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CONTENT

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ISSN : 0082 - 6340 Date of issue: 30 JUNE 2020
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UDC: 595.78(594.73)

David J. Lohman

Syntopic *Elymnias agondas aruana* female forms mimic different *Taenaris* model species (Papilionoidea: Nymphalidae: Satyrinae) on Aru, Indonesia

TREUBIA, June 2020, Vol. 47, No. 1, pp. 1–12.

Wing patterns of female *Elymnias agondas* (Boisduval, 1832) butterflies are highly variable, presumably to mimic different *Taenaris* species throughout New Guinea and surrounding islands. Labels on most *E. agondas* museum specimens lack precise locality information, complicating efforts to match *E. agondas* female wing patterns with presumed *Taenaris* model species. This paucity of data also makes it impossible to determine where different forms occur and whether they are strictly allopatric. During fieldwork on the Aru Archipelago, we found two distinct forms of *E. agondas* females occurring syntopically. The "light form" resembles *T. catops*, while the "dark form" seems to mimic *T. myops* and *T. artemis*. We discuss the significance of this finding and illustrate species in the *Taenaris* mimicry ring encountered on Aru.

(David J. Lohman, Sarino, and Djunijanti Peggie)

Keywords: adaptation, Batesian mimicry, butterfly, mimicry ring, polymorphism

UDC: 598.2:910.4(594.4)

Tri Haryoko

Recent ornithological expeditions to Siberut Island, Mt. Talamau and Rimbo Panti Nature Reserve, Sumatra, Indonesia

TREUBIA, June 2020, Vol. 47, No. 1, pp. 13–38.

Siberut Island, Mt. Talamau, Rimbo Panti Nature Reserve, and intervening locations in West Sumatra Province were visited during two expeditions in 2018-2019 by ornithologists from the Museum Zoologicum Bogoriense-Indonesian Institute of Sciences (LIPI), Louisiana State University Museum of Natural Science, and Andalas University. The main objective of these expeditions was to obtain data and tissue-subsample rich museum specimens for morphological and genetic studies of phylogeny and population genetics of Southeast Asian birds aimed at understanding the causes of avian diversification in the region. We also observed, photographed, and audio-recorded numerous bird species during the expeditions and archived these data. In total, 285 species were identified, and specimen material was collected from 13 species and 26 subspecies not previously represented in tissue resource collections. Here, we provide complete lists of birds found at each location, highlight distributional discoveries, and note cases of potential taxonomic, ecological, and conservation interest.

(Tri Haryoko, Oscar Johnson, Matthew L. Brady, Subir B. Shakya, M. Irham, Yohanna, Rusdiyan P. Ritonga, Dewi M. Prawiradilaga, and Frederick H. Sheldon)

Keywords: birds, distribution, diversity, conservation, West Sumatra

UDC: 598.813.063(59)

Elize Y. X. Ng

Integrative taxonomy reveals cryptic robin lineage in the Greater Sunda Islands

TREUBIA, June 2020, Vol. 47, No. 1, pp. 39–52.

Southeast Asian avifauna is under threat from both habitat loss and illegal poaching, yet the region's rich biodiversity remains understudied. Here, we uncover cryptic species-level diversity in the Sunda Blue Robin (*Myiomela diana*), a songbird complex endemic to Javan (subspecies *diana*) and Sumatran (subspecies *sumatrana*) mountains. Taxonomic inquiry into these populations has previously been hampered by a lack of DNA material and the birds' general scarcity, especially *sumatrana* which is only known from few localities. We demonstrate fundamental bioacoustic differences in courtship song paired with important distinctions in plumage saturation and tail length that combine to suggest species-level treatment for the two taxa. Treated separately, both taxa are independently threatened by illegal poaching and habitat loss, and demand conservation action. Our study highlights a case of underestimated avifaunal diversity that is in urgent need of revision in the face of imminent threats to species survival.

(Elize Y. X. Ng, Arya Y. Yue, James A. Eaton, Chyi Yin Gwee, Bas van Balen, and Frank E. Rheindt)

Keywords: bioacoustics, bird trade, passerines, songbird crisis, taxonomic neglect

UDC: 595.76:591.46(594.53)

Arif Maulana

A contribution to the taxonomy and ecology of little-known Indonesian *Afissa* ladybird beetles (Coccinellidae, Epilachnini)

TREUBIA, June 2020, Vol. 47, No. 1, pp. 53–62.

We collected the little-known ladybird beetle *Afissa incauta* in the mountainous region of Bandung, West Java. The beetle occurred sympatrically with the very similar species *A. gedeensis*. Here, we provide an update to the current knowledge for these two species. The *A. incauta* we collected have a slightly smaller and duller body compared to the previously known specimens of *Afissa incauta*, with convergent elytral maculation similar to *A. gedeensis*.

(Arif Maulana, Tri Atmowidi, and Sih Kahono)

Keywords: *Afissa gedeensis*, *Afissa incauta*, Coleoptera, Epilachnini, ladybird beetle

UDC: 595.733:574.2(594.57)

Ainun Rubi Faradilla

The life history and microhabitat ecology of a phytotelm-breeding damselfly *Pericnemis stictica* in Jatimulyo forest, Yogyakarta

TREUBIA, June 2020, Vol. 47, No. 1, pp. 63–75.

This study aims to understand the life history and microhabitat ecology of a phytotelmata-breeding species, *Pericnemis stictica*. Data was collected at 46 breeding sites in the Jatimulyo Forest, Kulonprogo. Several parameters were recorded from each breeding site, i.e. plant species, diameters, depth, water depth, water volume, water pH, and water turbidity. Naiads and imagoes of *P. stictica* were measured morphometrically. The data taken was analyzed descriptively using Minitab 19. The results showed that 17 naiads of *P. stictica* were found in 13 bamboo stumps. The bamboo species most commonly used by *P. stictica* as a breeding site was *Dendrocalamus asper*. Naiads of *P. stictica* were found in the same habitat as mosquito larva from genera *Toxorhynchites*, *Aedes*, *Armigeres*, and *Culex*. During the rearing process, it was recorded that *P. stictica* naiads can eat more than ten mosquito larvae a day. Four males and one female imagoes of *P. stictica* were found. The imagoes were mostly found in a secondary forest with shady ravine areas. Imago's average total length was 7.19 cm. Naiad's final instar average size was 16.7 mm. Water depth, water temperature, bamboo depth, bamboo volume, and humidity were all positively correlated to *P. stictica's* phytotelmata-breeding behavior.

(Ainun Rubi Faradilla, Mariza Uthami, Bella Andini, and Hening Triandika Rachman)

Keywords: breeding, *Pericnemis*, phytotelm, Yogyakarta

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INTEGRATIVE TAXONOMY REVEALS CRYPTIC ROBIN LINEAGE IN THE GREATER SUNDA ISLANDS

Elize Y. X. Ng[1], Arya Y. Yue[1,2], James A. Eaton[3], Chyi Yin Gwee[1], Bas van Balen[4], and Frank E. Rheindt*[1]

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ABSTRACT

Southeast Asian avifauna is under threat from both habitat loss and illegal poaching, yet the region's rich biodiversity remains understudied. Here, we uncover cryptic species-level diversity in the Sunda Blue Robin (*Myiomela diana*), a songbird complex endemic to Javan (subspecies *diana*) and Sumatran (subspecies *sumatrana*) mountains. Taxonomic inquiry into these populations has previously been hampered by a lack of DNA material and the birds' general scarcity, especially *sumatrana* which is only known from few localities. We demonstrate fundamental bioacoustic differences in courtship song paired with important distinctions in plumage saturation and tail length that combine to suggest species-level treatment for the two taxa. Treated separately, both taxa are independently threatened by illegal poaching and habitat loss, and demand conservation action. Our study highlights a case of underestimated avifaunal diversity that is in urgent need of revision in the face of imminent threats to species survival.

Keywords: bioacoustics, bird trade, passerines, songbird crisis, taxonomic neglect

ABSTRAK

Fauna burung di Asia Tenggara mengalami ancaman yang disebabkan oleh kehilangan habitat dan perburuan liar, namun keanekaragaman tinggi di kawasan ini masih kurang dipelajari. Pada makalah ini kami mengungkapkan keragaman tersembunyi pada tingkat jenis burung berkecet biru tua (*Myiomela diana*), suatu kelompok burung berkicau yang pelik, endemik di pegunungan Jawa (anak jenis *diana*) dan Sumatra (anak jenis *sumatrana*). Sebelumnya penelitian taksonomi pada populasi burung tersebut terkendala oleh kekurangan material DNA dan kelangkaan burung, khususnya pada anak jenis *sumatrana* yang hanya diketahui dari sedikit lokasi. Kami menunjukkan perbedaan bioakustik dalam kicauan percumbuan dipasangkan dengan perbedaan penting pada warna bulu dan panjang ekor yang dikombinasikan untuk perlakuan tahap jenis pada kedua taksa. Diperlakukan sebagai jenis yang berbeda, kedua taksa ini terancam perburuan liar dan kehilangan habitat, dan memerlukan aksi konservasi. Studi ini menyoroti kasus keragaman fauna burung yang tidak terlalu diperhitungkan yang perlu segera direvisi dalam menghadapi ancaman nyata terhadap keberlangsungan jenis ini.

Kata kunci: bioakustik, perdagangan burung, passerines, krisis burung berkicau, pengabaian taksonomi

INTRODUCTION

Birds are the most well studied group of organisms. Yet despite this detailed taxonomic knowledge, there is ongoing turn-over in the classification of birds as a relatively high number of populations previously subsumed under more widespread species have recently gained recognition as independent species, especially in tropical regions of Asia (Collar, 2003; Barrowclough et al., 2016), indicating a potential underestimate of avian species diversity. Such erroneous assessments of avifaunal richness can impede conservation and management actions that depend upon accurate taxonomic delimitations (Lohman et al., 2010; Rojas-Soto et al., 2010). Examples of such victims of unrecognized cyptic diversity include the Critically Endangered Javan Green Magpie (*Cissa thalassina*) that was once lumped with the non-threatened Bornean Green Magpie (*C. jefferyi*) (van Balen et al., 2013); the Critically Endangered Javan Leafbird (*Chloropsis cochinchinensis*) was previously considered a species with the widespread Blue-winged Leafbird (*Chloropsis moluccensis*) (BirdLife International, 2017); the Critically Endangered Javan Pied Starling (*Gracupica jalla*) was recognised as a species with its Least Concern northern sister taxon Asian Pied Starling (*Gracupica contra*) (BirdLife International, 2019).

In Southeast Asia, especially in the Greater Sundaic region, birds are threatened with habitat loss and illegal poaching (Symes et al., 2018). In particular, insular Southeast Asia has one of the highest rates of deforestation globally (Miettinen et al., 2011, FAO, 2015), a trend that is set to continue into the future as nations develop. To further exacerbate the critical situation, birds are trapped incessantly throughout the region for the illegal wildlife trade (Chng et al. 2015, 2016a, 2016b, 2018; Eaton et al. 2015, 2017a, 2017b; Krishnasamy & Stoner, 2016). There is a race to uncover cryptic species that remain beneath the conservation radar before they perish in the face of anthropogenic threats.

In this study, we uncover cryptic species-level diversity in the Sunda Blue Robin (*Myiomela diana*) complex from montane Java and Sumatra. The species consists of two currently recognized subspecies; *diana* from the western and central mountains of Java and *sumatrana* from the mountains of Sumatra (Fig. 1). Taxonomic inquiry into these two taxa has thus far been hampered by their general scarcity, especially *sumatrana* which is known from very few localities, and a general lack of DNA material. Both taxa have long been considered conspecific until Eaton et al. (2016a) upgraded them as separate species based on distinct vocalisations and plumage. Herein, we shed light on the taxonomic status of these two distinct taxa using an integrative approach relying on morphological specimen inspection and vocal analysis.

MATERIALS AND METHODS

We examined a subset of the series of *M. diana* specimens at the Natural History Museum at Tring (henceforth NHM Tring), Naturalis Museum (Leiden, Netherlands) (henceforth NM), and the Lee Kong Chian Natural History Museum (Singapore) (henceforth LKCNHM). In total we examined 30 specimens: 15 at NM comprising five male and five female *M. d. diana* and five male *M. d. sumatrana*; 12 at NHM Tring comprising six male and four female *M. d. diana* and one male and one female *M. d. sumatrana*; and 3 at LKCNHM comprising two male and one female *M. d. sumatrana* (Table S1). Five measurements were taken: (1) tarsus length, (2) length of upper mandible (as measured from the bill tip to the point where the upper mandible meets the forehead), (3) wing length, (4) tail length, and (5) total body length

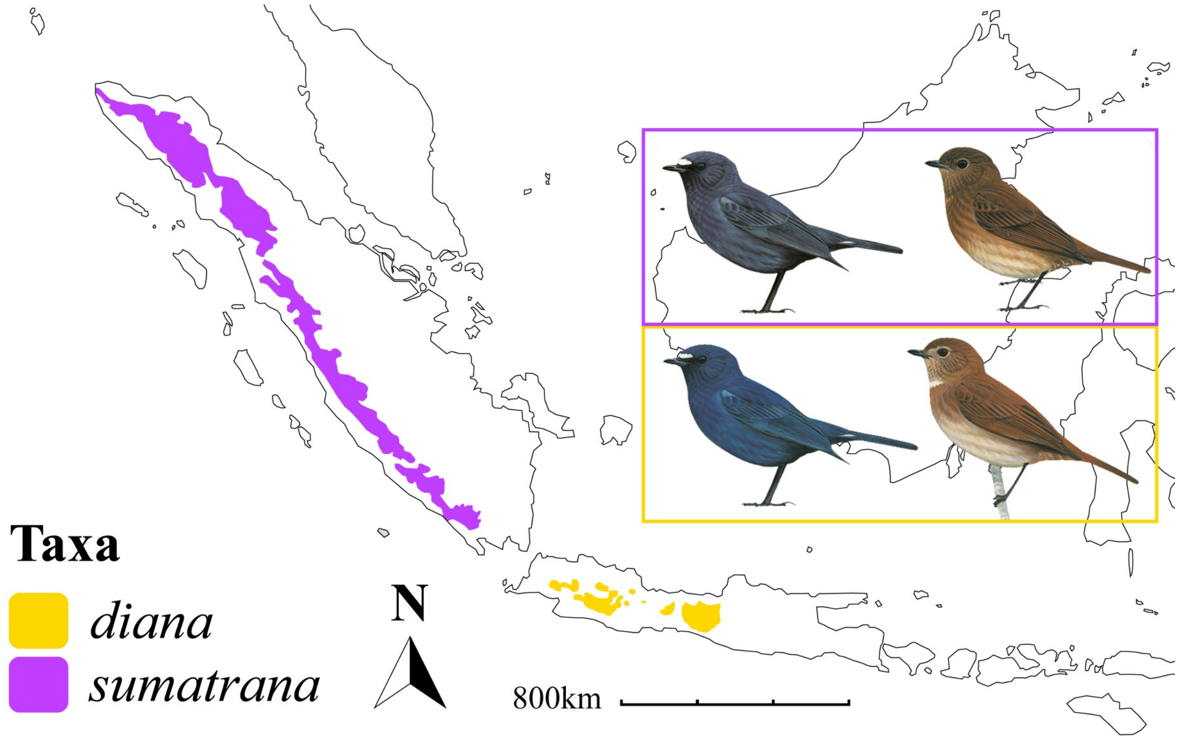

Figure 1. Range map of the Sunda Blue Robin (*Myiomela diana*) complex. Illustration of Javan *diana* (bottom) and Sumatran *sumatrana* (top) depicting plumage differences in both males and females are modified from Eaton et al. (2016a).

(Table S1). Measurements (1) and (2) were taken with a calliper to the nearest tenth of a millimetre, while measurements (3), (4) and (5) were taken with a ruler to the nearest millimetre. Statistical analysis was not conducted for (1), (3) and (5) due to the large amount of missing measurements taken across examined specimens. Statistical differences between measurements were calculated using the one-sample Wilcoxon test as implemented in R3.4.3 (R Development Core Team, 2017). Plumage coloration of birds at NHM Tring was assessed against natural light. JAE took photos of NHM Tring specimens using a Sony DSC W90.

Sound recordings of courtship songs were obtained from online repository (Xeno-Canto) and comprise a total of 19 recordings which were included in our analysis (13 from *M. d. diana*, and six from *M. d. sumatrana*) (Table S2). We measured a total of nine vocal parameters: (1) number of elements per motif, (2) motif duration, (3) highest frequency, (4) lowest frequency, (5) bandwidth frequency, (6) peak frequency, (7) centre frequency (Charif et al., 2010), (8) frequency modulation in first half of motif, and (9) frequency modulation in second half of motif. Frequency modulations (parameters 8 and 9) were measured first by splitting the motif into four equal partitions, with parameter 8 reflecting the difference in peak frequency between the first and second partitions, and parameter 9 the difference between the third and the fourth. Vocal analyses were conducted and sonograms were generated using Raven Pro Version 1.5 (Bioacoustics Research Program, Cornell Laboratory of Ornithology, Ithaca, NY, USA). Default settings of Raven Pro were applied except window size, which was adjusted to 1000 after inspection of all sonograms to select the optimal level.

Principal Component Analysis (PCA) was conducted for vocal measurements in R using the 'prcomp' function. Additionally, we assessed the vocal diagnosability of variables using the criterion outlined by Isler et al. (1998), henceforth referred to as the Isler criterion. The Isler criterion is based on two conditions: (i) there must be no overlap between the ranges of measurements between the two taxa being compared, and (ii) the means x and standard deviations (SD) of the taxon with the smaller set of measurements (a) and the taxon with the larger set of measurements (b) have to meet the following requirement: xa + taSDa ≤ xb – tbSDb, where ti refers to the t-score at the 97.5th percentile of the t distribution for n – 1 degrees of freedom. Since there must be no overlap between the two sets of measurements, measurements of one taxon are uniformly higher than the other, and a one-tailed test with a significance level of 5% was used. The Isler criterion is substantially more discriminating than t-tests, Mann-Whitney U tests and tests including effect sizes because it uses the standard deviations of the sample points, not the standard deviation of the taxon mean, which is much smaller (Isler et al., 1998; Rheindt et al., 2011). In addition to the Isler criterion, a two-tailed t -test was also performed to assess the conservative nature of the Isler criterion.

RESULTS

Morphometrics

Both taxa were found to differ significantly in tail length. This difference was observed both in sex-specific comparisons (p-value = 0.003382 between males, and p-value = 0.03139 between females) and across all individuals (p-value = 0.005552) (Fig. 2, Table S1). There was no significant difference observed for bill length between the two taxa (p-value = 0.7011) (Fig. 2a). Based on total body length, *M. d. diana* is on average larger than *M. d. sumatrana*, both across and between sexes (Table S1).

Plumage

The male of *M. d. diana* has a glossy dark-blue plumage that can appear surprisingly pale when perched in the open in good light (JAE and FER, personal observation), strongly contrasting with the black primaries (Figs. 1 and S1). The small white feathers on the forecrown are usually hidden when the bird is feeding but often exposed when the bird is agitated or responding to playback in much the same way that the Javan Shortwing *Brachypteryx montana* can seemingly hide and expose its white supercilium on demand (JAE and FER, personal observation). Female *M. d. diana* shows bright chestnut upperparts and head with a small grey wedge on the lower throat, a rufous breast band and dark grey underparts across all specimens.

In *M. d. sumatrana*, the male is much darker blue, with little contrast with the black primaries (Fig. S1). The extent of white on the forecrown is similar to *diana*. Female

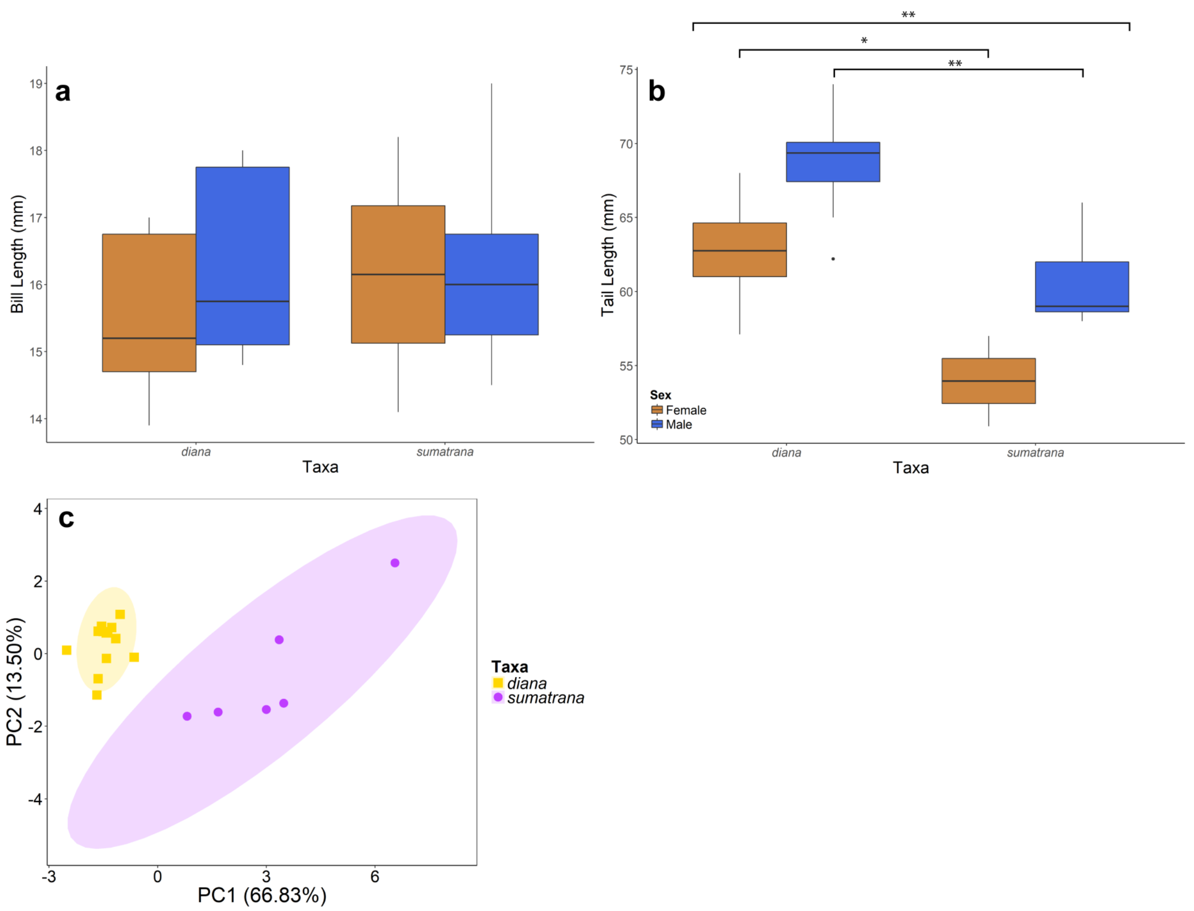

Figure 2. Sex-specific box plots of morphometric measurements of (a) bill length (from bill tip to the point where the upper mandible meets the forehead); (b) tail length. Significant differences for the pairwise Wilcoxon Test are listed for $p \leq 0.05$ (*) and $p \leq 0.01$ (**). (c) Principal component (PC) plot based on nine vocal parameters for Sunda Blue Robins, with PC1 explaining 66.83% of total variance and PC2 explaining an additional 13.50% of total variance.

sumatrana is also much darker in plumage compared to all female *diana*, lacking the bright chestnut tones (Fig. S1). Although the throat appears slightly paler than the breast and ear-coverts, it lacks the pronounced grey wedge of *diana*. The belly is a mucky, darker grey than female *M. d. diana* (Fig. S1).

Bioacoustics

The main courtship vocalizations of these two taxa are consistently and easily separable. *M. d. diana*'s song is a simple descending warble of 4-5 sweet melancholy glissading notes, usually with an ascending final note or – less commonly – a final flourish. In sharp contrast, *M. d. sumatrana's* song is a much more heterogeneous, complex, tinkling motif – usually around twice as long as that of *diana* (Table S2) – consisting of a series of 5-8 high-pitched, rising-and-falling elements that invariably ascend into a fading pitch. This song is strongly reminiscent of the Bamboo Bush Warbler (=Yellow-bellied Warbler) *Abroscopus superciliaris*.

Principal Component Analysis (PCA) of all bioacoustic measurements showed the two taxa to be distinctly different with no overlap in PCA space (Fig. 2c). It also agreed with our vocal characterizations in showing Sumatran songs to be more heterogeneous than Javan ones (i.e., filling out more bioacoustic space in Fig. 2c). Of the nine parameters, three – motif duration, highest and bandwidth frequency – did not overlap between the two taxa. However, due to the conservative nature of the Isler criterion, none of the parameters were deemed Isler-diagnosable (Table S2). In contrast, a two-tailed t-test revealed significant differences (p-values < 0.05, df =18, t-value = 2.101) between the Javan and Sumatran taxa in 7 out of 9 parameters (except lowest and peak frequencies) (Table S2).

DISCUSSION

Many modern taxonomic treatments recognize the Sumatran and Javan taxa as subspecies of the Sunda Blue Robin *M. diana*. However, in light of the differences in plumage, vocalizations, and morphometrics here documented, we propose that the two subspecies should be recognized separately as Sumatran Blue Robin (*M. sumatrana*) and Javan Blue Robin (*M. diana*). The differences documented in plumage, vocalization, and morphometrics are testimony to the true differences between taxa, as both taxa have been showed to be statistically different despite being measured and/or recorded by various co-authors and/or recordists.

The subtle difference in plumage coloration is likely of reproductive significance, especially in the amount of male brightness, which may act as an honest signal of sexual selection (Hill, 2002; Dunn et al., 2015). More importantly, however, courtship vocalisations differ strongly between the two (Fig. 2c, Table S2). Vocalizations are an important factor in reproductive isolation in songbirds and have been used in documenting cryptic, overlooked species-level diversity in other Asian robins, thrushes and flycatchers (superfamily Muscicapoidea), e.g. *Brachypteryx* shortwings (Alström et al., 2018), *Sholicola* sholakilis (Robin et al., 2017), *Ficedula* flycatchers (Dong et al., 2015), and *Cyornis* jungle-flycatchers (Gwee et al., 2019).

In our taxonomic recommendation to separate *M. diana* and *M. sumatrana* into different species, we follow the yardstick approach (Mayr & Ashlock, 1991) under the umbrella of the multi-dimensional Biological Species Concept (Mayr, 1996). Although plumage differences detected are not substantial and may suggest mere subspecific differentiation, the important comparison is whether other Asian Muscicapoidea species pairs of relatively close phylogenetic affinity display plumage differences of the same order of magnitude or not. The same rationale can be applied to bioacoustic differences, which are arguably more important in reproductive isolation in these songbirds (Kroodsma & Miller, 1982; Kroodsma & Byers, 1991; Catchpole & Slater, 2003). The White-browed Shortwings of the *Brachypteryx* *montana* complex from mainland Asia have extensive similarities in plumage and have consequently been considered members of only one species until a combination of bioacoustic and molecular evidence led to their recent separation (Alström et al., 2018). In the same vein, vocal similarities arguably smaller than the ones observed between our robins have been documented among a number of *Cyornis* jungle-flycatchers (Gwee et al., 2019) that are known to be genetically deeply diverged (e.g. *Cyornis montanus* and an undescribed form from the Meratus mountains (Shakya et al., 2018; Eaton et al., 2016b). These cases illustrate that the vocal differences here documented between Javan and Sumatran Blue Robins are consistent with their treatment as independent species. Future studies can be made using genomic markers to confirm the distinctiveness between *M. diana* and *M. sumatrana.*

The recognition of Sumatran and Javan Blue Robins as independent species has important implications for their conservation. When cryptic species are lumped and treated as mere subspecies of each other because of taxonomic neglect, they are usually not granted the same conservation attention as compared to recognized species (Hazevoet, 1996). Population decline in such species often goes undetected as the overall population size of the combined umbrella species remains seemingly safe, leading to real extinction risk of species-level taxa (Hazevoet, 1996). Examples of such taxonomic neglect are abundant in the Indonesian Archipelago (e.g. Rheindt et al. 2017, 2020; Ng et al., 2016) and include Critically Endangered species such as the Javan Green Magpie (*Cissa thalassina*) (van Balen et al., 2013) and the Aceh Bulbul (*Pycnonotus bimaculatus*) (Eaton & Collar, 2015).

In the face of the songbird crisis that Southeast Asia is currently experiencing (Eaton et al., 2015), many species are threatened with extinction owing largely to the synergistic effects of illegal poaching for the bird trade and habitat loss (Symes et al., 2018). Currently, the Sunda Blue Robin is considered 'Least Concern' by the IUCN due to its large distribution on both Java and Sumatra (Birdlife International, 2018). With the present taxonomic revision, we propose that the Javan Blue Robin be given an IUCN classification of 'Vulnerable' under criterion A3 (IUCN, 2012) in which the population is projected or suspected to be reduced by at least 30% within the next 10 years. The species is restricted to the montane forests of west and central Java and is known to be targeted for the bird trade. A total of 19 *diana* individuals were found at three Jakarta markets during a single visit on one day (JAE, pers. obs., 4 July 2019). The Javan Blue Robin is only known from six localities across west and central Java (Fink et al., 2020), attesting to its rarity. Unsustainable poaching pressures will decimate populations if protection is not granted in the near future.

In a similar vein, we recommend that the Sumatran Blue Robin be given a classification of 'Near Threatened' based on the IUCN red list criteria: A3 (IUCN, 2012) – given the increasing trapping pressures on Sumatran species as poachers seek to supply cage birds from elsewhere in the archipelago (Chng et al., 2015; Chng et al., 2018); B1a – despite the extensive reported range, the species has only been recorded at eight sites across Sumatra (Fink et al., 2020); B1bii – due to the ever increasing forest clearance in Sumatra that threatens the survival of the species (Miettinen et al., 2011). With habitat loss and illegal trade continuing to drive many Asian birds and other animals into extinction, it is increasingly important that taxonomic treatments reflect true species-level diversity as the survival of species depends upon it.

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SUPPLEMENTARY MATERIAL

Table S1. Morphometric measurements for *M. d. diana* and *M. d. sumatrana*

Museum*	Taxon	Sex	Bill (mm)	Tarsus (mm)	Tail (mm)	Wing (mm)	Total length (mm)
NHM Tring	*sumatrana*	Male	14.5	-	58.5	83.1	139
NM	*sumatrana*	Male - Immature	16	26	59	-	125
NM	*sumatrana*	Male	17	25	no tail	-	-
NM	*sumatrana*	Male	16	25	63	-	137
NM	*sumatrana*	Male	17	26	59	-	134
NM	*sumatrana*	Male	15	26	58	-	160
LKCNHM	*sumatrana*	Male	-	26	61	81	146
LKCNHM	*sumatrana*	Male	19	26	66	82	153
M. d. sumatrana (Male) Mean			16.36	25.71	60.64	82.03	142.00
NHM Tring	*sumatrana*	Female	14.10	-	50.90	76.80	130.00
LKCNHM	*sumatrana*	Female	18.2	24.5	57	75	137
M. d. sumatrana (Female) Mean			16.15	24.50	53.95	75.90	133.50
M. d. sumatrana Mean			16.31	25.56	59.16	79.58	140.11
NHM Tring	*diana*	Male	15.1	-	70.1	84.9	160
NHM Tring	*diana*	Male	15	-	68.1	84.5	151
NHM Tring	*diana*	Male	15.5	-	69.7	87.8	162
NHM Tring	*diana*	Male	15.1	-	62.2	83	161
NHM Tring	*diana*	Male	14.8	-	67.2	85.2	160
NM	*diana*	Male	18	26	72	-	145
NM	*diana*	Male	18	28	74	-	150
NM	*diana*	Male	18	29	70	-	145
NM	*diana*	Male	16	26	69	-	140
NM	*diana*	Male	17	26	65	-	136
M. d. diana (Male) Mean			16.25	27.00	68.73	85.08	151.00
NM	*diana*	Female	16	26	63	-	140
NM	*diana*	Female	17	26	61	-	135
NM	*diana*	Female	17	25	68	-	145
NM	*diana*	Female	15	25	65	-	142
NM	*diana*	Female	17	28	61	-	132
NHM Tring	*diana*	Female	14.3	-	57.1	78.9	150
NHM Tring	*diana*	Female	14.6	-	65.9	80.3	155
NHM Tring	*diana*	Female	15.4	-	63.5	81.2	159
NHM Tring	*diana*	Female	13.9	-	62.5	80	140
NHM Tring	*diana*	Female	15	-	57.8	78.5	152
M. d. diana (Female) Mean			15.52	26.00	62.48	79.78	145.00
M. d. diana Mean			15.89	26.50	65.61	82.43	148.00

*Measurements made at NHM Tring (Natural History Museum at Tring, United Kingdom) were by JAE; NM (Naturalis Museum, Leiden, Netherlands) were by BvB; LKCNHM (Lee Kong Chian Natural History Museum, Singapore) were by CYG.

Table S2. Details of recordings used in this study. Mean for each recording measured is presented here.

Taxon	Filename	Recordist	Location	No. of Motifs	Average no. of elements	Motif Duration (s)	Frequency (kHz)					Modulation	
							Highest	Lowest	Band-width	Peak	Centre	1st	2nd
diana	Robin_Javan Blue_MN	Mike Nelson	Gunung Gede-Pangrango, Java	9	3.67	0.67	3859.88	2780.69	1079.19	3517.09	3517.09	0	0
	Robin_Javan Blue_MN 2	Mike Nelson	Gunung Gede-Pangrango, Java	14	4.00	0.64	4038.96	2571.13	1467.84	3374.54	3389.93	0	1
	Robin_Javan Blue_MN 3	Mike Nelson	Gunung Gede-Pangrango, Java	1	3.00	0.70	3760.90	2767.60	993.30	3186.90	3186.90	0	0
	Robin_Sunda Blue_Java	James Eaton	Gunung Gede-Pangrango, Java	22	4.09	0.65	4062.19	2744.40	1317.78	3717.40	3566.66	0	0
	Robin_Sunda Blue_Java_JE	James Eaton	Gunung Gede-Pangrango, Java	8	3.75	0.66	3889.84	2635.88	1253.96	3423.76	3439.90	1	1
	Cincdian5iii86_0714hrs_21Bxx4	Bas van Balen	Java	14	3.43	0.58	3976.43	2933.90	1042.53	3612.74	3545.76	0	0
	Cincdian17ii81_640_2B036	Bas van Balen	Java	7	3.71	0.55	4040.40	2798.89	1241.51	3582.60	3549.13	0	0
	20090822_GedePangrango_David Marquez	David Marquez	Gunung Gede-Pangrango, Java	5	4.80	0.71	3874.58	2680.90	1193.68	3367.78	3298.86	1	0
	Paulo Alves recordings 1	Paulo Alves	Java	3	3.33	0.56	3987.03	2798.53	1188.50	3287.37	3344.83	0	1
	Paulo Alves recordings 2	Paulo Alves	Java	15	3.73	0.63	3966.81	2760.84	1205.97	3471.15	3439.56	0	0
	Blue Robin_Java_Gede	-	Gunung Gede-Pangrango, Java	12	3.50	0.57	4026.14	2875.18	1150.96	3269.45	3280.21	0	1
	Myiomela diana_25v2019_735#98_Masigit	Bas van Balen	Mount Masigit, Java	12	3.67	0.57	4025.20	2790.92	1352.83	3562.50	3546.88	0	0
	Myiomela diana_4iii2019_622#87 Patuha (1)	Bas van Balen	Mount Patuha, Java	15	4.00	0.57	4022.55	2749.38	1422.83	3537.50	3425.00	0	0
	Min				3.00	0.55	3760.90	2571.13	993.30	3186.90	3186.90	0	0
	Max				4.80	0.71	4062.19	2933.90	1467.84	3717.40	3566.66	1	1
	SD				0.43	0.06	90.56	93.82	141.58	153.29	120.78	0.38	0.48
	mean				3.74	0.62	3963.92	2760.63	1223.91	3454.67	3425.44	0.15	0.31

Table S2. ***continued***

Taxon	Filename	Recordist	Location	No. of Motifs	Average no. of elements	Motif Duration (s)	Frequency					Modulation	
							Highest	Lowest	Bandwidth	Peak	Centre	1st	2nd
sumatrana	11_Mike Nelson_Sum_Kerinci	Mike Nelson	Gunung Kerinci, Sumatra	14	7.79	1.04	6638.58	2988.29	3650.29	3509.91	3512.97	1	1
	Robin_Sumatran Blue_MN	Mike Nelson	Gunung Kerinci, Sumatra	15	8.07	1.07	6198.68	3059.87	3138.81	3861.62	3738.15	1	1
	Robin_Sunda Blue_Kerinci	James Eaton	Gunung Kerinci, Sumatra	8	11.88	1.55	7087.13	2627.18	4459.95	4801.88	3886.73	1	1
	Robin_Sunda Blue_Sumatra	James Eaton	Gunung Kerinci, Sumatra	17	7.82	1.09	5696.61	2769.15	2927.46	3962.09	3886.11	1	1
	Cinc suma 201A188	Bas van Balen	Sumatra	5	4.00	1.06	4951.54	2998.86	1952.68	3562.50	3834.38	1	1
	Cinc suma203A339	Bas van Balen	Sumatra	5	5.00	0.76	4781.70	3010.96	1727.40	3646.88	3515.62	1	1
	Min				4.00	0.76	4781.70	2627.18	1727.40	3509.91	3512.97	1	1
	Max				11.88	1.55	7087.13	3059.87	4459.95	4801.88	3886.73	1	1
	SD				2.76	0.25	920.34	171.17	1028.77	479.24	174.90	0	0
	mean				7.43	1.10	5892.37	2909.05	2976.10	3890.81	3728.99	1	1
	Isler Criterion			Criterion 1	Fail	Pass	Pass	Fail	Pass	Fail	Fail	Fail	Fail
				Criterion 2	-	Fail	Fail	-	Fail	-	-	-	-
	Two-tailed t-test			p-value	0.02	0.01	0.00	0.09	0.01	0.08	0.01	0.00	0.00

Figure S1. Sunda Blue Robin males in (A) dorsal view and (B) ventral view. Sunda Blue Robin females in (C) dorsal and (D) ventral view. In A-D, *M. d. diana* (left) and *M. d. sumatrana* (right).

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