



Supplementary Materials for

Avian nesting and roosting on glaciers at high elevation, Cordillera Vilcanota, Peru

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Figs. S1 to S11 Supplemental Reference



Figure S1. Quelccaya Ice Cap western margin (partial view) and surrounding terrain, Jun 2008 (~5,200 m). Note moraine in foreground, small lake and bofedal near the location of our Moraine Camp (Fig. 1), sparse vegetation, and proglacial lake Morojanicocha (unofficial name for the source of Quebrada Morojani; an Aymara word approximately meaning 'lake in the place without vegetation'). The 2 first-ever-observed active White-winged Diuca Finch (*Idiopsar speculifera*) nests were found along a retreated position of this margin in Apr 2014 (6 years later); see text. Nest DA-16 and figure S4 is out of view, further up the margin on the image right-hand side. The location of figure 5 is across Morojanicocha, at the left-hand ice margin. Credit: DRH.



Figure S2. Looking south along part of the Quelccaya Ice Cap western margin, Oct 2014 (~5,200 m). Moraine Camp (Fig. 1) is located near the small lake (left side of image). Morojanicocha is just out of view to the left. Note meltwater drainage from the glacier and bofedales, still present as the 2014 dry season is concluding (transient snowline is visible on the glacier). Credit: DRH.



Figure S3. Example of an old, not in situ White-winged Diuca Finch (*Idiopsar speculifera*) nest beside Quelccaya Ice Cap, Jul 2012 (~5,200 m). Note glacier ice in background. For scale, GPS unit length is ~16 cm and screen is 5.75 cm. Nest material here, and in other photos, appears to be of differential ages; it is not known whether this is due exposure, or to rebuilding of the 2012-season nest (upper portion) on an older base. Credit: DRH.



Figure S4. Ice cliff filming site, Apr 2016. Nestcam is at waist level to the right of climber; both are secured by ropes anchored at the top. Nest DA-16 is within the hole approximately 3 body lengths to the right of climber. Nestcam controls and monitor are within the hide at base of the cliff (5,240 m). Credit: DRH.

Hardy et al. (2018) Avian nesting and roosting on glaciers in Peru



Supplemental Material



Figure S5. Automated weather station at Quelccaya Ice Cap summit, shown during (a) and following (b) annual service and extension of the tower, May – Jun 2010 (5,680 m). Adjacent snowpit (c) reveals less-than-normal accumulation during the 2009-2010 El Niño event (1.82 m) and a dramatic contrast at the prior year's dry-season surface. Credit: DRH.

Hardy et al.	(2018)	Avian	nesting	and	roosting	on	glaciers	in	Peru
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Supplemental



Figure S6. Active White-winged Diuca Finch (*Idiopsar speculifera*) nest #1 (5,200 m), located along Quelccaya Ice Cap margin at Morojanicocha on 29 Apr 2014. a) ice margin with nest site circled in blue, and blue ellipse around a person at lower right; ice in the foreground was gone by Oct; b) KCG observing the nest, \sim 1 m below his feet; c) one nestling in a typical-size nest; and d) adult White-winged Diuca Finch visiting the nest, which is visible behind icicle at bottom of photo. Credit: KCG (a, c); DRH (b, d).



Figure S7. Active White-winged Diuca Finch (*Idiopsar speculifera*) nest #2 (5,200 m), located along Quelccaya Ice Cap margin and across Morojanicocha from nest #1, 29 Apr 2014. a) ice margin with blue circles indicating nest locations (#1 on right, #2 on left); all remnants of the glacier on this side of the lake were gone by Oct; b) KCG photographing the nest; although nest is not visible, the protective advantages of the location are readily apparent; c) "documentation shot" of two nestlings, in a typical-size nest, with copious fecal sacs. Credit: KCG (a, c); DRH (b).



Figure S8. Active nest of White-fronted Ground-Tyrant (*Muscisaxicola albifrons*), on a boulder beneath overhanging glacier ice at Quelccaya Ice Cap margin, Oct 2014 (5,200 m). a) Two chicks (2 heads are visible, but only a small portion of one bill); b) as above, showing the gape of one chick; c) "documentation shot" of the two nestlings. Credit: DRH.



Figure S9. Feather remains of an apparently depredated Rufous-bellied Seedsnipe (*Attagis gayi*), found beneath the ice margin, Aug 2018 (5,210 m). a) glacier ice is visible at upper right and recent snow is to the left; GPS width is 7 cm; b) close-up of area on the right-hand side of image a in shadow of an icicle. Credit: DRH.



Figure S10. Color version of Fig. 4 in paper: Active White-winged Diuca Finch nest, April 2014. This location is typical of many of the nests we found, virtually inaccessible without ice-climbing equipment or wings. Note nested inset photos, and ascending observer. Credits: KCG (insets) and DRH.



Figure S11. Color version of Fig. 5 in paper: Glacier nest site of both White-fronted Ground-Tyrant and White-winged Diuca Finch, found in July 2017 at 5,330 m. Approximate position of White-fronted Ground-Tyrant nest—built directly on glacier ice—is indicated by the left-hand arrow in the upper image, with detail provided in middle and lower images. Right-hand arrow of upper image marks White-winged Diuca Finch nest location; note person for scale. Two of three nearly identical White-fronted Ground-Tyrant nests found previously were also directly on glacier ice. Fecal pellets are within red ellipse (middle) and a shell fragment is visible in the lower image. Credit: DRH.

Supplemental Reference. A BBC Natural History Unit team was at Quelccaya with all 3 co-authors in April and May of 2016, and co-produced a film with PBS (Public Broadcasting Service, US). The three-part documentary series features "extraordinary animals and remarkable people who make a home on the iconic mountain ranges of the world – Rockies, Himalaya and Andes." There are 2 Glacier Bird clips within the segment on the Andes. The BBC series titled *Mountain: Life at the Extreme* (UK distribution) premiered in September 2017, while the PBS version for US distribution is titled *Kingdoms of the Sky*. It appears that only the narration differs between the 2 titles (i.e., accent of Presenter).

Clips can be streamed at no cost, but currently only from either the US (via PBS) or UK (BBC). The following are links to the 2 clips from within the US:

- 1. "Meet the Bird that Nests Inside Glaciers" (02:50): <u>http://www.pbs.org/kingdoms-sky/episodes/andes/</u>
- 2. "How We Were the First to Film Glacier Birds" (08:14), a behind-the-scenes clip: <u>http://www.pbs.org/kingdoms-sky/blogs/mountain-diaries/video-diary-how-we-were-the-first-to-film-glacier-birds/</u>.

And from the UK:

- 1. "Glacier birds raise families at 5,500m" (01:51): https://www.bbc.co.uk/programmes/p05fdmvj
- "Glacier birds" (08:14 ?): http://www.bbc.co.uk/programmes/articles/31kqyFzTvWxNSHC0NKDmLGZ/glacier-birds.

The entire series of *Kingdoms of the Sky* is available for purchase, from either BBC or PBS – although there may be restrictions on shipping destinations:

- DVD in UK: <u>https://shop.bbc.com/video/new-releases/kingdoms-of-the-sky-21628.html</u>
- Blu-Ray in UK: <u>https://shop.bbc.com/video/shop-by-format/blu-ray/kingdoms-of-the-sky-bd-21629.html</u>.
- DVD in US (ISBN: 9781531703998): <u>https://shop.pbs.org/kingdoms-of-the-sky-dvd/product/KOTS601</u>. Unfortunately, this cannot be shipped to Canada due to limited US rights.
- Blu-Ray in US (ISBN 9781531704001): <u>https://shop.pbs.org/kingdoms-of-the-sky-blu-ray/product/KOT601B</u>. Unfortunately, this cannot be shipped to Canada due to limited US rights.