

Rediscovery of Black-breasted Puffleg *Eriocnemis nigrivestis* in the Cordillera de Toisán, north-west Ecuador, and reassessment of its conservation status

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El Zamarrito Pechinegro *Eriocnemis nigrivestis* es un colibrí endémico de Ecuador que se considera Críticamente Amenazado a nivel global. Su distribución se confina a los centros de endemismo del Páramo de los Andes Centrales y Laderas Interandinas y Valles, donde en años recientes fue registrado en los bosques altoandinos montanos en dos volcanes aislados, Pichincha y Atacazo. De acuerdo a especímenes de museo, la especie habitaba históricamente entre los 2.440 y 4.725 m. En los últimos años, la mayoría de los registros se encuentran entre 2.700 y 3.500 m, con individuos inmaduros itinerantes registrados hasta 1.700 m. La mayoría de observaciones recientes corresponden a la ladera noroccidental del volcán Pichincha, con un avistamiento adicional de una posible hembra en Atacazo en 1983. En este artículo reporto el redescubrimiento de una pequeña población en la cordillera de Toisán, provincia de Esmeraldas, sobre el valle de Intag, provincia de Imbabura, un sitio histórico de colección del Zamarrito Pechinegro. Aunque su población global se ha estimado entre 50–249 individuos adultos, nueva información sugiere que los números reales son mayores. La expansión de la frontera agrícola, particularmente el establecimiento de pastizales y la tala del bosque montano para la producción de madera y carbón, son las principales amenazas para la especie. Sin embargo, tomando en cuenta que en la ladera occidental del Pichincha y la cordillera de Toisán todavía existen extensas áreas de bosque, y que una posible especialización en la dieta no parece ser la razón para la rareza del Zamarrito Pechinegro, el factor que limita el tamaño de la población de este colibrí podría estar asociado a otras causas importantes de cambio ambiental. Considero que la ausencia de registros actuales sobre los 3.500 m podría ser la clave para comprender la declinación de la especie. Si esta evaluación es acertada, el calentamiento global podría ser una amenaza muy importante para su supervivencia.

Black-breasted Puffleg *Eriocnemis nigrivestis* is endemic to Ecuador and considered Critically Endangered^{3,4}. It was assigned to the endemic centres Central Andean Páramo (EBA043)²⁷ and Inter-Andean Slopes and Valleys³². More than 100 specimens are known (altitudinal range 2,440–4,725 m), most of them poorly labelled⁷. For the period 1950–2000, only a few records were published^{15,21,27}, all but one from the north-western ridge of Volcán Pichincha, prov. Pichincha: Cerro Pugsí, Loma Gramalote and above Yanacocha (Table 1, Fig. 1). An additional sighting of a possible female in 1983 was reported from neighbouring Volcán Atacazo, from where the species is known also from three males collected in 1898⁷. Since October 2000 increased observer effort at Volcán Pichincha has produced annual records, with several seen or mist-netted at various sites between 2,700 and 3,500 m²⁹ (E. Guevara, R. Maldonado, P. Mena V., F. Sornoza M. and J. C. Valarezo pers. comm.). Dispersing individuals, particularly immatures, occasionally appear at considerably lower altitudes, e.g., Reserva Las Gralarias, at 2,070 m²³ and Sachatamia Lodge, at 1,700 m (F. Sornoza pers. comm.). However, I am unaware of the circumstances surrounding the latter observation and existence of any documentation

(e.g., photographs). The species' global population was estimated at 50–249 mature individuals^{3,4}.

Given the lack of recent records away from Pichincha and Atacazo, specimens labelled 'Intag', among others, were regarded as probably mislabelled⁷, and ignored by most recent authors^{2–5,9,27,28}. Only a few researchers continued to mention Intag as a collection site, either without details^{15,29} or with the caveat that 'the restricted preferred habitat of this species was probably greatly depleted during the past century'³⁰. One important reason why Intag, prov. Imbabura, has been widely ignored could be the misleading information provided by Paynter & Traylor²⁵, who stated that it lies in the subtropical zone, at 1,200 m (c.00°24'N 78°36'W). However, considering the spectrum of specimens mentioned by Ridgely & Greenfield²⁷, it is clear that skins labelled 'Intag' have been taken in the foothills (e.g., Greenish Elaenia *Myiopagis viridicata*, Yellow-tufted Dacnis *Dacnis egregia*) to the upper subtropical and temperate zones (e.g., Grass-green Tanager *Chlorornis riefferii*), and not just in a specific area of the subtropics. Future revisions of Intag specimens should take into account that they could have been obtained anywhere in the valley south and east of the Cordillera de Toisán, i.e., roughly

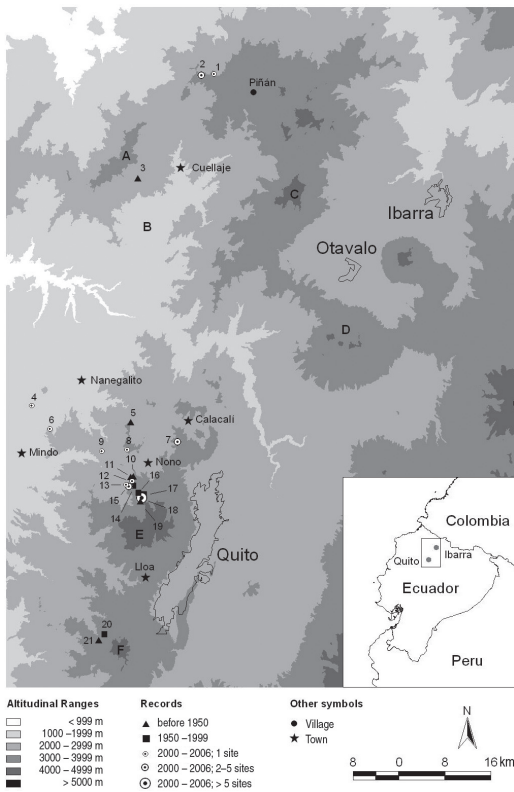


Figure 1. Recent and historical records of Black-breasted Puffleg *Eriocnemis nigrivestis*. See Table 1 for names, coordinates, altitude and dates of last record. Note that precise localities are unknown for several historical records. Abbreviations: A = Cordillera de Toisán, main massif; B = Intag Valley; C = Volcán Cotacachi; D = Mojanda Mountains; E = Volcán Pichincha; F = Volcán Atacazo.

from the mouth of the río Intag in the río Guayllabamba (c.00°13'N 78°43'W; 800 m), to the headwaters of its confluent Cristopamba (c.00°31'N 78°29'W; 2,600–3,400 m), or even on the slopes of the cordillera itself. Curiously, Paynter & Traylor²⁵ also mentioned the río Llurimaguas, another confluent of the río Guayllabamba, far to the west (c.00°18'N 78°58'W; 1,200 m). The entire valley is now mostly deforested, with fragments of natural vegetation restricted to surrounding slopes. In recent decades, only limited field work has been undertaken, especially within the appropriate altitudinal range of Black-breasted Puffleg¹³ (N. Krabbe pers. comm.).

Forest cover is still intact on the poorly studied northern and western flanks of the Cordillera de Toisán, prov. Esmeraldas, within the Cotacachi-Cayapas Ecological Reserve (RECC: 243,638 ha; 80–4,900 m). Here, in August–September 2006, I discovered a population of *E. nigrivestis*,

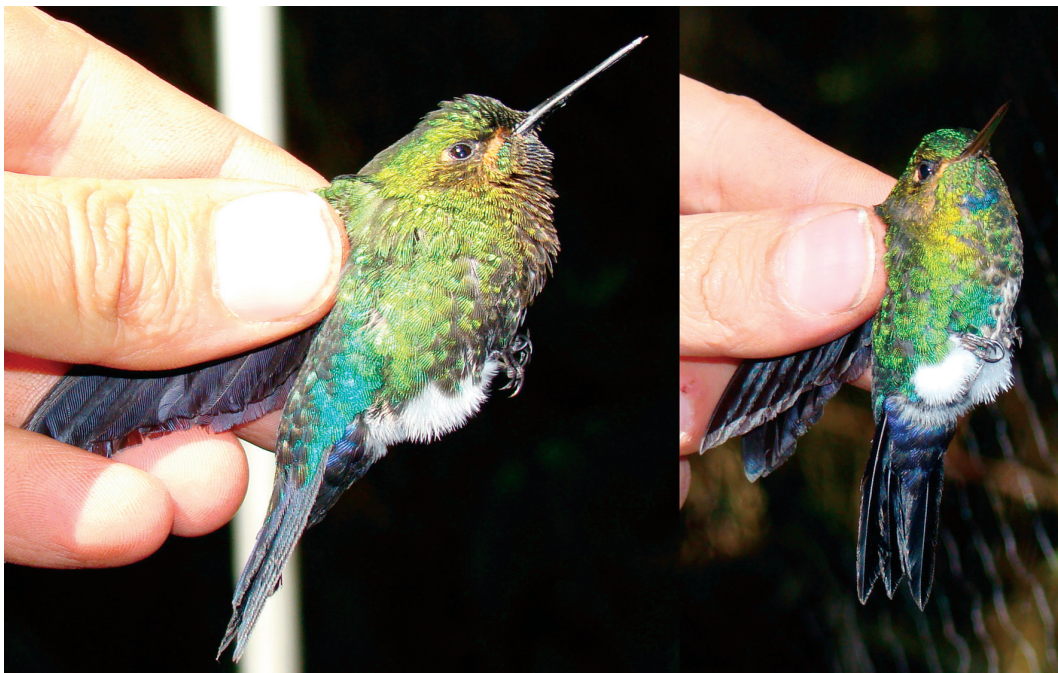


Figure 2. The two Black-breasted Pufflegs *Eriocnemis nigrivestis* mist-netted in 2007 at c.3250 m in Cotacachi-Cayapas Ecological Reserve, below Cayapachupa, Cordillera de Toisán, prov. Esmeraldas; left: presumed immature male (25 September); right: adult female (26 September) (Olaf Jahn)

presumably the same as the source of the Intag specimens.

A male Black-breasted Puffleg was seen on 19 August, on a ridge crest at 3,245 m, during a bird survey along transect RECC03 (see below). The observation site was c.1 km north-west of the base camp at Cayapachupa, prov. Esmeraldas (00°33'N 78°29'W; 3,460 m) and the latter c.8 km north-west of the old village of Piñán, prov. Imbabura (00°31'N 78°25'W), which can be reached by dirt road from Otavalo (Fig. 1). On 9 September, three males were observed at c.3,200 m along a 2.5–3.0 km trail that connects the base camp with an unnamed mountaintop on the neighbouring ridge to the south-west (Cordillera de Cayapas). This area represents a pass between the upper río Cristopamba–Intag Valley to the east and the drainage of the río Pumiyacu, a confluent of the río Santiago, to the west. From above, it appears to be a relatively flat area, but in fact rolling hills and a few gullies with small streams intersect the pass. Geopolitically it forms the limit between the provinces of Imbabura and Esmeraldas.

In 2007, between 20 and 27 September, males, females and immatures of Black-breasted Puffleg were observed on a daily basis ($n=13$), with up to four different individuals per day, at the base camp in Cayapachupa and along the ridge crest below it (RECC03; see below). In addition, two were mist-netted, photographed and released at c.3,250 m, a presumed immature male on 25 September and an adult female on 26 September (Fig. 2).

Habitat, behaviour and ecology

High-Andean wet forest, forming a mosaic of relatively tall trees (canopy height c.12–25 m) and patches of *Chusquea* bamboo, covers the ridge crest below Cayapachupa. Elfin forest (height <12 m) is restricted to a narrow band just below the timberline (i.e., at the base camp), but mean tree height and precipitation increase rapidly descending the ridge crest. Mature patches of closed-canopy forest occur, mainly on saddles of flat ground. By contrast, the canopy is broken on the steep slopes due to high rainfall and soil instability, promoting treefalls, landslides and the development of an impenetrable undergrowth of shrubs, epiphytes and bamboo. Moss, ferns and epiphytes densely envelop trees. The abundance and diversity of hummingbird-pollinated plants is impressive and includes herbs, vines, epiphytes, shrubs and trees of numerous families.

Whilst the forest on the Cayapachupa ridge is undoubtedly primary, human activities might have locally affected the pass area to the south-west, where patches of very low bushes and ferns possess the typical appearance of regenerating pastures. However, local people emphasised that these areas had not been used or cultivated for at least 30–50 years, indicating that forest regeneration is probably very slow in the high Andes. Although forest structure on the rolling hills of the pass was very similar to that on the ridge crest, the almost complete absence of *Chusquea* bamboo and the

Table 1. Known sites and collecting localities for Black-breasted Puffleg *Eriocnemis nigrivestis* with coordinates, altitude and year of most recent record (see also Fig. 1). Where the site number and coordinates are presented in parentheses, the precise locality is unknown. Adapted and enhanced from Santander *et al.*²⁹ (Table 1), Lyons & Santander²³; E. Guevara, R. Maldonado, P. Mena V., F. Sornoza M. and J. C. Valarezo (pers. comm.). Some specimens, e.g., 'Tumbaco', 'Napo' and 'Sarayacu' were regarded as mislabelled⁷ and are omitted here (but see Schuchmann *et al.*³⁰).

Locality	Site no. (Fig. 1)	Massif / subpopulation	Province	Coordinates	Altitude (m)	Most recent record
Cerro Atacazo	(20,21)	Volcán Atacazo	Pichincha	(00°22'S 78°38'W)	3,000–4,450	1898 (1983?)
Loma Gramalote	16	Volcán Pichincha	Pichincha	00°07'S 78°36'W	3,250	1993
Cerro Pugsí	(14),15	Volcán Pichincha	Pichincha	00°06'S 78°36'W	3,000	2007
Yanacocha	18,(17,19)	Volcán Pichincha	Pichincha	00°06'S 78°35'W	3,200–3,500	2007
Verdecocha	(11),12,13	Volcán Pichincha	Pichincha	00°05'S 78°36'W	2,800–3,400	2007
Loma Frutillas	(10)	Volcán Pichincha	Pichincha	(00°05'S 78°34'W)	3,150	Unknown (historic site)
Sachatamia	4	Volcán Pichincha	Pichincha	00°02'S 78°46'W	1,700	2006
Loma La Bola	9	Volcán Pichincha	Pichincha	00°02'S 78°38'W	2,700	2006
Loma Chiquilpe	8	Volcán Pichincha	Pichincha	00°02'S 78°36'W	3,250	2002
Hacienda La Merced de Nono	7	Volcán Pichincha	Pichincha	00°02'S 78°32'W	3,000–3,200	2006
Reserva Las Gralarias	6	Volcán Pichincha	Pichincha	00°01'S 78°44'W	2,070	2006
Alaspungo	(5)	Volcán Pichincha	Pichincha	(00°00'S 78°36'W)	3,200	Unknown (historic site); rediscovered 2007
'Intag'	(3)	Cordillera de Toisán	Imbabura	(00°24'N 78°36'W)	unknown	Unknown (historic site)
Cayapachupa	1,2	Cordillera de Toisán	Esmeraldas/ Imbabura	00°33'N 78°29'W	3,200–3,300	2007

presence of some hummingbird-pollinated shrub species not found on the ridge, was striking.

In 2006 all males of *E. nigrivestis* were discovered through intensive searching. They were observed at distances of 3–5 m and at least one was seen closely in ideal light for almost one minute, while it perched on a branch c.2 m above ground, in the open. Apart from a weak *tzeet tzeet*, emitted by one bird after taking flight, no vocalisations were heard under natural conditions. However, both mist-netted individuals (Fig. 2) gave a loud and piercing single-note *tzeet* call, almost hermit-like in quality, on being released. The birds moved 1–5 m above the ground, either within light gaps or in the forest undergrowth. Encounters occurred at the crests and on upper slopes of ridges, and at the base of rolling hills in the pass area. The only other hummingbird to regularly occupy the same ecological niche with similar behaviour (mostly silent, feeding territories centred on shrubs with ornithophilous flowers in forest undergrowth) was Gorgeted Sunangel *Heliangelus strophianus*. In 2006 the latter was much commoner than the puffleg, with ten and nine observations (mostly males) during standardised surveys of transects RECC03 and RECC05, respectively (see below). However, in 2007, only one male Gorgeted Sunangel was noted during non-standardised observations along RECC03. All other hummingbirds in the area either occupied the higher forest strata, visited flowers in the shrub level opportunistically, or passed through the lower growth mainly in quick flight. In order of decreasing abundance, they were: Tyrian Metaltail *Metallura tyrianthina*, Buff-winged Starfrontlet *Coeligena lutetiae*, Sapphire-vented Puffleg *Eriocnemis luciani*, Collared Inca *Coeligena torquata* and Mountain Velvetbreast *Lafresnaya lafresnayi* (flight-calls and songs of several other hummingbird taxa were tape-recorded but have not been identified).

In August–September 2006 records of Black-breasted Puffleg were restricted to the extremely narrow belt of 3,200–3,300 m, from the wider c.550 m altitudinal range in forest intensively surveyed according to the ‘Multi Time-Window Transect-Mapping’ (MTW) protocol for monitoring studies¹⁹ ($n=48$ samples of two transects; total length 2.4 km; altitudinal ranges RECC03 3,405–3,105 m, and RECC05 3,075–2,840 m; mean survey effort 60.9 \pm 2.7 hours per transect, total effort 121.8 hours; survey periods RECC03 14–20 August and RECC05 13–18 September, or 13 man-days). An additional transect (RECC04) was surveyed above the timberline, in a mosaic of herbaceous (grass) páramo, *Chuquiragua* shrubs and *Polylepis* woodland along the río Pantaví, prov. Imbabura (00°29'N 78°22'W; 3,609–3662 m), but

this did not produce any records of *E. nigrivestis* ($n=24$ samples; length 1.2 km; survey effort 39.8 hours; survey period 23–28 August, or six man-days).

In September 2007, Black-breasted Puffleg was detected over a much wider altitudinal range than in the previous year, between c.3,100 and 3,460 m. The highest record was of an adult male that had established a feeding territory right at the base camp.

That Black-breasted Puffleg tends to be rare and local, even in its very restricted altitudinal range, was noted earlier⁵. However, recent observations on Volcán Pichincha have revealed that it does not strictly depend on a certain type of elfin forest on ridge crests, as Bleiweiss & Olalla⁵ presumed. Most recent records come from bushy forest edges at roadsides, steep slopes with stunted vegetation, and from the interior of montane forest with a canopy height >15 m²⁹. In December 2006 two males were found in a forest fragment of 75 ha at Hacienda La Merced de Nono, on the northernmost slope of Volcán Pichincha (P. Mena V. pers comm.; see Table 1). The present study adds light gaps within forest to the habitat spectrum. No fewer than 29 food plants of 11 families are known, including eight species of Ericaceae (cf. table 3.3 in Jahn & Santander²⁰). Thus, it is unlikely that *E. nigrivestis* is rare due to specialised diet. However, its local and seasonal appearance might be linked to staggered flowering periods of certain plant species along altitudinal gradients⁹.

Based on specimens and sight records, *E. nigrivestis* historically appeared to be most numerous at 2,440–3,050 m in April–September and at 3,100–4,725 m in November–February^{5,7,15}. My data from Cayapachupa clearly do not fit this pattern, with records restricted to above 3,100 m in August–September. Similarly, new data from Volcán Pichincha suggest that seasonal movements are either more complex than previously thought, or that patterns have changed recently, with records from Reserva Las Gralarias (2,070 m) in December–January; lower parts of Hacienda Verdecocha (2,800–3,100 m), including Cerro Pugsí, in March, July, September and November; and Yanacochoa (3,200–3,400 m) in almost all months^{20,29} (F. Sornoza M. pers. comm.). Only those observations from Loma Chiquilpe (3,250 m) in September–April seem roughly to match historical data. The breeding season of *E. nigrivestis* is probably between October and March¹⁵, i.e. the early wet season, when the species might be most common at the upper end of its altitudinal range. The only recent breeding data involve a mist-netted female with a well-developed brood patch at Cerro Pugsí in early March²⁹. Numbers at any given site may fluctuate considerably, e.g., along transect

RECC03 the species was rare in 2006 but uncommon to fairly common in 2007. At Yanacocha, 13 individuals were present in 2001 but only a few in the same months in 2002²⁹ and just one in all of 2006. Park rangers, who pay much attention to hummingbirds and keep records of Black-breasted Puffleg, patrol the reserve almost daily throughout the year (F. Sornoza M. pers. comm.), meaning that such fluctuations are probably genuine, at least along trails frequented by the guards.

Population estimates

Within the species' known range of 44 km², on the north-west flanks of Volcán Pichincha, only 33.8 km² of suitable habitat remains²⁹. However, Black-breasted Puffleg could be present also on the west slope, which is covered by primary forest but inaccessible. BirdLife International⁴ estimated the species' Extent of Occurrence¹⁸ to be 80 km² and based a precautionary and preliminary population estimate on the following: 20% of the Extent of Occurrence may be occupied, and taking a population density of 10.0 individuals/km² (lowest density range of six estimates for five similar-sized high-altitude hummingbirds), 160 individuals might be extant. They suggested the estimated population is probably best placed at 50–249 individuals.

Appropriate habitat for the rediscovered population above Intag occurs in two areas: (a) c.24 km² known and projected to be occupied around Cayapachupa, and (b) c.30 km² probably but not confirmed to be occupied on the flanks of the highest ridges of the Cordillera de Toisán (determined with a GIS). The former is restricted to Esmeraldas, the latter also includes forest remnants on the east slope of the cordillera in Imbabura. They are separated by c.10 km where the cordillera does not exceed 2,800 m, or roughly the lowest altitude of recent records at Volcán Pichincha²⁹, with seasonal migrants or dispersing individuals occurring somewhat lower. Using BirdLife International's precautionary procedure (see above), the Toisán population can be estimated at 48–108 birds, yielding a global population of 208–268 mature individuals. A small population (perhaps 10–50) might also persist on the south-west flanks of Volcán Atacazo where, according to recent satellite images, a few hundred hectares of appropriate habitat remain. In consequence, an updated population estimate should probably be placed at 250–999 individuals.

Future studies should determine the species' true mean population density and occupied proportion of its Extent of Occurrence. However, even under the most optimistic scenarios, it seems unlikely that the global population of *E. nigrivestis* exceeds 1,000 individuals.

Threats and conservation status

It has been estimated that the species' presumed historical range of suitable habitat in Pichincha was reduced by 96.8%, from an initial 1,046 km² to 33.8 km² in 2001²⁹. Habitat degradation continues on the north-west slope of Volcán Pichincha, principally due to the expanding agricultural frontier, particularly the establishment of cattle pastures. Furthermore, slash-and-burn agriculture and felling of montane forest for timber and charcoal production are still common in Pichincha (pers. obs.). Charcoal is used for auto-consumption as well as commercialisation in Quito. Statements in the literature^{2–4,15,28} that charcoal production on Volcán Pichincha was forbidden by local authorities are misleading. The original source referred only to the small area of Yanacocha²⁶, where the Municipal Water Company of Quito controlled access before it was purchased by a conservation organisation. However, it should be emphasised that no municipal decrees regulate charcoal production in the area (Departamento de Archivos del Municipio de Quito pers. comm.). Recently established private reserves, Yanacocha (Jocotoco Foundation) and Verdecocha (Nubesierra Foundation), protect 1,000 ha and 1,269 ha of the species' key habitat. However, man-made fires threaten large tracts of forest in the dry season (e.g., in August 2004). A large part of the unexplored primary forests of the volcano's west slope lies within the limits of the Bosque Protector Mindo-Nambillo (19,200 ha). Although a new management plan³³ was ratified by the Ministry of the Environment, there is no effective surveillance system due to lack of funds. All three reserves are part of BirdLife International's Important Bird Area (IBA) 'Mindo and western foothills of Volcán Pichincha' (EC043)¹⁰.

No recent field work has been undertaken at Volcán Atacazo (IBA EC054¹²; T. Santander pers. comm.), where some forest cover remains on the steep western and southern flanks. It is unclear whether *E. nigrivestis* survives there, but if so the extant population must be very small. Habitat degradation is ongoing and probably threatens the integrity of the forest remnants. Above the current timberline at c.3,500 m, grass páramos have replaced the natural woody vegetation.

The western slopes of the Cordillera de Toisán lie within Cotacachi-Cayapas Ecological Reserve (IBA EC037¹¹). Forest cover is mainly intact and pristine, but locally threatened by the burning of páramo grasslands. Furthermore, local people from Piñán openly admit that they plan to establish cattle pastures on the pass south-west of Cayapachupa and are preparing to invade other parts of the reserve via the Cordillera de Cayapas. Forest cover on the south and east slopes of the

Cordillera de Toisán is much reduced. At least 10,000 ha are protected in various governmental and private reserves (IBA EC038: Intag-Toisán⁹), a small fraction of which might be within the appropriate altitudinal range of *E. nigrivestis*. However, the area suffers from ongoing encroachment by the agricultural frontier, timber harvesting, charcoal production and pressure from mining companies. Forest fires were frequent in August–September 2006, some of them directly below the boundaries of RECC.

Taking into account that specialised diet appears not to be the cause of Black-breasted Puffleg's rarity, and that extensive forest is extant on the west slopes of Volcán Pichincha and Cordillera de Toisán, the species' population bottleneck might be linked to other important causes of environmental change. Curiously, Collar *et al.*⁷ stated that 'records from above 4,000 m seem somewhat dubious as this is well above the treeline'. As with Intag specimens, some authors discontinued to mention records from above 3,500 m²⁷, considering them to be probably mislabelled (R. S. Ridgely pers. comm.). However, the lack of recent records of *E. nigrivestis* from above that altitude might offer the key for understanding its decline.

Man has altered high-Andean forests and páramos for thousands of years, particularly through wood-cutting, burning and animal herding⁸. However, anthropogenic impacts increased after the early 1500s when the Europeans introduced cows, sheep, horses and goats, requiring more extensive grazing areas¹. In the Ecuadorian Andes, forest fragments occur up to 4,100–4,350 m. Typically, their borders are demarcated, evidence that they are conditioned by fire, as I documented photographically in 2007 for the Páramo of Piñán²⁰. There, almost all contemporary forest fragments above 3,500 m are restricted to steep valleys and gulleys where they are protected from the direct impact of wind-driven fires. Lægaard²² suggested that they form remnants of previously more extensive forest cover and that the original timberline was 650–900 m higher. He presented evidence of marked physiognomic differences between páramo vegetation above and below the hypothetical true timberline, referring to the corresponding habitats as grass páramo and superpáramo, respectively. According to Lægaard's hypothesis, grass páramo is a human-influenced secondary vegetation, dominated by fire-resistant bunch grasses and scattered shrubs and perennial herbs. In contrast, superpáramo is rarely affected by fire because average cover of bunch grasses is too low to sustain extensive burns. Dominant plants are perennial herbs and dwarf shrubs, forming a complete ground cover of rosettes, cushions and mats. In sum, prior to human-

influenced habitat change, *E. nigrivestis* may have occupied the entire altitudinal gradient of c.2,400–4,700 m, as data from specimens suggest. Today, extensive grass páramo represents an uninhabitable vegetation type and insurmountable obstacle for seasonal migrations between the current timberline and fragments of forest and scrubland at higher altitudes. In other words, human activity might have destroyed a large portion of critical habitat in the species' life cycle, causing a bottleneck during the wet (=breeding) season. Critics have emphasised that this hypothesis is not supported by actual field data, apart from a number of doubtfully labelled museum specimens (R. Clay, J. F. Freile, R. S. Ridgely pers. comm.). However, if the former assessment is correct, the species' conservation status might be even more complex and critical than previously thought, whilst global warming might become an important factor during coming decades.

Recent studies have demonstrated that greenhouse warming causes temperatures to rise faster in highlands than in lowlands⁶. Mean annual temperatures in the tropical Andes increased by c.0.11°C per decade between 1939 and 1998, compared with the global mean of 0.06°C per decade³⁵. The rate of warming has doubled in the last 40 years, and tripled over the last 25 years of the 20th century³⁴. Consequently, in the range of Black-breasted Puffleg, mean annual temperatures are expected to increase by 3.5–4.5°C by the end of the 21st century⁶, if current trends in greenhouse gas emissions persist. In the same region, mean annual precipitation could increase by 6–20% by the 2080s¹⁷. Unsurprisingly, the tropical Andes are one of the hotspots of biodiversity most sensitive to global warming and 540–9,400 endemic plant species and 42–737 endemic vertebrate species might become extinct there in the next 100 years due to this cause²⁴. *E. nigrivestis* could be one such, as prognosticated changes might push the habitable climate zone above the current timberline within decades. Recent data suggest that this process might be already ongoing, given the species' presence above 3,100 m in April–September at Volcán Pichincha²⁹ (E. Guevara, P. Mena V. and J. C. Valarezo) and Cordillera de Toisán (this study). Particularly troubling is that Gorgeted Sunangel, which occupies a similar ecological niche, at least during the dry season, seems to have recently expanded its altitudinal range. Historically, *H. strophianus* was known from c.1,200 m to (rarely) 2,800 m^{14,16}, but mostly at 1,700–2,300 m²⁷. The upper range limit was extended to 3,020 m in 1980⁵ and the present study produced 19 records above 2,800 m in c.2 weeks in 2006, the highest at 3,300 m. Both species have straight bills and bill length in *E. nigrivestis* (18.7–19.3 mm; $n=52$ ³⁰) is just 3.5–4.1 mm longer than *H. strophianus*

(15.2 mm; $n=1^{31}$), making it probable that most flowers used by the puffleg are also accessible to the sunangel. Although no aggressive interactions between them were observed during this study, Gorgeted Sunangel is larger (5.3 g vs. 4.3–4.6 g^{14,15}) and also quite aggressive (pers. obs.), and thus might represent a serious competitor for the puffleg. Coincidentally, in 2007, when Black-breasted Puffleg was much commoner along transect RECC03 than in 2006, Gorgeted Sunangel was recorded only once. However, at present, it is unclear whether the higher abundance of Gorgeted Sunangel in 2006 was the direct cause for the rareness of the puffleg that year.

In a scenario where natural habitat in the species' upper altitudinal range is mostly destroyed, where shifting climate zones are caused by global warming and where there is growing competition from at least one similar-sized hummingbird, *E. nigrivestis* may be literally forced out of existence, unless grass *páramos* on Pichincha, Atacazo and Cordillera de Toisán are partially reforested in coming decades. Unfortunately, in the high Andes, subzero nocturnal temperatures and wind offer major obstacles to habitat restoration efforts during the dry season. Much research is needed to produce viable solutions for appropriate reforestation programmes²⁰. An additional challenge is the restoration of diverse plant communities containing important foodplants for Black-breasted Puffleg, i.e., the hummingbird will not benefit from a monoculture of *Polylepis*.

Reassessment of IUCN Red List category

My data suggest that the species' population size is probably too large to trigger criterion C of the IUCN Red List at the Critically Endangered level¹⁸. Even if we apply a precautionary approach and assume that the population may fall below 250 mature individuals (the threshold for Critically Endangered), sub-criterion '2a(ii)' would no longer apply as fewer than 90% of mature individuals are concentrated in one subpopulation (i.e., Pichincha 60%, Toisán and Cayapachupa 40%). Likewise, criterion C2a(i) is triggered only at the Endangered level (all subpopulations ≤ 250 mature individuals).

Although the total area of suitable habitat is now estimated at 139 km², I suggest that the Extent of Occurrence should be taken as the sum of the known range of 44 km² at Volcán Pichincha²⁹ and the estimated 24 km² at Cayapachupa, or a total of 68 km², which is below the 100 km² threshold for Critical (criterion B1). The additional areas of c.36 km² of unexplored habitat on the west slope of Volcán Pichincha, c.30 km² on the flanks of the highest ridges of the Cordillera de Toisán, and c.5 km² on the south-west flanks of Volcán Atacazo

should be regarded as possible habitat until observations confirm the species' presence in these areas. Although now known from two localities, sub-criterion 'a' still applies as the species' habitat is 'severely fragmented'. In combination with sub-criterion 'b' (continuing decline in: (i) Extent of Occurrence; (ii) Area of Occupancy; (iii) area, extent and quality of habitat; and (v) number of mature individuals), this would continue to qualify the species as Critically Endangered under criterion B1a+b(i,ii,iii,v). However, the explicit caveat is needed that if future field work confirms its presence on the west slope of Volcán Pichincha or the main Toisán massif, then the species could be downlisted to Endangered.

Conclusion

The rediscovery of *E. nigrivestis* in the Cordillera de Toisán demonstrates that the Intag specimens were correctly labelled, increasing the number of extant subpopulations to at least two. Consequently, the species' global population might be slightly larger than previous estimates. However, unless future field work confirms its presence on the west slope of Volcán Pichincha or on the main Toisán massif, or its continued presence on the south-west flanks of Volcán Atacazo, the puffleg's threat status (Critically Endangered) should not be changed. Despite efforts to protect its remaining forests, the species could perish due to climate change. Thus, the partial restoration of native vegetation cover (i.e. trees and hummingbird-pollinated shrubs) in the grass *páramos* of Pichincha, Atacazo and Cordillera de Toisán are an urgent priority. Expeditions to unexplored forest should be undertaken in all three areas and known populations closely monitored. Furthermore, the hypothesis that Black-breasted Puffleg may have occurred well above 3,500 m historically should be tested above Yanacocha, where a mosaic of trees, shrubs, and perennial herbs still partially covers the steep slopes of Volcán Pichincha up to c.4,200 m. Satellite images could be used to identify other potential study sites where corridors between the current timberline and fragments of forest or scrubland at higher altitudes exist. Likewise, it should be studied under which conditions Gorgeted Sunangel migrates upslope and whether its increasing abundance above 2,800 m could have direct impacts on populations of Black-breasted Puffleg.

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