the grounds of Manu Paradise Lodge, Cock of the Rock Lodge and other nearby locations in the crossing of San Pedro and Kosñipata rivers (71º32'40"W, 13º03'25"S). Both places are accessible through Manu Road in the cloud forest of Cuzco at 1400 m elevation and are in the buffer zone of Manu National Park. This region is highly valuable for birdwatching in the country, due to its high bird diversity (Pukahha *et al.* 2011). The observations were done between the 15th and 19th of November 2011 (beginning of the rainy season) and covered ~ 10 Ha. During the field activities, we recorded all hummingbirds present in mist nets and by sight. We practiced point counts and linear transects (Hutto *et al.* 1986, Stiles & Rosselli 1998) up to 20 point of 5 minutes each and 50 m. radius. The mist nets were hanged in specific locations where they were possible to be monitored every 20 min; five nets were opened at different intervals in the morning and afternoons adding up to 45 net-hours. We also recorded the plants that these hummingbirds visited in all locations; we used the guide of Foster & Betz (2000) for plant identification. This workshop was designed to be an educational activity so we did not keep a strict quantitative record of the effort and the abundance of the hummingbirds.

RESULTS AND DISCUSSION

We recorded 14 species of hummingbirds (Table 1). Nine of them were captured by mist nets and four of them are shown in Fig.1. They are listed in order of abundance with the most common first.

All of these species are possible to be found in the cloud forest of Manu (Walker *et al.* 2006, Tobias *et al.* 2008). Jankowski (2010) and

Table 1. Hummingbird species recorded in the Cloud Forest of Manu road (1400m), November 2011.

SCIENTIFIC NAME	ENGLISH NAME	SPANISH NAME	Detection*	Ecosystem**
Colibri coruscans (Gould, 1846)	Sparkling Violetear	Oreja-Violeta de Vientre Azul	Cp	A,B,C
Heliodoxa leadbeateri (Bourcier, 1843)	Violet-fronted Brilliant	Brillante de Frente Violeta	Cp	B,C
Eutoxeres condamini (Bourcier, 1851)	Buff-tailed Sicklebill	Pico-de-Hoz de Cola Canela	Cp	B,C
Ocreatus underwoodii (Lesson, 1832)	Booted Racket-tail	Colibrí Cola de Raqueta	Cp	B,C
Adelomyia melanogenys (Fraser, 1840)	Speckled Hummingbird	Colibrí Jaspeado	Cp	B
Taphrospilus hypostictus (Gould, 1862)	Many-spotted Hummingbird	Colibrí Multipunteado	Cp	B,C
Discosura popelairii (Du Bus de Gisignies, 1846)	Wire-crested Thorntail	Cola-Cerda Crestado	Cp	B,C
Schistes geoffroyi (Bourcier, 1846)	Wedge-billed Hummingbird	Colibrí Pico de Cuña	Cp	B,C
Chaetocercus mulsant (Bourcier, 1842)	White-bellied Woodstar	Estrellita de Vientre Blanco	Cp	B,C
Phaethornis guy (Lesson, 1833)	Green Hermit	Ermitaño Verde	Ob	B,C
Doryfera ludovicae (Bourcier & Mulstant, 1847)	Green-fronted Lancebill	Pico-Lanza de Frente Verde	Ob	B
Colibri thalassinus (Swainson, 1827)	Green Violetear	Oreja-Violeta Verde	Ob	B,C
Coeligena coeligena (Lesson, 1833)	Bronzy Inca	Inca Bronceado	Ob	B,C
Chrysuronia oenone (Lesson, 1832)	Golden-tailed Sapphire	Zafiro de Cola Dorada	Ob	B,C,D

*Detection: Cp=Captured. Ob=Observed only. **Ecosystem: By Tobias *et al.* (2008), A: Treeline/scrub/puna, B: Montane forest and scrub, C: Foothills/submontane forest and scrub, D: Lowland forest.

Merkord (2010) did intensive bird surveys along Manu Road between 2005 and 2009 and both registered the same species that we did at the elevation of our study area; with two differences: Both reported *Chrysuronia oenone* at a maximum altitude of 1200 m and Jankowski (2010) did not report *Discosura popelairii*. The reason could be the altitudinal migration of hummingbirds; which has been shown in other cloud forests (Stiles 1988). On this topic Merkord (2010) mentioned that several bird species in this area show evidence of altitudinal migration, including *Colibri coruscans* and *C. thalassinus*.

The data available for this area in ebird (www.ebird.org), a popular electronic database for bird sightings worldwide (Sullivan *et al.* 2009), consists of 263 checklists from 1995 to 2013. The databases in each site are available by months, so in the month of November there are 35 hummingbird species recorded in Cock of the Rock Lodge and nearby. However, removing the species that could be mistakenly added (judging by being in the wrong altitudinal range or not being in previous records of Manu Road); the list is left with 28 species. Taking this into consideration, we estimate that we observed 50% of the hummingbird diversity expected in November for this section of the Cloud Forest in Manu Road.

Colibri coruscans is one of the most common hummingbirds in the Puna (high Andean plateau) at the west Andes; it was also the most common and territorial in the area. Both *C. coruscans* and *Heliodoxa leabeateri* were dominant in the nectar feeders which were hanging in the lodges' gardens. The forest has 20-30 m. in average of canopy, but some trees reach up to 40 m. The region has been logged in the past due to the access by the road, so it is not a primary forest. In the gardens of the lodges, some plants (*Stachytarpheta* sp.) have been planted to attract birds for the tourists. We

Table 2. Plants visited by the hummingbirds at the Cloud Forest of Manu road (1400m), November 2011.

Family	Genera
Campanulaceae	*Centropogon* (2 spp.)
Gesneriacee	*Drymonia* sp., *Columnea* (3 spp.), *Kohleria* sp.
Passifloraceae	*Passiflora* sp. (aff. *vitifolia*)
Acanthaceae	*Justicia* or *Aphelandra* sp.
Heliconiaceae	*Heliconia* (2 spp.)
Costaceae	*Costus* sp.
Zingiberaceae	*Renealmia* sp.
Verbenaceae	*Stachytarpheta* sp. (planted, rat-tail inflorescence, purple flowers).
Rubiaceae	*Palicourea* (2 or 3 spp.), *Cephaelis* (or *Psychotria*) sp.
Bromeliaceae	*Pitcairnia* sp., *Tillandsia* (?) sp.
Cucurbitaceae	*Gurania* sp.

a.White-bellied Woodstar *Chaetocercus mulsant*
Photo by Oswaldo Cortes, Birding Bogota.

c.Many-spotted Hummingbird *Taphrospilus hypostictus*
Photo by Victor Martinez.

b.Sparkling Violetear *Colibri coruscans*
Photo by Oswaldo Cortes, Birding Bogota.

d.Violet-fronted Brilliant *Heliodoxa leadbeateri.*
Photo by Victor Martinez.

Figure 1. Some hummingbirds observed at the Cloud Forest of Manu Road, Peru.

identified 11 plant families genera that were flowering during our visit and that were visited by hummingbirds; we could identify part of them at the genera level in 12 taxa (Table 2).

Several of these plants are conspicuous in this forest (Foster & Betz 2000) and have the bird-pollinated syndrome; with long and colorful corollas (Proctor *et al.* 1996). However, we did not see hummingbirds visiting *Seemannia sylvatica*, as Caraimpoma & Martel (2012) reported.

Though often overlooked, pollination is critical for producing viable seeds and fruit which then become food resources for many animal and bird species, including humans. In the highly biodiverse neotropics, more than 90% of tropical plants depend on animals for pollination (Bawa 1990). Hence, these interactions are considered key drivers of biodiversity. Hummingbirds, as pollinators, rely upon dependable nectar resources throughout the year. With changing phenologies of both the flowering plants and hummingbirds, it is essential to know where and when expected gaps in key floral nectar availability will likely occur. Further studies on plant-animal interactions are needed to understand the potentially disruptive influences of changing phenologies. Pollination is an essential process in nature and a valuable ecological service for human society. We encourage other researchers to study plant-animal interactions in the pollination process; this will be a way to understand the functioning of the ecosystems (Mayer *et al.* 2011).

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BIBLIOGRAPHIC REFERENCES

Altshuler, D.L.; Stiles, F.G. & Dudley, R. 2004. Of helicopters and hummingbirds: hovering costs, competitive ability and foraging strategies. American Naturalist, 163:16-25.

Arizmendi, M. & Rodríguez-Flores, C. 2012. How many plant species do hummingbirds visit? Ornitología Neotropical, 23 (Supplement): 67-71.

Bawa, K. 1990. Plant-pollinator interactions in tropical rain forests. Annual Review of Ecology and Systematic, 21:399-422.

Brown, J.H. & Bowers, M.A. 1985. Community organization in hummingbirds: relationships between morphology and ecology. The Auk, 102: 251-269.

Caraimpoma, L. & Martel, C. 2012. Notes on floral visitors in *Seemannia sylvatica* (Kunth) Hanstein (Gesneriaceae). Revista Peruana de Biologia, 19: 11 -16.

Faegri, K. & van der Pijl, L. 1971. *The principles of pollination ecology.* Pergamon, Londres. 291 pp.

Foster, R. & Betz H. 2000. *Conspicuous plants at the San Pedro cloud forest.* Rapid color guide 104. Environmental & Conservation Programs, The Field Museum, Chicago.

Garrison, J.S.E. & Gass, C.L. 1999. Response of a traplining hummingbird to changes in nectar availability. Behavioral Ecology, 10: 714-725.

Gegear, R.J. & Burns, J.C. 2007. The birds, the bees, and the virtual flowers: can pollinator behavior drive ecological speciation in flowering plants? American Naturalist, 170:551-566.

Hernández-Baños, B. E.; Zamudio-Beltrán, L.E.; García-Moreno, J. & Eguiarte, L.E. 2012. Phylogenetic relationships within the genus Eupherusa inferred from mtdna sequences. Ornitología Neotropical, 23 (Supplement): 73-79.

Hutto, R.L.; Pletschet, S.M. & Hendricks, P. 1986. A fixed-radius point count method for nonbreeding and breeding season use. The Auk, 3: 593-602.

Jankowski, J.E. 2010. *Distributional ecology and diversity patterns of tropical montane birds*. Phd dissertation. University of Florida. USA.

Kearns, C.A. & Inouye D.W. 1993. *Techiques for Pollination Biologists.* University Press of Colorado, Colorado, 583 pp.

Lara, C.; Feria-Arroyo, T.P.; Dale, J.; Muñoz, J.; Arizmendi, M.; Ornelas, J.F.; Ortíz-Pulido, R.; Rodríguez-Flores, C.I.; Díaz-Valenzuela, R.; Martínez-García, V.; Díaz-Palacios, A.; Partida, R.; Enríquez, P.L.; Rangel-Salazar, J. L. & Schondube, J. 2012. Posible cambio en la distribución de colibríes: un estudio de caso con especies del género Amazilia y Cynanthus. Ornitología Neotropical, 23 (Supplement): 53-66.

Mayer, C.; Adler, L.; Armbruster, W. S.; Dafni, A.; Eardley, C.; Huang, S.; Kevan, P.G.; Ollerton, J.; Parker, L.; Ssimank, A.; Stoutt, J.C. & Potts, S.G. 2011. Pollination ecology in the 21st century: key questions for future research. Journal of Pollination Ecology, 3: 8-23.

Memmott, J.; Craze, P.G.; Waser, N.M. & Price, M.V. 2007. Global warming and the disruption of plant-pollinator interactions. Ecology Letters, 10:710-717.

Merkord, C.L. 2010. *Seasonality and elevational migration in an Andean bird community*. PhD. Dissertation. University of Missouri-Columbia. USA.

Proctor, M.; Yeo, P. & Lack, A. 1996. *The Natural History of Pollination.* Timber Press. Oregon. USA.

Puhakka, L.; Salo, M. & Sääksjärvi, I.E. 2011. Bird diversity, Birdwatching tourism and conservation in Peru: A Geographic Analysis. PLoS ONE, 6: e26786. doi:10.1371/journal.pone.0026786.

Rodríguez-Flores, C.; Stiles, F.G. & Arizmendi, M. 2012. Pollination network of a hermit hummingbird community (Trochilidae, Phaethornithinae) and their nectar resources in the Colombian Amazon. Ornitología Neotropical, 23 (Supplement): 81-96.

Russell, S.M. & Russell, R.O. 2001. *The North American Banders' Manual for Banding Hummingbirds*. North American Banding Council, Point Reyes, CA.

Schondube, J.E. 2012. Differences in nectar use potential in a guild of birds: a gut's view. Ornitología Neotropical, 23 (Supplement): 97-113.

Stiles, F.G. 1988. *Altitudinal movements of birds on the Caribbean slope of Costa Rica: implications for conservation.* pp. 243-258. In: Almeda, F. & Pringle, C.M. *Tropical rainforests: diversity and conservation.* California Academy of Sciences. San Francisco, California.

Stiles, F.G. 1995. Behavioral, ecological and morphological correlates of foraging for arthropods by the hummingbirds of a tropical wet forest. Condor, 97:853-878.

Stiles, F.G. 2008. Ecomorphology of hummingbirds: divergence and convergence in adaptation to high elevations. Ornitología Neotropical, 19 (Suplement): 511-520.

Stiles, F.G. & Rosselli, L. 1998. Inventario de las aves de un bosque altoandino: comparación de dos métodos. Caldasia, 20:29-43.

Stotz, D.F.; Fitzpatrick, J.W.; Parker III, T.A. & Moskovits, D.K. 1996. *Neotropical Birds: Ecology and Conservation*. University of Chicago Press. Chicago, Illinois.

Sullivan, B.L.; Wood, C.L.; Iliff, M.J.; Bonney, R.E.; Fink, D. & Kelling, S. 2009. eBird: a citizen-based bird observation network in the biological sciences. Biological Conservation, 142: 2282-2292.

Temeles, E.J. & Kress, W.J. 2003. Adaptation in a plant-hummingbird association. Science, 300:630-633.

Tobias, J.A.; Koch, P. & Merkord, C. 2008. *Hummingbirds of the Madre de Dios watershed, Peru*. Rapid Color Guide 230, Environmental & Conservation Programs, The Field Museum, Chicago.

Walker, B.; Stotz, D.F.; Pequeño, T. & Fitzpatrick, J.W. 2006. Birds of the Manu Biosphere Reserve. Fieldiana Zoology, 110:23-49.

Wethington, S.M.; Carrothers, C. & Craig, D. L. 2010. *Western Hummingbird Partnership Action Plan*. Dowloaded from:http://www.hummonnet.org/pdf/201006whp_actionplan.pdf.

Wethington, S.M. & Finley, N. 2009. *Addressing hummingbird conservation needs: An initial assessment*. Proceedings of the Fourth International Partners in Flight Conference: Tundra to Tropics: Connecting Birds, Habitats, and People. 2008. McAllen, Texas.

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