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Subspeciation in the Ruby-throated Bulbul *Rubigula dispar*

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Summary.—Ruby-throated Bulbul *Rubigula dispar*, currently Vulnerable on the IUCN Red List owing to trade pressure, is considered monotypic across its range on three Sundaic islands in Indonesia: Sumatra, Java and Bali. However, examination of photographs and museum specimen labels and measurement of 37 Sumatran and 50 Javan specimens indicate that birds from Sumatra differ from those on Java (type locality) and Bali in exhibiting a variably red (not pale yellow) iris and a slightly longer bill and wing. Consequently, we propose subspecies rank for the Sumatran population. We recommend that the two taxa be maintained pure in captivity and that any releases of confiscated birds take place on the correct island based on eye colour.

Ruby-throated Bulbul *Rubigula dispar* (Horsfield, 1821) is endemic to the Greater Sunda Islands of South-East Asia, where it occurs on Sumatra, Java and Bali in Indonesia, inhabiting a range of wooded habitats (apparently preferring degraded areas) in lowlands below 1,000 m (Eaton *et al*. 2021). The species is currently listed as Vulnerable on the IUCN Red List because of perceived significant pressure from the Indonesian songbird trade (Eaton *et al*. 2015, Chng *et al*. 2016), which is suspected of causing declines exceeding 30% in the last ten years (BirdLife International 2022).

Although treated as a species for the first *c.*140 years of its taxonomic existence, in the second half of the 20th century *Rubigula dispar* was lumped as a subspecies of Black-capped Bulbul *Pycnonotus melanicterus* (now *R. melanictera*) along with the forms *flaviventris*, *gularis* and *montis* (e.g. Rand & Deignan 1960, MacKinnon 1988, Sibley & Monroe 1990, Inskipp *et al*. 1996). In the present century, however, a five-species treatment of these taxa proposed by Fishpool & Tobias (2005) has been widely adopted in regional and global classifications (e.g. Dickinson & Christidis 2014, Eaton *et al*. 2021, Clements *et al*. 2022, Gill *et al*. 2022, HBW & BirdLife International 2022). This arrangement—originally made based on external morphology—has since been affirmed by molecular data (Shakya & Sheldon 2017).

When treated specifically, *R. dispar* has always been considered monotypic (Fishpool & Tobias 2005, Dickinson & Christidis 2014, del Hoyo & Collar 2016, Eaton *et al*. 2016, 2021). Recently, however, a difference in iris colour between Sumatran and Javan / Bali birds has been noted (Eaton *et al*. 2021; J. K. Menner *in litt*. 2021), with the additional suggestion that '[Sumatran] birds have…red throat bleeding into breast' (Eaton *et al*. 2021). Previously, apart from a remark that the eyes of the species were 'either cream-coloured or dull red', with no geographical basis indicated for this circumstance (Tilford 2000[1]), the iris colour was consistently described and / or illustrated as red (e.g. MacKinnon 1988, MacKinnon & Phillipps 1993, Fishpool & Tobias 2005, Eaton *et al*. 2016, del Hoyo & Collar 2016, Arlott 2018). We therefore sought to assemble the evidence to determine the potential taxonomic

[1] While this paper was in press, a revised version of the book (Tilford 2023) was published in which the iris colour of Ruby-throated Bulbul was described as 'pale orange', yet illustrated with a photograph of a bird with eyes that are clearly very pale yellow.

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significance of this claimed distinction and any other difference that close examination of morphological and acoustic material might disclose.

Methods

Iris colour.—Photographs of *R. dispar* were collated (to October 2022) by AJB from the Macaulay Library (www.macaulaylibrary.org) (n = 86) and opportunistically from online trip reports (e.g. www.cloudbirders.com), and iris colour was noted when clearly visible. To minimise possible duplication, images taken at the same site on the same day were not counted unless it was explicitly mentioned that multiple individuals were involved, leaving a final sample of 55 photographs (n = 40 Java / Bali, n = 15 Sumatra). During the study of museum material (below) a note was made when iris colour was indicated on specimen labels (including females that were not measured).

Morphometrics and plumage.—One of us (NJC) examined and measured 87 specimens of male *R. dispar* at the following institutions: Naturalis Biodiversity Center, Leiden (RMNH; n = 41 Java, n = 20 Sumatra); American Museum of Natural History, New York (AMNH; n = 14 Sumatra); Natural History Museum, Tring (NHMUK; n = 5 Java, n = 1 Sumatra); Zoologische Staatssammlung, Munich (ZSM; n = 2 Java); Museo Civico di Storia Natural 'Giacomo Doria', Genoa (MSNG; n = 1 Sumatra); Museum für Naturkunde, Berlin (ZMB; n = 1 Java); Muséum national d'Histoire naturelle, Paris (MNHN; n = 1 Sumatra); and National Museum of Natural History, Washington DC (USNM; n = 1 Java). Thus our sample comprised 50 specimens from Java and 37 from Sumatra but none from Bali (material from which would naturally group with Java, as indicated in Eaton *et al*. 2021). A further 28 female specimens were measured in RMNH (n = 16 Java, n = 9 Sumatra) and NHMUK (n = 2 Java, n = 1 Sumatra). Unsexed and immature specimens were not measured. Specimens were checked for appreciable differences in plumage, and standard measurements (in mm) were taken as follows: bill from skull to tip; wing curved, from carpal to tip; tail from point of insertion to tip.

Morphometric data were normally distributed but of unequal variance, hence for each sex morphological characters were compared using Welch's unpaired t-test applying a Bonferroni correction (where the threshold for statistical significance is set at $p<0.05/n_v$). The effect size, expressed as Cohen's d, was calculated to investigate the strength of morphometric differences between populations, adopting the thresholds suggested by Tobias *et al*. (2010) where values >0.2, >2, >5 and >10 correspond to differences considered 'minor', 'medium', 'major' and 'exceptional' respectively.

Vocalisations.—Recordings from xeno-canto (www.xeno-canto.org) and the Macaulay Library (to October 2022) were provided on request and collated. After removing duplications and material of low quality, just five (n = 4 Java, n = 1 Sumatra) recordings of *R. dispar* song were available. Because of the small sample size, these were only visually inspected and not subject to analysis.

Results

Iris colour.—Sumatran populations of *R. dispar* exhibited consistent differences from Javan birds in iris colour. The collector J. J. Menden labelled four skins in ZMB from Indramayu, Java, as having brown eyes, and he reported a fifth with red-brown eyes to Kuroda (1933), but he appears to have been wholly cavalier ('doubtless false') in his notation of iris colour (Mees 1957). We therefore set his testimony aside, leaving specimen label data available for eight Javan and 19 Sumatran specimens. All those from Java (n = 5 males, n = 3 females) were labelled as 'pale lemon', 'pale yellow' or 'yellowish', while all

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Figure 1. Example comparison of iris colour in Ruby-throated Bulbul *Rubigula dispar* from Java (left; © Forest Botial-Jarvis) vs. Sumatra (right; © Lars Petersson)

from Sumatra (n = 16 males, n = 3 females) were labelled as variations of red or orange and in a single case brown (which is commonly the colour of the eyes of young bulbuls [F. H. Sheldon *in litt*. 2023] including Javan populations of *R. dispar* [J. K. Menner *in litt*. 2023]).

Birds photographed on Sumatra (n = 15) always showed a deep orange to dark red iris, while those on Java and Bali (n = 40) exhibited a pale yellow to greyish iris 97.5% of the time (Fig. 1), with the exception of a single red-eyed individual (ML 109621061). This last was photographed at Bogor Botanical Gardens, West Java, a locality close to the cities of Jakarta and Bandung, where *c*.125,000 and 980,000 native songbirds respectively were estimated to be kept as pets in 2018 (Marshall *et al*. 2020). Notably, *R. dispar* was not recorded from Bogor Botanical Gardens historically (Hoogerwerf 1948, 1950, Diamond *et al*. 1987) and only appeared there after the release of 'hundreds of cagebirds' by local authorities in the 1990s / early 2000s (B. van Balen *in litt*. 2022). Consequently, we consider this individual a Sumatran bird that is either a descendant of this introduction or, perhaps more likely, a recently escaped individual from a local market.

Morphometrics.—In both sexes, Sumatran birds had longer bills and wings than Javan birds, but differences in tail length were statistically non-significant (Table 1). In males, Cohen's *d* effect sizes of 1.93, 1.07 and 0.48 were generated for bill, wing and tail length differences respectively, which classify them as 'minor' according to Tobias *et al*. (2010) thresholds (although bill length almost met the threshold for 'medium'). In females, equivalent values were 1.06, 1.87 and 0.85, thus all 'minor' differences (but with wing close to meeting the threshold for 'medium').

Plumage.—Our review of specimens suggested that the extent to which the red throat 'bleeds' onto the rest of the underparts (Eaton *et al*. 2021; see Introduction) is individually

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TABLE 1
Morphometric data (in mm) of populations of Ruby-throated Bulbul *Rubigula dispar* showing mean, standard deviation, range and sample size for each character. * denotes statistical significance using a Welch's unpaired t-test applying a Bonferroni correction.

Males	**Bill**	**Wing**	**Tail**
Sumatra	**16.9 ± 0.6*** (15.6–18.1, *n* = 33)	**81 ± 3.0*** (76–92, *n* = 37)	**73 ± 2.6** (68–78, *n* = 37)
Java	**15.7 ± 0.6*** (14.6–17.1, *n* = 48)	**78 ± 1.8*** (75–83, *n* = 50)	**72 ± 3.0** (68–80, *n* = 50)
Females	**Bill**	**Wing**	**Tail**
Sumatra	**16.6 ± 0.8*** (14.9–18.2, *n* = 10)	**80 ± 1.5*** (77–82, *n* = 10)	**73 ± 2.3** (69–76, *n* = 10)
Java	**15.8 ± 0.7*** (14.1–16.7, *n* = 18)	**77 ± 1.7*** (74–80, *n* = 18)	**71 ± 2.4** (68–76, *n* = 18)

and not geographically variable. We found no consistent plumage differences between Javan and Sumatran birds.

Vocalisations.—A visual inspection of the small available sample (minimal for Sumatra) yielded no appreciable difference between islands.

Discussion

Iris colour has, in other bulbuls, been noted as a probably important reproductive signal. For example, the previous assumption that Bornean populations of Cream-vented Bulbuls *Pycnonotus simplex* were polymorphic in eye colour (red or white) was falsified when the two phenotypes were found to be only distantly related, despite nearly identical plumage (Shakya *et al*. 2019). Similarly 'Barusan Bulbul' *P. porphyreus* was recently avowed to be specifically distinct from Olive-winged Bulbul *P. plumosus* on the basis of a number of morphological differences, including a much paler iris (Rheindt *et al*. 2020, Eaton *et al*. 2021).

However, we find no plumage character that distinguishes Sumatran from Javan Ruby-throated Bulbuls, morphometric differences between them are only minor, and at present on very limited evidence no vocal differences can be detected. Furthermore, the only comparative genetic data available (Dejtaradol *et al*. 2015) are inconclusive, since their samples ostensibly from 'Jakarta' were collected from bird markets, thus could reasonably refer to either taxon. Nevertheless, we consider that Sumatran birds are sufficiently distinct from Javan birds to merit subspecific recognition.

Rubigula dispar matamerah subsp. nov.

Holotype.—Adult male, NHMUK 1888.4.1.724, collected at Sidjoendjoeng [Sijunjung], *c*.00°42'S 100°58'E, *c*.270 m, Sumatra, Indonesia, in October 1878 by Carl Bock. Bill 16.8 mm, wing 82 mm, tail 76 mm. The specimen label documents the iris colour as 'red'.

Diagnosis.—The iris of *R. d. matamerah* is basically red (varying individually between orange and crimson) instead of creamy yellow as in *P. d. dispar*. In both sexes the bill (mean males 16.9 vs. 15.7 mm, females 16.6 vs. 15.8 mm) and wing (males 81 vs. 78 mm, females 80 vs. 77 mm) are slightly longer than in the nominate.

Description of holotype.—Head black except the throat, which has loose, pale fiery-red feather tubules. Upper breast orange-yellow tinged red, shading to mustard yellow on rest of underparts. Mantle, scapulars, back, rump and uppertail-coverts dull olive green. Wing-coverts and remiges dull blackish brown broadly fringed dull yellowish green. Uppertail

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Figure 2. Holotype of *Rubigula dispar matamerah*, NHMUK 1888.4.1.724, showing the specimen label and description of iris colour (Paul F. Donald, © Natural History Museum, London)

blackish brown; undertail greyer with whitish shafts. Bill black. Legs blackish brown. Iris red, as noted on label. Illustrated in Fig. 2.

Distribution.—Judged endemic to Sumatra, Indonesia, where photographs of red-eyed individuals were collated from the northernmost (Aceh) and southernmost (Lampung) provinces of the island. Like nominate *R. d. dispar* of Java and Bali, *R. d. matamerah* appears to be confined to elevations below *c*.1,000 m.

All photographs collated from West Java were obtained at Bogor Botanical Gardens, where the species is thought to have been introduced (see above). Consequently, these images cannot eliminate the possibility that native populations elsewhere in West Java belong to *R. d. matamerah* rather than the nominate. Such a distribution (where Sumatra and West Java share one taxon and the rest of Java holds its closest relative) would not be novel, and is observed in (e.g.) *Chrysocolaptes* flamebacks and White-rumped Shama *Copsychus malabaricus*, where Sumatran taxa occur on Java west of a line that runs approximately from Pelabuhanratu Bay to Cirebon (see Mees 1996). However, the only other evidence available to us from west of this line is provided by Nicholson (1881), who reported an adult female Ruby-throated Bulbul from Mt. Karang, Banten, in westernmost Java, with straw-yellow eyes. Consequently, we conclude with reasonable certainty that *matamerah* occurs only on Sumatra.

Etymology.—'Mata merah' means 'red eye' in Bahasa Indonesia. We use the name as a noun in apposition.

Conservation.—Owing to suspected declines caused by the songbird trade *R. dispar* has been listed as Vulnerable on the IUCN Red List (BirdLife International 2022) since its acceptance as a species by BirdLife International in 2016 (del Hoyo & Collar 2016). However, Symes *et al*. (2018) postulated that trapping pressure was causing the species to decline so rapidly it merited listing as Critically Endangered, the highest IUCN category of threat. By contrast, recent studies and records have suggested that the species is not commonly kept in captivity (Marshall *et al*. 2020) and remains frequently observed and widespread in the wild (Squires *et al*. 2021, eBird 2022). As a consequence, in 2022 the species was moved from the IUCN Asian Songbird Trade Specialist Group 'Tier 1' priority list (species considered most threatened by trade for which captive breeding is considered a major management

ISSN-2513-9894 (Online)

intervention; see Collar & Wirth 2022) to the 'Tier 2' watch list (species for which population monitoring and research are recommended) (Chng & Shukhova 2022).

Such monitoring will determine whether a re-evaluation of the species on the IUCN Red List is appropriate, but for the present it is likely to remain Vulnerable (AJB). A particularly valuable dimension to the monitoring of birds in markets will be to use iris colour to track the degree of movement of birds from Sumatra to Java (and presumably but much less probably vice versa). Which of the two subspecies is contributing more to the captive populations in Indonesia will be useful to gauge. We certainly recommend that the two taxa are treated as independent conservation units and suggest that—with iris colour providing a simple and reliable means of determination—those in captive-breeding programmes (such as the small one at Prigen Ark: J. K. Menner *in litt*. 2023) are maintained as separate populations, while those seized as part of the songbird trade are released—if that is the decision of the authorities—onto the correct island to prevent admixture.

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ISSN-2513-9894 (Online)

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