

Appendix 1. Supplemental Materials for:

Many Central American hummingbirds can be aged and sexed by molt patterns and bill corrugations

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Acknowledgements

Table S1. Molt, plumage, and bill coloration ageing and sexing criteria for nineteen species of Central American hummingbirds. Preformative molt extent partial, and prebasic molt extent complete in all species. Information on presence/absence and degree of sexual dichromatism from Birds of the World accounts (Billerman et al. 2020) and Fagan and Komar (2016).

Species	Clade	N	Molt limits in FCF	DCB bill corrugations (maximum %)	Sexual dichromatism (presence/absence or degree)	Delayed plumage/bill color maturation in males?
White-necked Jacobin	Topaz	133	Between primary and greater coverts, or within greater coverts	0% (N = 101)	Major, but a minority of DCB females show male-like plumage	Yes. FCF males retain juvenile tail pattern until SPB.
Band-tailed Barbthroat	Hermit	72	Between primary and greater coverts, or within greater coverts	0% (N = 43)	Negligible. Potential difference in coloration of underside.	No.
Long-billed Hermit	Hermit	62	Within greater coverts, or between primary and greater coverts	0% (N = 13)	None.	No.
Stripe-throated Hermit	Hermit	68	Between primary and greater coverts, or within greater coverts	5% (N = 36)	Slight. Potential difference in rectrix shape.	No.
Brown Violetear	Mango	137	Between median and greater coverts	0% (N = 43)	None.	No.
Purple-crowned Fairy	Mango	114	Between median and greater coverts, or between primary and greater coverts	0% (N = 42)	Moderate. DCB males with iridescent purple crown, tail with different pattern and shorter length.	Yes. FCF males retain intermediate tail pattern until SPB, and may retain brown feathers in crown.
Green-breasted Mango	Mango	224	Between median and greater coverts, or within primary coverts	0% (N = 103)	Major. DCB males with green body, dark stripe on breast. Female with dark stripe on white underside. Some DCB females with male-like body plumage.	Yes. FCF males with juvenile-like body plumage.
Black-crested Coquette	Coquette	150	Between median and greater coverts	0% (N = 104)	Major. DCB male with thin black plumes around iridescent patches on crown and throat, and red bill. Female with white throat and black on upper mandible.	Yes. FCF males without plumes and iridescent patches on head, and bill with red only at base of upper mandible.

Canivet's Emerald	Emerald Group A	141	Between median and greater coverts	0% (N = 76)	Major. DCB male entirely iridescent green, with deeply forked tail and red bill. Female with white underside and black upper mandible.	Yes. FCF males with incomplete iridescence, upper mandible black.
Wedge-tailed Sabrewing	Emerald Group B	136	Within greater coverts or between primary and greater coverts	0% (N = 64)	Minor. DCB males with white tips to rectrices, modified rachides in outer primaries.	Yes. FCF males retain unmodified juvenile primaries, have narrower rectrices with less white.
Violet Sabrewing	Emerald Group B	105	Between median and greater coverts, or within greater coverts	0% (N = 90)	Complete. DCB males iridescent violet and green with modified rachides in outer primaries, females with green backs, gray belly, some iridescence in throat.	Yes. FCF males with incomplete iridescence, no modified outer primaries.
Stripe-tailed Hummingbird	Emerald Group C	64	Between median and greater coverts	0% (N = 21)	Partial. Male with iridescent green on throat, breast, and belly, female grayish white below.	Yes. FCF males with incomplete iridescence.
Crowned Woodnymph	Emerald Group C	76	Within greater coverts or between median and greater coverts.	0% (N = 48)	Complete. Male entirely iridescent, with purple crown, breast, and belly, green head, throat, and back, and forked blue tail. Female green above and gray below.	Yes. FCF males with incomplete iridescence.
Scaly-breasted Hummingbird	Emerald Group D	84	Between median and greater coverts	0% (N = 24)	Minor. DCB males with modified rachides in outer primaries.	Yes. FCF males retain unmodified juvenile primaries
Azure-crowned Hummingbird	Emerald Group D	178	Between median and greater coverts	0% (N = 79)	Negligible. Potential difference in brightness of crown color.	No.
Cinnamon Hummingbird	Emerald Group D	168	Between median and greater coverts	0% (N = 78)	Minor. DCB males with extensive pink on upper mandible,	Yes. FCF males with mixed pink and black coloration on mandible.
Buff-bellied Hummingbird	Emerald Group D	59	Between median and greater coverts	0% (N = 17)	Minor. DCB males with extensive red on upper mandible.	Yes. FCF males with mixed red and black on mandible.
Rufous-tailed Hummingbird	Emerald Group D	290	Between median and greater coverts	10% (N = 85)	Minor. DCB males with extensive red on upper mandible, iridescent green gorget; DCB females with limited red mandible, "frosted" gorget.	Yes. FCF males with limited red on mandible and "frosted" gorget.
White-bellied Emerald	Emerald Group D	170	Between median and greater coverts	10% (N = 67)	None.	No.

Figures S1-S19. Images of 19 Central American Hummingbird Species exemplifying different molts and plumages, showing age and sex criteria.

These images focus on showing differences between formative and definitive plumage, and all species include at least 2 images. In some species, rather than an individual in formative plumage, an individual partially through the second prebasic molt but still showing a molt limit is included, and for Band-tailed Barbthroat, which had a low number of presentable images in the ML, we show an individual in juvenile plumage rather than an individual in formative plumage. For species with sexual dichromatism we show images of both males and females for the ages at which sexes are discernible.

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Figure S1. Images exemplifying molts and plumages in White-necked Jacobin



FPF. Note buffy malar stripe and turquoise-blue head feathering (contrasting with deep blue of the actively molting throat). Molt limit between dull brown-green greater coverts and metallic green median coverts. [ML 190568541](#)



SPB of unknown sex. Note actively molting primaries (with remaining older primaries quite worn and frayed at the tips) contrast between worn, dull juvenile greater coverts and deep green formative median coverts, and broad blue edging and gray interior of central rectrices. [ML 134566741](#)



SPB female molting into “speckle-throated” basic plumage. Note actively molting outer primaries and remaining blue feathers in the throat. [ML 95185891](#)



DCB female “speckle-throated” morph. Note lack of contrast between greater and median coverts. [ML 171030221](#)



DCB male. Note rectrices almost entirely white with thin blue edging, and lack of contrast between greater and median coverts. [ML 240480861](#)

Figure S2. Images exemplifying molts and plumages in Band-tailed Barbthroat



FCJ. Note pale buff edging to most feathers. [ML 193782571](#)



DCB. Note lack of molt limits within wing. [ML 156492471](#)

Figure S3. Images exemplifying molts and plumages in Long-billed Hermit



FCF. Note pale tips to retained outer juvenile greater coverts. [ML 317168681](#)



DCB. Note lack of contrast between greater and median coverts. [ML 290028221](#)

Figure S4. Images exemplifying molts and plumages in Stripe-throated Hermit



FCF. Note worn and dull retained juvenile outer greater coverts and worn tail. [ML 211747861](#)



DCB. Note lack of contrast within wing feathers. [ML 389910811](#)

Figure S5. Images exemplifying molts and plumages in Brown Violetear



FCF. Note buff tips to greater coverts. [ML 383572291](#)



DPB. Note lack of tipping on the retained greater coverts. [ML 279961321](#)

Figure S6. Images exemplifying molts and plumages in Purple-crowned Fairy



FCF male. Note brown feathers in the cap and sides of the head, and slight contrast in color between the formative median coverts and juvenile greater coverts. [ML 228153981](#)



DCB female. Note lack of contrast within the wing. [ML 409133341](#)



SPB female. Note significant wear and color contrast in the remaining inner juvenile greater coverts versus the formative median coverts. Significant wear to the remiges as well. [ML 279582971](#)



DCB male. Note lack of contrast within the wing and complete adult head pattern. [ML 400234081](#)

Figure S7. Images exemplifying molts and plumages in Green-breasted Mango



FCF. Note contrast in wear and color between the juvenile greater coverts and formative median coverts. [ML 62100661](#)



DCB female with typical plumage. Note lack of contrast within the wing. [ML 408096031](#)



DCB female with male-like body plumage on a nest. [ML 218729461](#)



DCB male. Note lack of contrast within the wing. [ML 142975861](#)

Figure S8. Images exemplifying molts and plumages in Black-crested Coquette



FCF male. Note contrast in color and wear between the juvenile greater coverts and formative median coverts, mixed bill color, and dark throat. [ML 156059641](#)



FCF female. Note contrast in color and wear between the juvenile greater coverts and formative median coverts, and dark upper mandible. [ML 338778121](#)



DCB female. Note lack of contrast in the wing and mixed bill color. [ML 23625071](#)



DCB male. Note lack of contrast in the wing, red bill, and full male-like appearance in the feathering of the head. [ML 383553521](#)

Figure S9. Images exemplifying molts and plumages in Canivet's Emerald



FCF male. Note dark upper mandible and patchy iridescence on the breast and throat. [ML 235634071](#)



SPB male. Note contrast in color and wear between the formative median coverts and juvenile greater coverts, and the dark bill. Patchy iridescence on throat and breast as in FCF. [ML 253587301](#)



SPB female. Note contrast in color and wear between the median coverts and two formative inner greater coverts versus the juvenile outer greater coverts. Additionally, significant wear to the remaining juvenile remiges. [ML 246035701](#)



DCB female. Note lack of contrast within the wing. [ML 289383721](#)



DCB male. Note lack of contrast in the wing, red bill with black tip, and complete iridescence. [ML 47817731](#)

Figure S10. Images exemplifying molts and plumages in Wedge-tailed Sabrewing



FCF. Note contrast in color between formative median coverts and inner two greater coverts versus the juvenile outer greater coverts and remiges. [ML 327685111](#)



DCB female. Note lack of contrast within the wing. Rachides of outer primaries not modified. [ML 119482111](#)



DCB male. Note lack of contrast in the wing and modified rachides to the outer primaries. [ML 191469471](#)

Figure S11. Images exemplifying molts and plumages in Violet Sabrewing



FCF male. Note partial iridescence to body plumage, contrast in wear and color between the juvenile greater coverts and formative median coverts, and unmodified rachides to outer primaries. [ML 377108631](#)



DCB female. Note lack of contrast within the wing. [ML 124712951](#)



FCF female. Note contrast in color and wear between the formative median coverts and inner three greater coverts, versus the juvenile outer greater coverts and remiges. [ML 398967551](#)



DCB male. Note completely iridescent body plumage, lack of contrast within the wing, and modified rachides to the outer primaries. [ML 200412261](#)

Figure S12. Images exemplifying molts and plumages in Stripe-tailed Hummingbird



FCF male. Note iridescence on the underside confined to the gorget. Wing criteria as in FCF females. [ML 141626641](#)



DCB female. Note lack of contrast within the wing. [ML 161154401](#)



FCF female. Note contrast in color and wear between the formative median coverts and inner two greater coverts versus the juvenile outer greater coverts. [ML 34208931](#)



DCB male. Note lack of contrast within the wing, complete iridescence of body plumage. [ML 363305151](#)

Figure S13. Images exemplifying molts and plumages in Crowned Woodnymph



FCF male. Note incomplete iridescence to underside. Wing criteria as in FCF female. [ML 171325891](#)



FCF female. Note contrast in color and wear between juvenile greater coverts and formative median coverts. [ML 93329261](#)



DCB female. Note lack of contrast in the wing. [ML 92381241](#)



DCB male. Note lack of contrast in the wing and complete iridescence to the gorget. [ML 304572151](#)

Figure S14. Images exemplifying molts and plumages in Scaly-breasted Hummingbird



FCF. Note contrast in color and wear between the formative median coverts and juvenile greater coverts, which have pale tips. No modification to rachides of outer primaries. [ML 91132441](#)



DCB female. Note lack of contrast in the wing and unmodified rachides in outer primaries. [ML 213735061](#)



DCB male. Note lack of contrast in the wing and modified rachides to the outer primaries. [ML 350480691](#)

Figure S15. Images exemplifying molts and plumages in Azure-crowned Hummingbird



FCF. Note contrast in color and wear between the formative median coverts and juvenile greater coverts. [ML 228071781](#)



DCB. Note lack of contrast in the wing. [ML 384046131](#)

Figure S16. Images exemplifying molts and plumages in Cinnamon Hummingbird



FCF. Note contrast in color and wear between the formative median coverts and juvenile greater coverts. Significant wear to the juvenile remiges and coverts. Upper mandible with some dark coloration in the outer third and black line along edge. [ML 87300961](#)



DCB female. Note lack of contrast in the wing, upper mandible mostly pink with black along outer edge. [ML 166138671](#)



DCB male. Note lack of contrast in the wing, upper mandible pink with black tip. [ML 125567581](#)

Figure S17. Images exemplifying molts and plumages in Buff-bellied Hummingbird



FCF male. Note contrast in color and wear between the formative median coverts and juvenile greater coverts. Upper mandible mostly red, but with black line along outer edge. Gorget with some pale tipping. [ML 408952211](#)



FCF female. Note contrast in color and wear between the formative median coverts and juvenile greater coverts. Upper mandible mostly dark. [ML 336914131](#)



DCB female. Note lack of contrast in the wing, upper mandible mostly red but with black line along outer edge, gorget with pale tipping. [ML 118561121](#)



DCB male. Note lack of contrast in the wing, upper mandible red with black tip, gorget with minimal pale tips. [ML 288795691](#)

Figure S18. Images exemplifying molts and plumages in Rufous-tailed Hummingbird



FCF male. Note contrast in color and wear between formative median coverts and juvenile greater coverts. Upper mandible mostly dark. Gorget with frosted appearance. [ML 395001481](#)



DCB female. Note lack of contrast within the wing. Upper mandible mostly dark. Gorget with frosted appearance. [ML 223643881](#)



FCF female. Note contrast in color and wear between formative median coverts and juvenile greater coverts. Upper mandible black. [ML 81726791](#)



DCB male. Wing criteria as in DCB female. Upper mandible mostly red, with black along outer edge. Gorget without pale tips. Photo from MoSI banding data.

Figure S19. Images exemplifying molts and plumages in White-bellied Emerald



FCF. Note contrast in color and wear between the formative median coverts and juvenile greater coverts. [ML 367646701](#)



DCB. Note lack of contrast in the wing. [ML 167833551](#)

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