

Mystery of the lowland Giant Hummingbirds (*Patagona gigas*) of central Chile

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Project Overview

Andean hummingbirds have narrow elevational distributions (500-1,500 m in amplitude) as a result of their specialized hemoglobin, which is genetically optimized to bind oxygen at low atmospheric pressures (Graham et al. 2009; Projecto-Garcia et al. 2013). As such, few elevational generalist hummingbird species exist. The Giant Hummingbird (*Patagona gigas*) – the largest hummingbird in the world – defies this tendency. It is distributed from sea level to ~4,500 m in the Andes (Fernández et al. 2011), but it only occurs at sea level where the southern subspecies, *P. g. gigas*, breeds in central Chile (Estades et al. 2008). Furthermore, *P. g. gigas* is migratory and it does not winter at sea level. This raises the question: *At what latitude and altitude do lowland Giant Hummingbirds winter?*



Figure 1. Left: Giant Hummingbird perches near *Lobelia excelsa*. Right: *L. excelsa*, or “devil’s tobacco”, is the Giant Hummingbird’s preferred food source during the summer in Chile.

Objectives

I propose to describe migratory connections between Giant Hummingbird breeding and wintering populations for the first time using ultra-light geolocators. I predict that southern lowland Giant Hummingbirds migrate to lower latitudes (closer to the equator). I

hypothesize: **H₁**: Lowland Giant Hummingbirds winter at mid-elevations (1,500-2,500 m). **H₂**: Lowland Giant Hummingbirds winter high elevations (1,500-4,500 m; Fig. 2). Based on the overall tendency for hummingbird elevational range specialization, I predict that H₁ will be supported. Whether H₁ or H₂ is supported will allow me to ask what seasonal physiological adjustments are made between breeding and wintering grounds, and how this relates to patterns of gene flow between migratory and sedentary populations, a longstanding mystery in the field. It has been proposed that *P. g. gigas* prefers low to mid-elevations (0-2,000 m), while *P. g. peruviana* prefers mid to high-elevations (1,800-4,500 m; 5). I predict that the lowland *P. g. gigas* is genetically differentiated and reproductively isolated from the high altitude-resident *P. g. peruviana*, pointing to cryptic speciation driven by specialization on the partial pressure of atmospheric oxygen.

Value to Ornithology

This study will identify where southern Giant Hummingbirds winter (latitude and altitude) for the first time. Additionally, this research will begin to characterize the diversity of migratory and life history strategies within this ancient, monotypic lineage, which are unresolved in the literature. In doing so, it will provide clues about how differences in migratory behavior, combined with cryptic genetic adaptation to different seasonal elevational distributions, might lead to genetic isolation and speciation. Results will stimulate ecological questions about migration timing and location of stopover sites, as well as evolutionary questions about gene flow among *Patagona* populations along the extent of their Andean distribution.



Figure 2. Left: Jessie takes bill plus head measurement; middle: researchers examine juvenile wing plumage; right: close-up of a Giant Hummingbird shortly after foraging, its head dusted in pollen.

Methods

I completed my first field season in Valparaíso Region, Chile in January 2017. Two key field sites were identified: Quebrada San Gerónimo (33°21.542' S, 071°38.096' W) and Estero Membrillo (33°20.913' S, 071°38.203' W), both near the small coastal town of Algarrobo.

Giant Hummingbirds were captured with mist nets, morphometric measurements were taken (Fig. 2), and blood and feather samples were collected for future genetic and physiology studies. To track hummingbird movement, I attached Migrate Technology geolocators to 24 individuals (Fig. 3). Geolocators store ~ 200 archival fixes, allowing me to track movement for one year. Devices weighed 0.55 g with harness, or ~ 3% of the birds' 18-31 g body weight, which falls below the threshold shown to reduce the effects of devices in tracking studies (Barron et al. 2010). These methods have been used successfully with smaller hummingbirds species (Hadley and Betts 2009; Zenzal et al. 2014).



Figure 3. Left: Giant Hummingbird is fitted with a backpack harness in the flight tent; right: Giant Hummingbird outfitted with backpack harness sits calmly prior to release.



Figure 4. Giant Hummingbird with a geolocator backpack is observed in the flight tent prior to release.



Figure 5. Giant Hummingbird with a geolocator backpack seen perching and foraging around Quebrada San Gerónimo several days after being released.

Backpack harnesses were made with Stretch Magic cord (Streby et al. 2015). I modified the harness design used by Akesson et al. (2012), as hummingbird legs are too attenuated for the passerine leg-loop harness (Rappole and Tipton 1991), and custom-fit backpack harnesses on each individual. Through careful device model and attachment method selection, all efforts were made to minimize adverse health effects on body condition, flying and foraging ability, energetic expenditure, and survival (Barron et al. 2010). I will return to Chile in Jan 2018 to recover geolocators and download data. All research was conducted with University of New Mexico Institutional Animal Care and Use Act (IACUC) and Servicio Agrícola y Ganadero (SAG) permits and approval.

Pilot Field Season Highlights (project ongoing)

- Successfully deployed the target 24 geolocators on lowland *P. gigas* individuals. All birds were observed in a “flight tent” prior to release (Fig. 4). Hummingbirds received the harnesses well, and displayed normal flight and perching behavior (Fig. 5).
- Throughout fieldwork we noted high numbers of Giant Hummingbirds at both study sites, with as many as ~20 individuals observed in 1-2 hours at the Quebrada San Gerónimo site (see sample eBird checklists from [Quebrada San Gerónimo](#) and [Estero Membrillo](#)). *P. gigas* is attracted to the common flower *Lobelia excelsa*, or “devil’s tobacco”, which grows in large patches and is numerous in the area (Fig. 1).
- Formed key partnerships with local businessman, Alfredo Zelada, property owner of our Estero Membrillo field (Fig. 6), and Margarita Espinoza, caretaker for the property where our Quebrada San Gerónimo field site is located. Mr. Zelada and Mrs. Espinoza have kindly granted us site access for our upcoming fieldwork (January 2018 and beyond).

- Trained field assistant Javier Reinoso (Chilean undergraduate student, Universidad Pontificia Católica de Chile) in mist netting, avian morphological measurement, and geolocator deployment; collaborated with Natalia Ricote (Chilean Ph.D. Candidate, Universidad Pontificia Católica de Chile).
- We continue to work closely with our Chilean collaborator, Dr. Francisco Bozinovic, of the Universidad Pontificia Católica de Chile, and are optimistic about permitting, collaboration, and future fieldwork.



Figure 6. Researcher, Jessie Williamson, and field assistant, Javier Reinoso, pack out the field camp with the help of local partner, Mr. Alfredo Zelada.

Future Plans

I will return to Chile in January 2018 to recover geolocators and download data, and aim to deploy ultra-light Platform Terminal Transmitters (PTTs) at this time. I have begun processing blood and feather data for analysis, and in the coming months will begin the genetics and genomics portion my research. I am grateful to the Nuttall Ornithological Club Blake-Nuttall Fund, the Frank M. Chapman Memorial Fund, UNM Biology Graduate Student Association, and UNM Graduate and Professional Student Association for supporting this research.

Literature Cited

- Akesson S, Klaassen R, Holmgren J, et al (2012) Migration Routes and Strategies in a Highly Aerial Migrant , the Common Swift *Apus apus*, Revealed by. PLoS One 7:1–9. doi: 10.1371/journal.pone.0041195
- Barron DG, Brawn JD, Weatherhead PJ (2010) Meta-analysis of transmitter effects on avian

- behaviour and ecology. *Methods Ecol Evol* 1:180–187. doi: 10.1111/j.2041-210X.2010.00013.x
- Estades CF, Vukasovic MA, Tomasevic JA, Desert N (2008) Giant Hummingbirds (*Patagona gigas*) Ingest Calcium-rich Minerals. *Wilson J Ornithol* 120:651–653. doi: 10.1676/07-054.1
- Fernández MJ, Dudley R, Bozinovic F (2011) Comparative energetics of the giant hummingbird (*Patagona gigas*). *Physiol Biochem Zool* 84:333–40. doi: 10.1086/660084
- Graham CH, Parra JL, Rahbek C, McGuire JA (2009) Phylogenetic structure in tropical hummingbird communities. *Proc Natl Acad Sci* 106:19673–19678. doi: 10.1073/pnas.0912879107
- Hadley AS, Betts MG (2009) Tropical deforestation alters hummingbird movement patterns. *Biol Lett* 5:207–10. doi: 10.1098/rsbl.2008.0691
- Projecto-Garcia J, Natarajan C, Moriyama H, et al (2013) Repeated elevational transitions in hemoglobin function during the evolution of Andean hummingbirds. *Proc Natl Acad Sci* 110:20669–20674. doi: 10.1073/pnas.1315456110
- Rappole JH, Tipton AR (1991) New Harness Design for Attachment of Radio Transmitters to Small Passerines. *J F Ornithol* 3:62–65.
- Sánchez Osés C (2003) Taxonomy, phylogeny, and biogeography of the Andean hummingbird genera *Coeligena* Lesson, 1832; *Pterophanes* Gould, 1849; *Ensifera* Lesson 1843; and *Patagona* Gray, 1840 (Aves: Trochiliformes).
- Streby HM, McAllister TL, Peterson SM, et al (2015) Minimizing marker mass and handling time when attaching radio-transmitters and geolocators to small songbirds. *Condor* 117:249–255. doi: 10.1650/CONDOR-14-182.1
- Zenzal TJ, Diehl RH, Moore FR (2014) The impact of radio-tags on Ruby-throated Hummingbirds (*Archilochus colubris*). *Condor* 116:518–526. doi: 10.1650/CONDOR-13-142.1



Thank you!