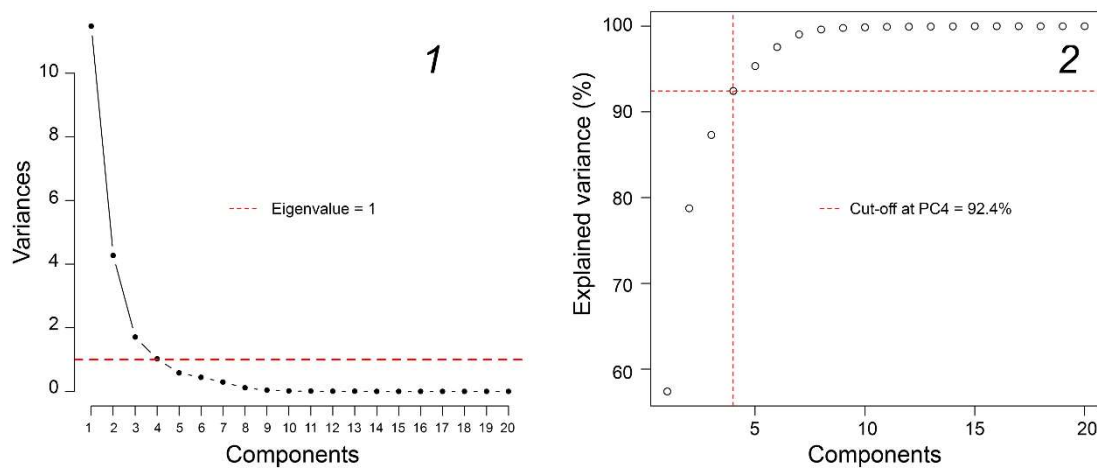


Ramoni-Perazzi, P., Schuchmann, K.-L., Weller, A., Soto-Werschitz, I.A. and Passamani, M. Niches and radiations: A case study on the Andean Sapphire-vented Puffleg (*Eriocnemis luciani*) and Coppery-naped Puffleg (*E. sapphiropygia*) (Aves, Trochilidae) – J. Avian Biol. 000: 000–000.  
DOI: 10.1111/jav.02242

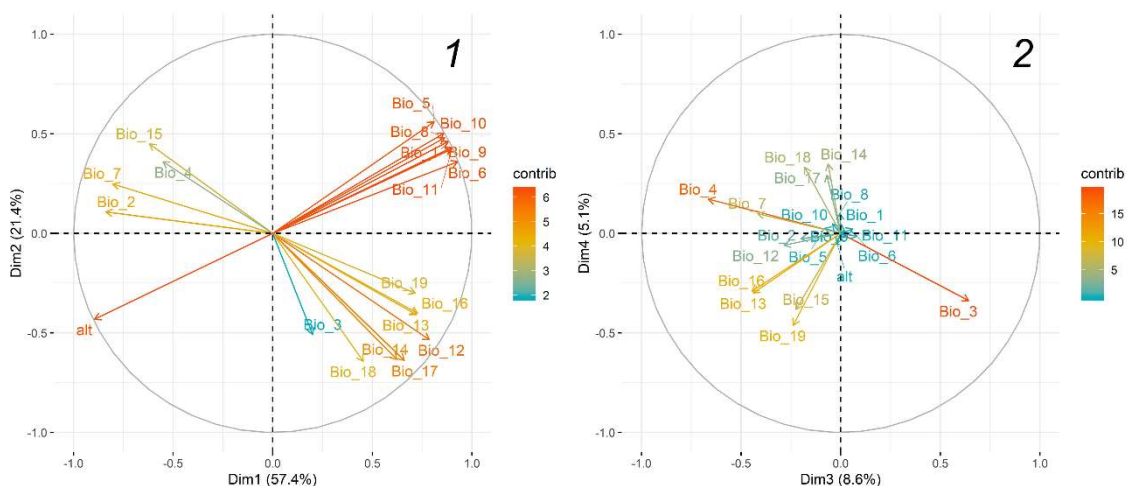
## Supplementary material

# Appendix 1

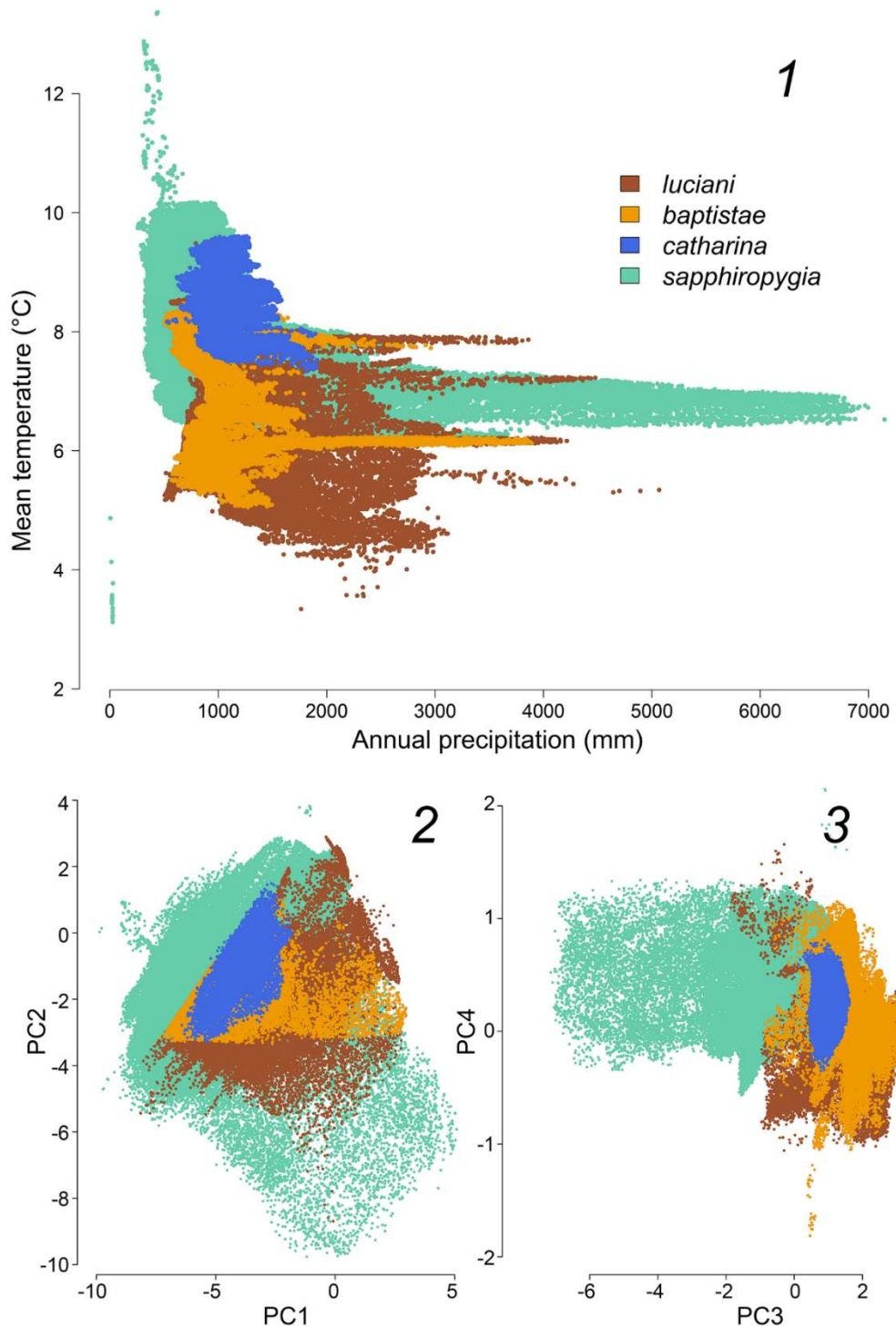
**Figure A.** (1) Scree plot showing that the first four components, from the analysis performed to the continuous variables have eigenvalues equal or greater than one. (2) These four components explain 92.4% of the variation in the data.



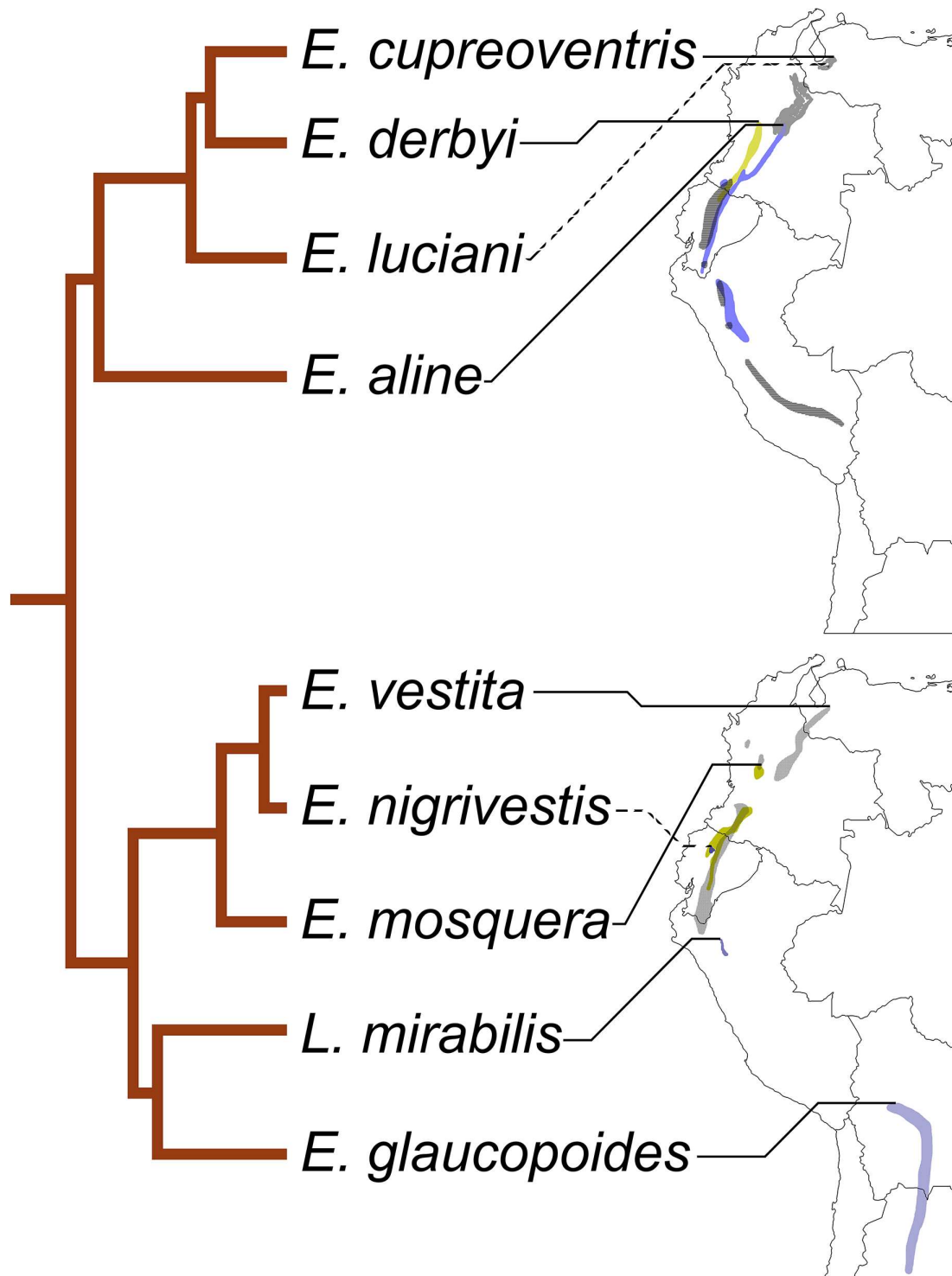
**Figure B.** Loading plots which graph the coefficients of each variable for: (1) the first component versus the coefficients for the second component; and (2) the third component versus the coefficients for the fourth component. Bio\_1 = Annual mean temperature; Bio\_2 = Mean diurnal range; Bio\_3 = Isothermality; Bio\_4 = Temperature seasonality; Bio\_5 = Max temperature of warmest month; Bio\_6 = Min temperature of coldest month; Bio\_7 = Temperature annual range; Bio\_8 = Mean temperature of wettest quarter; Bio\_9 = Mean temperature of driest quarter; Bio\_10 = Mean temperature of warmest quarter; Bio\_11 = Mean temperature of coldest quarter; Bio\_12 = Annual precipitation; Bio\_13 = Precipitation of wettest month; Bio\_14 = Precipitation of driest month; Bio\_15 = Precipitation seasonality; Bio\_16 = Precipitation of wettest quarter; Bio\_17 = Precipitation of driest quarter; Bio\_18 = Precipitation of warmest quarter; Bio\_19 = Precipitation of coldest quarter; alt = elevation.



**Figure C.** Predicted E-space with regard of the continuous variables based on the Climatologies at High resolution for the Earth's Land Surface Areas (CHELSA v 1.2; Karger et al. 2017), and elevation information from the global multi-resolution terrain elevation data (GMTED2010; Danielson and Gesch 2011). (1) Annual precipitation (mm) and Mean temperature (°C); (2) plot of the predictions of the first versus the predicted second principal component; and (3) plot of predicted third principal component and the predictions of the fourth principal component.



**Figure D.** Phylogeny of the *Eriocnemis-Lodiggesia* subclade (McGuire et al. 2014), and the distribution areas of the different species according to BirdLife International (2019)<sup>1</sup>, from Northern Argentina to Venezuela. Black and dashed lines indicate the northernmost range known for each species.



<sup>1</sup> BirdLife International. 2019. IUCN Red List for birds.

## **Appendix 2**

**Table A.** List of the geographic coordinates where each taxon of the *Eriocnemis luciani-sapphiropygia* complex has been recorded. Locality names reproduce those provided by the original source (museum or similar institutions, and eBird).

Subspecies	COUNTRY/State	Locality	Longitude	Latitude	
<i>E. i. baptistae</i>	ECUADOR				
	Azuay	Carretera Cuenca - Molleturo - Naranjal	-79.2259860	-2.7830670	
		Cerro Yanaurco	-79.0666670	-3.5333330	
		Cuenca	-78.9833000	-2.8833000	
		Estación Científica "El Gullán", La Paz, Nabón	-79.1713580	-3.3381530	
		Hacienda Nero	-79.1253470	-2.9666220	
		Llaviucu PN Cajas	-79.1520060	-2.8460140	
		Reserva de Mazán	-79.1235140	-2.8760360	
	Bolívar	Bosque Protector Cashca Totoras	-78.9666670	-1.7500000	
		Hacienda Talahua	-79.0666670	-1.3500000	
		Sinchig	-78.9833330	-1.5333330	
	Cañar	Biblian near	-78.8892420	-2.7137890	
		Cañar	-78.9333000	-2.5500000	
	Chimborazo	Alausi	-78.8333000	-2.2000000	
		Ceche	-78.8500000	-2.1833330	
		Chambo Mts. above Chambo	-78.5833000	-1.7333000	
		Riobamba 1	-78.6333330	-1.6666670	
		Riobamba 2	-78.6333000	-1.6666000	
	Morona Santiago	Vicinity Macas Oriente	-78.1166000	-2.3166000	
	Tungurahua	Chanta pamba [Chontabamba] Occidente	-78.4833000	-1.4166000	
	<i>E. i. luciani</i>	COLOMBIA			
		Nariño	Puerres	-77.5058080	0.8819440
ECUADOR					
Cañar		Chical	-78.9666670	0.0013890	
Cotopaxi		Paichigal [Quebrada de Pichigalli]	-78.8666000	-0.7000000	
Esmeraldas		Cordillera de Toisán	-78.4833330	0.5500000	
		Cordillera de Toisán Cotacachi-Cayapas Ecological Reserve	-78.4670000	0.5500000	
Imbabura		Chota-occidente 600 m	-78.0666000	0.4666000	
		Intag	-78.6000000	0.4000000	
		Manantial track Cerro Blanco Reserve 8km WSW Otavalo	-78.3433000	0.2111000	
		Topo	-78.1500000	0.2166000	
Morona-Santiago		Cordillera Cutucú Oriental	-77.8500000	-2.6666670	
Napo		Papallacta	-78.1408440	-0.3775970	
		Santa Barbara Oriente Napo	-77.5833330	0.6333330	
Pichincha		0 degrees 00 minutes 78 degrees 36 minutes west of Alaspungo	-78.6000000	0.0000000	
		25 mi w of nono	-78.9392140	-0.0650720	
		27 km sw of quito	-78.7025280	-0.4428110	
		5 km E of Hacienda Yanacocha NW slopes of Mt. Pichincha	-78.6199250	-0.1772110	

Above Lloa	-78.5833000	-0.2500000
Alambi	-78.6000000	0.0666000
Alturas del Pichincha	-78.6000000	-0.1666000
Atacazo	-78.6169440	-0.3527780
Calamancha	-78.1274740	-0.3791110
Cerro Guagua Pichincha	-78.5991700	-0.1772810
Cerro Mojanda	-78.2833000	0.1333000
Cerro Puntas	-78.2000000	-0.1833000
Cerro Rumiñahui	-78.5000000	-0.5666670
Chamilco N side Corazon	-78.6500000	-0.4666670
Corazon	-78.6833000	-0.5333000
Corazon Aloag	-78.5833000	-0.4666000
El Cedral below Verdecocha NW slopes of Mt. Pichincha	-78.5615880	0.1213760
El Champi [= Chaupi]	-78.6333330	-0.6000000
El Dorado Chillo	-78.4971360	-0.2171390
El Pongo 50 km by road sw Quito elevation ~3000 meters	-78.6833060	-0.4838560
Faldas	-78.4333000	-0.6666000
Faldas del Pichincha	-78.5829520	-0.2467630
Guailabamba	-78.3500000	-0.0666670
Gualea	-78.5250030	-0.2845060
Hac. Garzon S base Mt Pichincha	-78.6220510	-0.2228930
Hacienda Pinantura near Pintag	-78.3666000	-0.4166000
Mojanda	-78.3000000	0.1500000
Monjas Occidente	-78.4442560	-0.0137720
Mt Pichincha SO base	-78.6486640	-0.2170360
Nanegal	-78.6167000	0.0333330
near Pintag Yunac Compania	-78.3736110	-0.3720090
near Quito	-78.5000000	-0.2166000
Nono	-78.5767310	-0.0669030
Pacaya above Quebrada de Moyas	-78.5605980	0.0117090
Padregal Below	-78.5333000	-0.4833000
Parque Cayambe-Coca 3300 m	-77.7933560	-0.0872720
Pasochoa Cordillera Oriental	-78.4833000	-0.4333000
Pichan	-78.6666000	0.0333000
Pichán (Río)	-78.5833330	0.0166670
Pichincha Calzanario	-78.6083000	-0.1583000
Volcan Pichincha Verdecocha	-78.6333970	-0.1000580
Pasochoa	-78.5110000	-0.4590000
Yanacocha Volcán Pichincha	-78.5850000	-0.1120000
Pifo-Papallacta rd. km 10 3000 m	-78.2997560	-0.2560080
Quebrada de Moyas Salpi	-78.5833000	0.0166000
Río Tambillo (Pachigal)	-78.9833330	0.3000000
San Ignacio	-78.5500000	-0.2000000
San Jadeo [Tadeo?]	-78.8000000	0.0166000
San Jorge	-78.1500000	0.0833000



		Santo Domingo de los Colorados	-79.1500000	-0.2500000
		Uparumi	-78.5833330	-0.2500000
		Volcán Pichincha	-78.5500000	-0.1666670
		Volcan Pichincha N Slope Yanacocha	-78.5834000	-0.1667000
	Quito	Bosque Protector Jerusalem	-78.3596390	0.0048330
		Guayllabamba Valley		
<i>E. s. catharina</i>	PERU			
	Amazonas	Atuen	-77.7794000	-6.9044400
		Leimebamba	-77.7995830	-6.7032390
		Limabamba	-77.4688500	-6.4306690
		Lluy	-77.8166000	-6.7500000
		Mts. E of Balsas	-77.9133250	-6.8359610
		Leimebamba (eBird)	-77.7972400	-6.6816280
		Abra Barro Negro east side Peru 3401 m (eBird)	-77.8717600	-6.7132620
		Not identified (eBird)	-77.8665700	-6.7120270
		Not identified (eBird)	-77.8545900	-6.7149550
		Leymebamba area (eBird)	-77.8269700	-6.7114500
		Distrito Leimebamba (eBird)	-77.8019100	-6.7112370
		Not identified (eBird)	-77.8743300	-6.7171430
		Pasture near Abra Barro Negra (eBird)	-77.8651900	-6.7178110
		Road to Abra Barro Negro (eBird)	-77.8450100	-6.7225370
		Abra Barra Negra - 2853 m asl (eBird)	-77.8369500	-6.7284700
		Leymebamba toward Abra Barro Negro (2400 -3400 m asl) (eBird)	-77.8253500	-6.7348580
		Utcubamba valley - Leymebamba (eBird)	-77.7942000	-6.7339810
		Abra Calla (eBird)	-77.8854000	-6.7521390
		Softtail spot (eBird)	-77.8940700	-6.7721150
		Tajopampa a Leymebamba (eBird)	-77.8080100	-6.7684640
		Abra Barro Negro (eBird)	-77.9068900	-6.7766830
		Abra Barro Negro -- 6.775x-77.896 (eBird)	-77.8959000	-6.7752510
		Camino Leymebamba-Tambillo (eBird)	-77.8075400	-6.7769080
		Fragment with flock - 2921 m asl (eBird)	-77.7919800	-6.8074200
		Celendin-Leymebamba (eBird)	-77.9474800	-6.8168870
		Quintecocha (eBird)	-77.7024400	-6.8601330
		Cochabamba - bosque hacia lagunas (eBird)	-77.8848700	-6.9095030
		El Jardin (eBird)	-77.6850400	-6.9571700
<i>E. s. sapphiropygia</i>	PERU			
	Apurimac	Abancay dist. Huanipaca Cocha	-72.8813000	-13.6338000
		Bosque Ampay Abancay	-72.8900000	-13.5788890
	Ayacucho	Chupon	-73.4444000	-13.2828000
		Uchuy Monte	-73.8333330	-12.8166670
	Cusco	Machu Picchu Headwaters Huayruro	-72.4833300	-13.2333300
		Creek Runcaraccay Ruins		
		Above Paccaypata	-72.5381360	-13.8063190
		Along hwy 101 at 142 Km. marker near Umasbamba	-72.4461190	-13.0509560
		Bosque San Luis	-72.3907280	-13.0790920

	Cordillera Vilcabamba	-73.0000000	-13.0000000
	Marcapata	-70.9769500	-13.5912250
Junin	Chanchamayo Huacapistana	-75.4833000	-11.2333000
	Hacienda Maraynioc	-75.4000000	-11.3333330
	Huacapistana	-75.5254500	-11.2348530
	Maraynioc	-75.4500000	-11.3500000
	Quebrada Tranca bei Palca	-75.5502000	-11.3061000
	Below Toldopampa	-74.9264000	-11.5050000
	ca. 1.1 km w Puente Carrizales	-74.8960920	-11.4888610
	Inca Mine	-69.6830000	-13.8500000
	Limbani	-69.6888000	-14.1477000

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**Table B.** Parameters of the best models (AICc = 0), used in further analyses. (FC) Feature Class, the mathematical transformation of the environmental covariates used in the model: linear (L); linear and quadratic (LQ); linear, quadratic and product (LQP). (RM) regularization multiplier, a parameter that adds new constraints, or the penalty imposed to the model. (AUC<sub>train</sub>) Area under the curve on train sample set. (AUC<sub>test</sub>) area under the curve of the receiver operating characteristic plot made based on the test data set. (Var<sub>test</sub>) Variance of AUC<sub>test</sub>. ( $\Delta$ AUCs) Average difference between training and testing AUCs, across the 10 bins. (Var<sub>both</sub>) Variance of the difference between training and testing AUCs, across the 10 bins. (AICc) Akaike Information criterion with correction for small sample sizes. (w.AIC) AIC weights for a set of fitted models. (Par.) Number of parameters estimated for each model. (Area) the area predicted by the model, in pixel, after thresholding the values. (Om.) Number of occurrences omitted in the binary map.

Subspecies	FC	RM	AUC <sub>train</sub>	AUC <sub>test</sub>	Var <sub>test</sub>	$\Delta$ AUCs	Var <sub>both</sub>	AICc	w.AIC	Par.	Area	Om.
<i>luciani</i>	LQP	2	0.988	0.964	0.025	0.026	0.024	1488.94	0.857	20	99336	1
	LQP	1	0.991	0.961	0.027	0.031	0.027	1465.10	0.848	24	53133	2
	LQP	1	0.991	0.967	0.015	0.025	0.015	1458.51	0.902	24	67608	1
	LQP	1	0.990	0.966	0.014	0.026	0.014	1480.09	0.963	22	122452	0
	LQ	1	0.987	0.964	0.014	0.025	0.013	1492.77	0.729	19	71605	2
	LQP	1	0.990	0.966	0.014	0.025	0.014	1453.79	0.998	22	116096	0
<i>baptistae</i>	LQP	3	0.966	0.941	0.114	0.047	0.111	443.33	0.466	6	32743	3
	LQP	3	0.971	0.945	0.098	0.046	0.094	443.89	0.498	6	30331	2
	LQ	3	0.969	0.947	0.088	0.042	0.086	439.18	0.710	8	28950	2
	LQP	3	0.968	0.947	0.090	0.041	0.086	439.27	0.448	6	30166	3
<i>catharina</i>	LQP	1	0.998	0.985	0.007	0.014	0.007	545.01	0.952	12	14326	0
	LQP	1	0.998	0.984	0.007	0.014	0.007	563.10	0.759	13	13594	0
	LQP	1	0.998	0.984	0.013	0.015	0.013	559.58	0.991	13	14022	0
	LQP	1	0.998	0.986	0.005	0.013	0.005	563.88	0.957	13	15382	0
	LQ	1	0.999	0.985	0.006	0.014	0.006	549.05	0.673	13	15940	0
	LQP	1	0.998	0.974	0.014	0.025	0.014	554.26	0.954	13	16040	0
	LQP	1	0.998	0.985	0.006	0.013	0.006	565.98	0.637	14	16613	0
<i>sapphiropygia</i>	L	2	0.981	0.859	0.329	0.126	0.326	520.97	0.866	12	112958	0
	L	2	0.981	0.915	0.131	0.068	0.129	521.12	0.483	12	118524	0
	L	2	0.982	0.920	0.115	0.065	0.113	519.54	0.589	12	112056	0
	L	2	0.982	0.918	0.126	0.068	0.124	519.00	0.567	12	108086	0
	L	2	0.982	0.917	0.158	0.070	0.156	518.47	0.536	12	117607	0
	L	2	0.982	0.919	0.125	0.067	0.122	521.05	0.514	12	118065	0

**Table C.** Values of the background randomization tests for the *Eriocnemis* taxa under study. This includes the observed (obs), and the lower (2.5%) and upper (97.5%) confidence limits, of distributions of values of D (Schoener 1968) and I (van der Vaart 1998). In each case, the test contrasts the observed niche overlap values to a null distribution of 100 overlap values generated by comparing the ENM of one subspecies (sspA) against an ENM created from random points from the G-space of other subspecies (sspB; Warren et al. 2008).

sspA	sspB	D <sub>obs</sub>	D <sub>2.5%</sub>	D <sub>97.5%</sub>	I <sub>obs</sub>	I <sub>2.5%</sub>	I <sub>97.5%</sub>
<i>baptistae</i>	<i>luciani</i>	0.494	0.145	0.201	0.762	0.350	0.456
<i>luciani</i>	<i>baptistae</i>	0.494	0.074	0.191	0.762	0.254	0.473
<i>catharina</i>	<i>luciani</i>	0.064	0.062	0.118	0.226	0.194	0.293
<i>luciani</i>	<i>catharina</i>	0.064	0.075	0.166	0.226	0.263	0.448
<i>sapphiropygia</i>	<i>luciani</i>	0.100	0.130	0.228	0.314	0.366	0.515
<i>luciani</i>	<i>sapphiropygia</i>	0.100	0.075	0.182	0.314	0.254	0.454
<i>baptistae</i>	<i>catharina</i>	0.105	0.126	0.209	0.323	0.327	0.488
<i>catharina</i>	<i>baptistae</i>	0.105	0.035	0.104	0.323	0.130	0.278
<i>baptistae</i>	<i>sapphiropygia</i>	0.169	0.120	0.201	0.433	0.299	0.465
<i>sapphiropygia</i>	<i>baptistae</i>	0.169	0.132	0.238	0.433	0.347	0.529
<i>catharina</i>	<i>sapphiropygia</i>	0.203	0.042	0.119	0.477	0.140	0.299
<i>sapphiropygia</i>	<i>catharina</i>	0.203	0.123	0.237	0.477	0.344	0.538