Evidence from citizen science and museum specimens suggests species rank for Erythrogenys [erythrogenys] imberbis (Salvadori, 1889), 'Red-eyed Scimitar Babbler'

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Evidence from citizen science and museum specimens suggests species rank for *Erythrogenys* [*erythrogenys*] *imberbis* (Salvadori, 1889), 'Red-eyed Scimitar Babbler'

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Summary.—Rusty-cheeked Scimitar Babbler *Erythrogenys erythrogenys* (Vigors, 1832) comprises two subspecies in the Himalaya (nominate and *ferrugilata*) and two more, disjunctly (with Spot-breasted Scimitar Babbler *E. mcclellandi* interposing), in Myanmar and Thailand (*imberbis* and *celata*). Prompted by the observation that these two populations appear to exhibit differences in eye colour, we use citizen science data (343 online photographs and >100 sound-recordings) and 66 museum specimens to evaluate potential differences in bare-part and plumage colour, morphometrics and vocalisations. We find that Thai-Burmese birds are distinguished from their Himalayan counterparts by their red vs. white irides, dark vs. pale bills, browner ear-coverts, typically grey vs. whitish lores and the absence of a white submoustachial spot. They also less frequently have white flecks on the eye-rim and are, on average, less heavily streaked on the breast. Thai-Burmese birds are further characterised by their smaller size with significantly shorter wings and tail, and divergent voice of females in duet (a mellow *peew* and burry *prreew* vs. a staccato *pip!*). Cumulatively these multiple differences, fully consistent in iris colour, size and female voice, and highly indicative in other features, point to a more appropriate treatment of the Thai-Burmese birds as a species, Red-eyed Scimitar Babbler *Erythrogenys imberbis* (Salvadori, 1889).

Scimitar babblers (genera *Pomatorhinus*, *Melanocichla* and *Erythrogenys* in the family Timaliidae) form a clade of distinctive semi-terrestrial passerines confined to dense forest understorey and edge habitats in tropical Asia, from north-east Pakistan east to eastern China and south to the Indonesian archipelago as far as Bali, with an introduced population east of Wallace's Line on Lombok (Winkler *et al*. 2015, del Hoyo & Collar 2016, Fjeldså *et al*. 2020). The genus *Erythrogenys* is now generally regarded (BirdLife International 2022, Clements *et al*. 2022, Gill *et al*. 2022) as comprising six species, Large *E. hypoleucos*, Rusty-cheeked *E. erythrogenys*, Spot-breasted *E. mcclellandi*, Black-streaked *E. gravivox*, Grey-sided *E. swinhoei* and Black-necklaced Scimitar Babblers *E. erythrocnemis*, the latter five allospecies discriminated primarily through morphological evidence (Collar 2006) but backed subsequently by as yet incomplete molecular study (Reddy & Moyle 2011, Dai *et al*. 2020). However, this arrangement contains an anomalous circumstance in which one of the species, *E. mcclellandi* of the north-eastern Indian subcontinent south to western Myanmar, is geographically interposed between Himalayan and Thai-Burmese populations of another, *E. erythrogenys* (Fig. 1). These two disjunct populations of *E. erythrogenys* each consist of two subspecies (*sensu* BirdLife International 2022), nominate *erythrogenys* in the western Himalaya with *ferrugilata* (including the sometime recognised *haringtoni*) in the central and eastern Himalaya, and *imberbis* in eastern Myanmar with *celata* in north-west Thailand.

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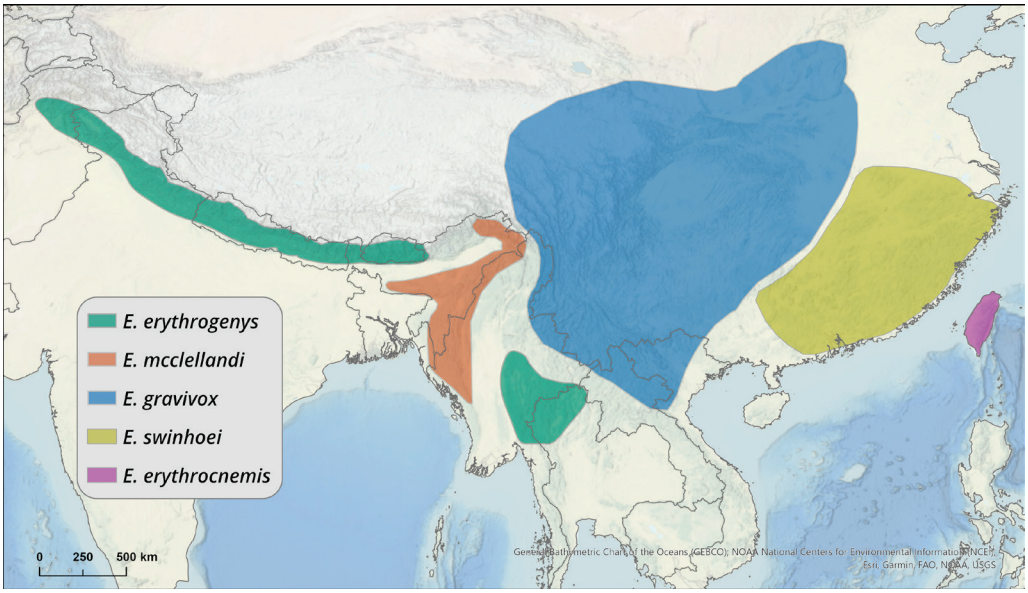

Figure 1. Distributions of five *Erythrogenys* species, at one time all considered conspecific, showing the interposition of *E. mcclellandi* with respect to *E. erythrogenys*. Polygons are derived from maps provided by BirdLife International (2022), adapted to recent records (eBird 2023).

The circumstance in which subspecies of a species are distributed in a leapfrog pattern either side of a closely related species is unusual, and strongly suggests diverging evolutionary pathways that merit closer investigation. Nevertheless, the relationship between Himalayan *E. erythrogenys* and Thai-Burmese *E. erythrogenys* was not explored in the taxonomic revision of *Erythrogenys* by Collar (2006) and has not been since. However, appreciation that these two populations might differ more than previously realised was recently prompted by a review of photographs uploaded to the Macaulay Library (www.macaulaylibrary.org), which indicated a consistent difference in iris colour between Himalayan (white-eyed) and Thai-Burmese (red-eyed) birds. Further comparison quickly suggested other potentially significant morphological differences between these pairs of taxa, cumulatively implying a level of divergence too high to be compatible with the retention of the pairs, by whatever criteria, as conspecific. We therefore investigated the situation using as many lines of inquiry as were open to us, namely bare-part (eye and bill) colours, plumage patterns, morphometrics and vocalisations. This involved reference to publicly available photographs, museum specimens and sound-recordings.

Methods

Photographs.—An original sample of 1,345 photographs was downloaded from the Macaulay Library (= all photographs of *E. erythrogenys* uploaded by April 2023). One photograph was analysed from each labelled locality (selected as the first on the list acquired), thus eliminating the risk of duplication while maximising the geographic spread of birds included. This yielded a final sample of 343 images. Following an initial qualitative inspection of photographs, for each image the following was recorded: (1) iris colour; (2) presence of white flecks around the eye-rim (scored 'absent', 'slight' or 'obvious'); (3) rear ear-covert colour; (4) lore colour; (5) presence of submoustachial spot; (6) presence of malar line; (7) breast streaking (scored 'absent', 'slight' or 'obvious'); (8) bill colour ('pale' or 'dark'). All images were analysed by a single author (AJB) to ensure consistency.

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Museum specimens.—One of us (NJC) measured a total of 66 specimens (64 in NHMUK and two—both females of the subspecies *imberbis*, including the type—in MSNG; for museum acronyms see Acknowledgements). These broke down as 20 nominate *erythrogenys* (eight males, nine females, three unsexed) and 20 *ferrugilata* with *haringtoni* (five males, three females, 12 unsexed), representing 40 Himalayan individuals; and ten *imberbis* (five males, three females, two unsexed) and 16 labelled *celata* (two males, two females, 12 unsexed) although the subspecific identity of these birds is uncertain. The type localities of *imberbis* and *celata* are, respectively, Yado, Myanmar (Salvadori 1889), and Chiang Dao, Thailand (Deignan 1941), but it is unclear to us where the two taxa might meet or be divided. Of the 16 specimens labelled as *celata* at NHMUK, only eight are accompanied by a precise locality: either Kalaw, Mogok or Taunggyi. Without explanation, Deignan (1941) associated these localities with *celata* but suitable habitat in Kalaw is continuously linked to Yado (*imberbis*), thus introducing considerable confusion as to the identity of the NHMUK material. Moreover, the diagnosis of *celata* from *imberbis* relies principally on plumage tone (Deignan 1941), which to us appears inconstant in all taxa inspected. Given these uncertainties (including whether *celata* is a valid taxon at all—see Discussion), for all analysis we chose to combine *imberbis* and *celata* into a single Thai-Burmese entity.

Measurements were taken with digital callipers and involved bill from skull to tip, tarsus from the notch on the back of the intertarsal joint to distal base of longest toe, wing curved from carpal to tip, and tail from point of insertion to tip. The 40 Himalayan birds (20 *erythrogenys* and 20 *ferrugilata*; chosen randomly from a larger body of material) formed one sample for comparison and the 26 Thai-Burmese birds (representing all the available adult material of these taxa in the museums in question) formed the other. Student *t*-tests did not uncover statistically significant differences between sexes of either group. Consequently, and because a large proportion of the specimen material available to us was unsexed, we pooled male, female and unsexed birds in each sample.

Morphometric comparisons of Himalayan and Thai-Burmese populations were analysed using principal component analysis (PCA), and a PCA biplot was drawn using the 'ggplot2' package in R. For differences in individual biometric traits between populations we carried out Welch's unpaired *t*-tests, applying a Bonferroni correction where the threshold for statistical significance is set at $p<0.05/n_v$. The strength of differences was assessed using Cohen's *d* statistic (see 'Taxonomic evaluation' below).

All specimens of *E. erythrogenys* at NHMUK (including those not measured) had their labels checked for iris colour annotation, of which 30 (25 Himalayan, five Thai-Burmese) possessed such data. For all 64 measured specimens at NHMUK, bill tone was also recorded.

Sound-recordings.—Rusty-cheeked Scimitar Babbler is a vocal species. The male's song consists of typically 2–3 rich low-pitched whistles, often answered or preceded as a duet by the (presumed) female with a short single note (Roberts 1992), as in most other species in the genus. When agitated or alarmed, a grating chattered series is uttered (Ali & Ripley 1996). To evaluate these vocalisations, we accessed the sound-recordings available in the Macaulay Library (https://www.macaulaylibrary.org/) and Xeno-canto databases (https://www.xeno-canto.org). We selected all relevant recordings from Nepal (n = 12), Bhutan (n = 10), Myanmar (n = 3) and Thailand (n = 36), and a subset (n = 42) of the best-quality recordings from India (see Appendix). One of us (PB) made sonograms of these using CoolEdit Pro (Blackman-Harris window at 1,024 band resolution for the sharpest image) and measured sound parameters manually using visual rulers for time and frequency on screen. Following qualitative assessment, six parameters were measured: duration and max. fundamental frequency of the female voice, total phrase duration, number of notes and max. fundamental frequency of the male song, and duration of the grating alarm notes.

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Comparisons between Himalayan and Thai-Burmese populations were made using Welch's unpaired *t*-tests and Cohen's *d* statistic scoring as for biometric data.

Taxonomic evaluation.—As an aid to consistent taxonomic judgement, we used the system of scoring in Tobias *et al*. (2010), in which an exceptional character (radically different coloration, pattern, size or sound) scores 4, a major character (pronounced difference in body part colour or pattern, measurement or sound) 3, medium character (clear difference, e.g., a distinct hue rather than different colour) 2, and minor character (weak difference, e.g., a change in shade) 1; a threshold of 7 is set to allow species status, which cannot be triggered by minor characters alone, and only three plumage characters, two vocal characters, two non-covarying biometric characters (both these and vocal characters assessed for effect size using Cohen's *d* where 5–10 is major, 2–5 medium and 0.2–2 minor) and one behavioural or ecological character (allowed 1) may be counted.

Results

Eye colour.—In photographs, all Himalayan birds displayed pale irides, while all those from Thailand and Myanmar had dark red eyes (Table 1, Fig. 2). This pattern was mirrored by museum specimen labels: the irides of all Himalayan specimens (n = 25) for which the colour was noted were pale (variably 'pale straw yellow', 'pale yellow', 'yellowish white', etc.). Those of all Thai-Burmese specimens (n = 5, all from Myanmar) were variably crimson or dark brownish.

TABLE 1
Plumage and bare-part characters of birds in photographs (n = 343) of Rusty-cheeked Scimitar Babbler *Erythrogenys erythrogenys*, divided into Himalayan and Thai-Burmese populations. Values refer to percentages of photographs for which the character in question could be determined.

		% Himalayan (n = 318)	**% Thai-Burmese (n = 25)**
Iris colour	whitish	100	0
	dark red	0	100
Bill colour	pale	100	4
	dark	0	96
White eye spots around eye-rim	major	75	0
	minor	24	24
	absent	1	76
Rear ear-coverts	rufous/orange	100	0
	brownish orange	0	100
Lore colour	whitish	88	0
	pale grey	12	8
	grey/brownish grey	0	92
White submoustachial spot	present	100	4
	absent	0	96
Blackish malar line	present	100	28
	absent	0	72
Breast streaking	major	69	0
	minor	31	12
	absent	0	88

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Figure 2. Comparison of Himalayan (left: © Yash Kothiala, ML 238443661) and Thai-Burmese (right: © Natthaphat Chotjuckdikul) Rusty-cheeked Scimitar Babblers *Erythrogenys erythrogenys*. Compared to Himalayan birds, the Thai-Burmese populations always exhibit a dark red iris, typically have a darker bill, browner ear-coverts, darker/greyer lores and less pronounced breast streaking and white eye-rim markings, and less frequently show a white submoustachial spot (not conspicuous on the Himalayan bird illustrated here) or a black malar line (see Table 1).

Bill colour.—In photographs, Himalayan birds were observed always to have a primarily pale straw-coloured bill (sometimes with a dark base, especially to the maxilla); in contrast, Thai-Burmese birds almost always (96%) had a dark grey bill, sometimes with a variably extensive pale tip. Among the 64 specimens measured at NHMUK, 33 of 40 Himalayan taxa had pale bills (seven could not be determined) while 20 of 24 Thai-Burmese taxa had dark bills (four indeterminate). Thus this material overwhelmingly supported the findings of the photographic research that the two populations exhibit differences in bill colour.

Plumage pattern.—Thai-Burmese birds exhibit a number of plumage differences from Himalayan ones, although there was often some variation (Table 1). Himalayan birds had a high propensity to exhibit white flecks on the eye-rim (99%), deep orange ear-coverts (100%), whitish to pale grey lores (100%), a white submoustachial spot (99%), a blackish malar line (100%) and some form of breast streaking (100%: 69% obvious, 31% slight). Conversely, Thai-Burmese birds infrequently showed white marks around the eye (24%: always slight), always had brownish-orange ear-coverts (100%) and rarely exhibited pale lores (8%), a white submoustachial spot (4%) or—hence Salvadori's (1889) name *imberbis* ('unbearded')—a blackish malar line (28%). Where they showed breast streaking (12%), it was always slight.

Morphometrics.—Himalayan birds were larger than Thai-Burmese birds in all variables measured (Table 2). The differences were most notable in wing and tail, where effect sizes of, respectively, 2.71 and 2.2 were recorded; both these values fall in the 'medium difference' classification of Tobias *et al*. (2010), and either of them triggers a score of 2. The PCA plot for morphometric data clearly separates Thai-Burmese birds from Himalayan ones along PC1, which accounted for 68.9% of variance (Fig. 3), while *erythrogenys* and *ferrugilata* were barely distinguished and did not differ statistically in any biometric parameter.

Vocalisations.—Recordings of duets in the Himalayan and Thai-Burmese populations were respectively 50% and 300% more frequent than male song alone. Female voice in both populations was only rarely recorded alone. The most conspicuous bioacoustic difference between Himalayan and Thai-Burmese populations is observed in the female vocalisation: in Himalayan birds, her contribution to the duet always consists of a stereotyped short emphatic staccato *pip!* (also transcribed as *kip* or *quip*: Ali & Ripley 1996) whereas Thai-

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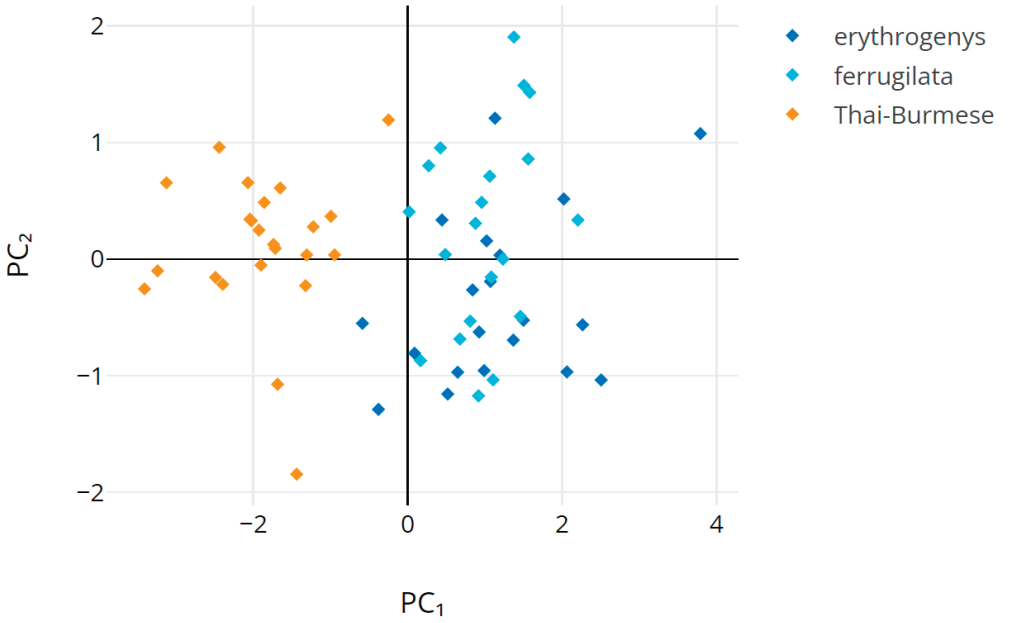

Figure 3. Principal component analysis (PCA) biplot for all morphometric parameters (length of bill, tarsus, wing and tail) showing differences in Himalayan (*erythrogenys* + *ferrugilata*) and Thai-Burmese (*imberbis*/*celata*) populations of Rusty-cheeked Scimitar Babbler *Erythrogenys erythrogenys*.

TABLE 2

Morphometrics of Rusty-cheeked Scimitar Babbler *Erythrogenys erythrogenys* comparing Himalayan nominate plus *ferrugilata* (including *haringtoni*) with Thai-Burmese *imberbis*/*celata*. See text for inclusion of *haringtoni* in *ferrugilata* and discussion on *celata*. Values in **bold** represent the mean of each character with standard deviation; parenthetic values are the range. All measurements in mm. [1] = sample size 24, [2] = sample size 25. * Statistical significance at the threshold of <0.01 using Welch's unpaired *t*-tests.

	Bill	Tarsus	Wing	Tail
erythrogenys (*n* = 20)	**35.9 ± 2.1** (33–41)	**37.4 ± 1.4** (35–41)	**95.6 ± 3.8** (90–105)	**104 ± 3.8** (96–108)
ferrugilata (*n* = 20)	**35.7 ± 1.6** (34–39)	**35.8 ± 0.9** (34–37)	**93.1 ± 2.9** (88–98)	**99 ± 3.9** (92–107)
Himalayan (*erythrogenys* + *ferrugilata*) (*n* = 40)	**35.8 ± 1.9** (33–41)	**36.6 ± 1.5** (34–41)	**94.3 ± 3.7** (88–105)	**101.4 ± 4.6** (92–108)
Thai-Burmese (*imberbis*/*celata*; *n* = 26)	**33.5 ± 1.4**[1] (31–36)	**35.2 ± 1.4**[2] (32–38)	**85.3 ± 3.0**[2] (79–91)	**91.1 ± 4.7**[1] (82–100)
Himalayan vs. Thai-Burmese effect scores (Cohen's *d*)	1.37*	0.95*	2.71*	2.20*

Burmese birds always emit one of two longer notes: a mellow *peew* or a very burry overslurred *prreew* (also transcribed *creee*: Smythies 1986) (see Fig. 4). The Himalayan note is much shorter in duration than either Thai-Burmese vocalisation (effect size 5.29, Tobias score 3) and its max. frequency averages slightly higher, albeit with overlap (effect size 1.56, Tobias score 1; Table 3).

Male song in the two populations is very similar, but Thai-Burmese birds may exclusively sing one- or two-note songs (mean 1.90, median 2; *n* = 29) while Himalayan birds often sing longer, more modulated notes which sound disyllabic and quite often break up into three

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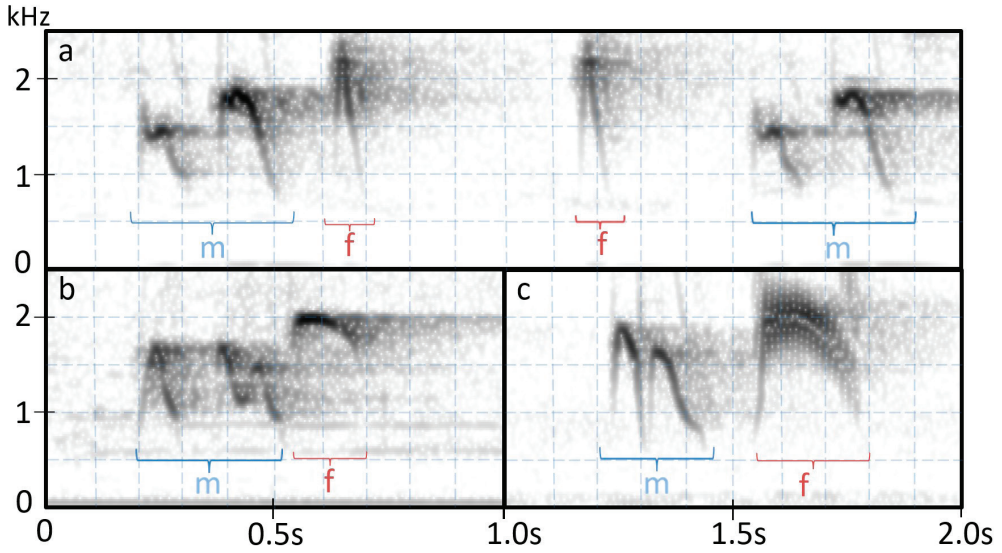

Figure 4. Sonograms of duets of Rusty-cheeked Scimitar Babbler *Erythrogenys erythrogenys* (m = male, f = female). a: Duet with female *pip!*, XC 472968, northern India, P. Boesman, b: Duet with female *peew*, XC 460633, Myanmar, T. Luijendijk, c: Duet with female *prreew*, ML 51965381, Thailand, I. Davies.

TABLE 3

Measurements of sound parameters of Rusty-cheeked Scimitar Babbler *Erythrogenys erythrogenys*: note duration and max. fundamental frequency of female voice, phrase duration and max. fundamental frequency of male song. Calculation of effect sizes between the two populations for selected parameters. † Frequency of this vocalisation difficult to assess. * Statistical significance at the threshold of <0.01 using Welch's unpaired *t*-tests.

			Range	Mean ± SD	Effect size
Females	Note duration (seconds)	Himalayan *pip* (*n* = 33)	0.04–0.08	0.055 ± 0.012	—
		Thai-Burmese *peew* (*n* = 15)	0.16–0.22	0.187 ± 0.023	7.19 (*pip* vs. *peew*)*
		Thai-Burmese *prreew* (*n* = 10)	0.15–0.30	0.230 ± 0.042	5.67 (*pip* vs. *prreew*)*
		Thai-Burmese all (*n* = 25)	0.15–0.30	0.204 ± 0.038	5.29 (*pip* vs. both)*
	Max. frequency (Hz)	Himalayan *pip*	1,950–2,600	2,258 ± 161	—
		Thai-Burmese *peew*	1,900–2,200	2,051 ± 96	1.56 (*pip* vs. *peew*)*
		Thai-Burmese *prreew*†	1,400–2,000	1,595 ± 281	2.90 (*pip* vs. *prreew*)*
		Thai-Burmese all	1,400–2,200	1,868 ± 295	1.64 (*pip* vs. both)*
Males	Phrase duration (seconds)	Himalayan (*n* = 51)	0.17–0.51	0.302 ± 0.065	—
		Thai-Burmese (*n* = 29)	0.14–0.36	0.268 ± 0.058	0.47
	Max. frequency (Hz)	Himalayan	1,600–2,150	1,839 ± 132	—
		Thai-Burmese	1,750–2,380	2,023 ± 175	1.18

notes (mean 2.2, median 2, *n* = 51). As a result, phrase duration in Himalayan songs averages higher, and their max. frequency is seemingly also lower pitched (see Table 3). There exists, however, considerable overlap between the two populations and in no parameter of male song were the differences between the two populations statistically significant.

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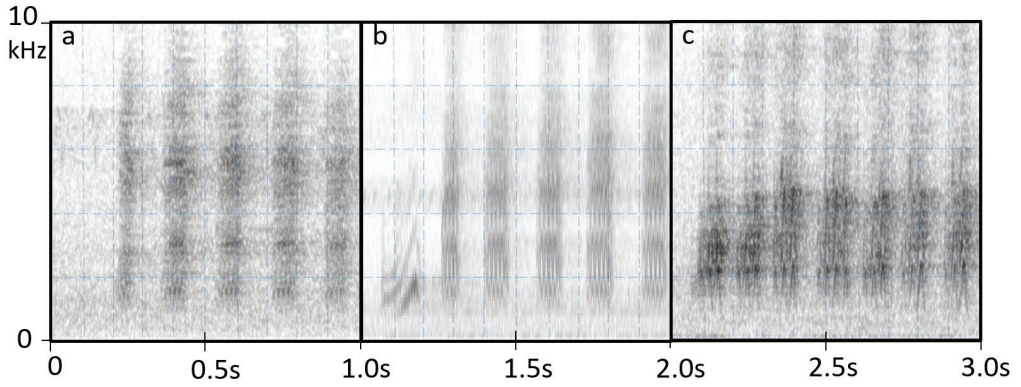

Figure 5. Sonograms of chatter call (first second) of Rusty-cheeked Scimitar Babbler *Erythrogenys erythrogenys*. a: Typical chatter call, XC 472969, northern India, P. Boesman, b: Chatter call with mellow introductory note, ML 543543, northern India, M. Medler, c. More grating chatter call with coarser oscillations, XC 348254, Thailand, G. Irving.

The chatter call notes of both populations are very similar with no difference in duration, but in Himalayan birds they may be more often introduced by a mellow rising note, and in Thai-Burmese birds they often sound more grating (reflected on sonograms by more articulated oscillations in all notes when zooming in) (Fig. 5).

Discussion

Using a combination of citizen science and museum datasets, we find divergence in several characters between Himalayan and Thai-Burmese populations of Rusty-cheeked Scimitar Babbler. Some of these differences have previously been noticed and illustrated, albeit without explicit taxonomic recommendation. For example, Lekagul & Round (1991), Robson (2002) and Treesucon & Limparungpatthanakij (2018) all illustrate (Thai-Burmese) Rusty-cheeked Scimitar Babbler with a brown or dark red iris, while Ali & Ripley (1983), Kazmierczak (2000), Rasmussen & Anderton (2005) and Grimmett *et al*. (2011) all show (Himalayan) birds with pale eyes. Similarly, Rasmussen & Anderton (2005) refer to the bill of Himalayan birds as 'whitish-horn' while Lekagul & Round (1991) described the bill of Thai birds as 'brown'. However, some of the other differences outlined herein appear to have gone unnoticed in the literature, with illustrations in regional works exhibiting several inaccuracies. For example, Grimmett *et al*. (2011) showed (Himalayan) Rusty-cheeked Scimitar Babbler without white eye-rim markings or a pale submoustachial spot, despite virtually all (99% and 100% respectively) adults from this region exhibiting these features.

Among babblers in general, and *E. erythrogenys* in particular, duetting has been associated with pair-bonding and joint territorial defence (Collar & Robson 2007), so differences in duets between populations can be expected to be of taxonomic relevance. Indeed, the point was made in a brief but astute note by Rasmussen & Anderton (2005), who remarked that 'female-type song-notes in N Thailand [are] longer than in Himalayas, and do not support conspecificity of all unspotted forms [i.e., of *E. erythrogenys*] to the exclusion of all spot-breasted forms [i.e., *E. erythrocnemis*]'. Here we validate that observation with more detailed analysis, and confirm the significant difference in the female-type contribution to the duet song of paired birds. Apparent differences in male song (in particular longer three-note songs being apparently confined to Himalayan birds) and chatter call require confirmation, with the (few) sound parameters measured here finding only minor (and statistically non-significant) divergence. Meanwhile, the existence of two clearly different

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variants of the female song in the Thai-Burmese population (vs. a single one in the Himalayan population) is intriguing and also needs further study; it is unclear if these are linked to specific behavioural functions.

Reviewing the characters that distinguish Thai-Burmese from Himalayan populations of Rusty-cheeked Scimitar Babbler, using what has been called the 'seven-point system' in Tobias *et al*. (2010), we itemise the red vs. white iris (major difference, score 3); dark vs. pale bill (medium difference, score 2); near-complete absence vs. entirely consistent presence of a whitish submoustachial spot combined with greyish vs. white lores (medium, 2); smaller size (medium, 2); and vocal differences (one major, one minor, together 4), yielding a total score of 13, almost twice the number of points required to reach species rank. Under any system used to adjudicate taxonomic cases, we suggest that the differences in morphology and bioacoustics enumerated here are incompatible with Himalayan and Thai-Burmese populations of Rusty-cheeked Scimitar Babbler remaining conspecific. We therefore propose it be divided into two species as: (1) Himalayan Scimitar Babbler *E. erythrogenys* (Vigors, 1832) (including *ferrugilata*) and (2) Red-eyed Scimitar Babbler *E. imberbis* (Salvadori, 1889) (including *celata*, if recognised). Deignan (1941) diagnosed *celata* as distinct from *imberbis* by virtue of its paler orange plumage tone, darker grey lores, and red eye. This last distinction was based on the testimony of Baker (1922), who mistakenly asserted that 'all [other] races of *erythrogenys* have the iris [pale]'; but, as noted above, all birds sampled from photographs and museum specimens in Myanmar (including many close to the type locality of *imberbis*) had not only red eyes but also grey lores (the latter feature somewhat variable: see Table 1), leaving only the paler plumage tone as diagnostic. However, in our experience this tone is variable in all Rusty-cheeked taxa, with birds generally becoming paler west to east, but with substantial overlap such that no individual can be reliably diagnosed on this feature alone. In the absence of clarity on the distributional limits of *celata*, and without Deignan's original specimen material to hand, we stop short of recommending *celata* be synonymised with *imberbis*, but speculate that future work (including genetic investigation) may conclude that Red-eyed Scimitar Babbler is best considered monotypic.

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Appendix. List of recordings used for the sound analysis. Identification numbers per country (c = chatter, d = duet, f = female voice, m = male song)

***Himalayan group*: Bhutan:** ML 164505 (m), ML 174685 (m), ML 204016331 (f), ML 227094321 (d), ML 484599531 (d), ML 485241321 (m), XC 115624 (c), XC 115626 (m), XC 6123229 (d), XC 64073 (m). **India:** ML 151370671 (d), ML 151374041 (d), ML 161779341 (m), ML 169430 (d), ML 173123471 (m), ML 173279491 (m), ML 173279491 (c), ML 175833481 (m), ML 290309421 (d), ML 313237731 (m), ML 326684801 (d), ML 326709951 (d), ML 387980761 (m), ML 492685641 (d), ML 550211361 (d), XC 105591 (d), XC 114403 (c), XC 115256 (d), XC 191156 (d), XC 191159 (m), XC 236796 (m), XC 320020 (d), XC 390039 (d), XC 407627 (d), XC 441161 (d), XC 472966 (d), XC 472667 (d), XC 472968 (d), XC 472969 (c), XC 506859 (d), XC 506910 (m), XC 511777 (d), XC 536009 (m), XC 547539 (d), XC 582843 (c), XC 585408 (m), XC 590263 (m), XC 70909 (c), XC 714355 (m), XC 743404 (f). **Nepal:** ML 448303741 (d), ML 448303981 (c), ML 484614411 (d), ML 507339691 (d), ML 515555001 (c), ML 522145281 (m), ML 529728451 (d), ML 545716971 (m), XC 488783 (c), XC 581887 (d), XC 777470 (d).

***Thai-Burmese group*: Myanmar:** XC 460633 (d), XC 89838 (f). **Thailand:** ML 145648831 (d), ML 183107 (m), ML 183162 (c), ML 337659191 (c), ML 400312861 (m), ML 51965401 (d), ML 53421561 (d), ML 53421591 (f), ML 559419471 (d), XC 166413 (m), XC 189161 (d), XC 19847 (c), XC 209862 (c), XC 295201 (d), XC 295202 (d), XC 306810 (d), XC 306811 (m), XC 328309 (c), XC 348254 (c), XC 357472 (m), XC 464385 (d), XC 464540 (d), XC 531608 (m), XC 612258 (d), XC 625859 (c), XC 655653 (d), XC 696269 (d), XC 792466 (d).

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