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The delusion of stripes: A century-old mystery of five-lined sun skinks (Reptilia: Scincidae: *Eutropis*) of Peninsular India elucidated

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ABSTRACT

We re-evaluate the taxonomic identities of five-lined skinks of the genus *Eutropis* (*E. trivittata*, *E. beddomei*, *E. nagarjunensis*, and *E. bibronii*) inhabiting the Indian subcontinent. Previously it has been considered that *E. trivittata* is distributed in the western India and *E. dissimilis* in the northern India (from north-eastern India up to Pakistan). Based on our analysis, we revealed that the illustration (iconotype) of the untraceable type specimen of *E. trivittata* depicted by Hardwicke in Gray (1834) from "Dumdum" near Kolkata, West Bengal matches the typical *E. dissimilis*, also described from "Bengal". The senior synonym, *E. trivittata* is a morphologically unique species, which is also supported by divergence in the mitochondrial 12S and 16S regions. *E. trivittata* is clearly separated with divergences of 5–7% from *E. beddomei*, *E. vertebralis* and *E. nagarjunensis* for 16S rRNA. After placing *E. dissimilis* with the synonymy of *E. trivittata*, the taxonomic status of the western Indian '*E. trivittata*' required to be clarified. Therefore, we resurrect *Mabuia vertebralis* Boulenger, 1887, a junior synonym of western Indian *E. trivittata*, and redescribe its holotype collected from "Belgaum", Karnataka. Although, morphologically closest to *E. beddomei*, *Eutropis vertebralis* comb. nov. is a sister taxon to *E. nagarjunensis* with divergence of 4% in the same mitochondrial regions. Based on our update of the currently confirmed localities for *E. vertebralis* comb. nov. and *E. trivittata*, we conducted a Species Distribution Modelling (SDM) using the Maximum Entropy algorithm to predict their distribution range, and we discuss their conservation status.

1. Introduction

The skink genus *Eutropis* comprises 46 species that are diurnal, mostly ground-dwelling lizards distributed throughout tropical Asia (Barley et al., 2015). Studies in the recent past explored the phylogenetic relationships within the genus and have elucidated their evolutionary history (Datta-Roy et al., 2012; Barley et al.,

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2015). However, the genus has received little attention in terms of taxonomic revisions, compared to other saurian genera. The members of the Peninsular Indian clade of *Eutropis* as defined by Datta-Roy et al. (2012) are endemic to the Indian subcontinent and Sri Lanka (Datta-Roy et al., 2015; Batuwita et al., 2020), however one species, *E. quadricarinata* (Boulenger 1887b) is also distributed in the Indochinese peninsula (Myanmar), probably through the 'gateway' of Assam (Datta-Roy et al., 2012). Among the two Indian clades of *Eutropis*, the *E. carinata* clade/species complex comprises of eleven described species (Amarasinghe et al., 2021): *E. carinata* (Schneider 1801); *E. trivittata* (Hardwicke & Gray 1827); *E. bibronii* (Gray 1839); *E. dissimilis* (Hallowell 1857); *E. beddomei* (Jerdon 1870); *E. quadricarinata* (Boulenger 1887b); *E. ashwamedhi* (Sharma 1969); *E. nagarjunensis* (Sharma 1969); *E. innotata* (Blanford 1870); *E. lankae* (Deraniyagala 1953); and *E. resetarii* Batuwita et al. 2020. Of the eleven species included in the clade, only the last three species lack molecular data and have been included therein based on morphological similarities. Four species of the clade bear five longitudinal stripes along the dorsal and lateral aspect of the body, namely: *E. trivittata*, *E. bibronii*, *E. beddomei*, and *E. nagarjunensis*. Based on morphological, morphometric evidence (see Chandramouli et al., 2012; Amarasinghe et al., 2016a), and phylogenetic studies, the closest congeners of *Eutropis trivittata* have been identified as *E. beddomei* and *E. nagarjunensis* (see Datta-Roy et al., 2012; 2015; Srinivasulu et al., 2016). However, Amarasinghe et al. (2016b) showed that *E. nagarjunensis* is morphologically much more similar to *E. bibronii* than to *Eutropis trivittata* or *E. beddomei*.

Tiliqua trivittata was described by Hardwicke & Gray (1827), based on a single specimen collected from "Dumdum" (Dum Dum near Kolkata, West Bengal, India). The description was based on a sketch, which was not provided in the original description, but was subsequently published by Gray (1834: plate 75) and the illustration was labelled as *T. trivittata*. Jerdon (1853) attributed two specimens from "Jalnat" (Jalna, Maharashtra), India, to this species as they matched Hardwicke's illustration. Later, Jerdon (1870) stated that an "imperfect specimen" of this species collected from "Central India" still existed in the "Calcutta Museum" (now Zoological Survey of India, Kolkata). Stoliczka (1872) stated that he received two young specimens from "Pùna" (Pune, Maharashtra). Theobald (1868, 1876) cited Jerdon's record from Jalna and Stoliczka's record from Pune, and considered that *T. trivittata* represents a part of the synonymy of *T. rufescens* (Shaw 1802) [now *Eugongylus rufescens*]. Furthermore, Günther (1864) also shared a similar opinion and considered this species to be a colour variant of *Euprepes rufescens*. However, Anderson (1871) predicted that this species is more closely allied to *Euprepes macularius* than to *T. rufescens*. Boulenger (1887a) described a similar species, *Mabuia vertebralis*, based on a single specimen from Belgaum, Karnataka. Furthermore, he synonymised *T. trivittata* with *M. dissimilis* [a mistake—it should have been the other way around]. Boulenger (1890) further reported *M. vertebralis* from Poona (Pune, Maharashtra), and Jalna [referring to Jerdon (1853)], and Nagpur [referring to Blanford (1870)] records.

Euprepis dissimilis was described based on two specimens also collected from Bengal, India, and since then it has been considered a valid species. Günther (1864) described a similar species, *Euprepes monticola* from Sikkim and Himalayas, India based on two specimens [Note. *Mabuia monticola* Annandale 1905 has no relation to this taxon. It is currently a junior synonym of *Scincus multifasciatus* Kuhl 1820; *fide* Amarasinghe et al. (2018)]. Steindachner (1867) also described another similar species, *Euprepes petersii* from Chamba and Rangna (West Himalayas) based on three specimens. Theobald (1876) observed similarities between *Euprepes monticola* and *Euprepes petersii*, but he did not synonymise the latter, as he did not examine specimens. Later, Blanford et al. (1879) nominated *Euprepes guentheri* as a replacement for Günther's species name, *Euprepes monticola*, to avoid confusion with the same nomen proposed by Annandale. Fischer (1885) also described another similar species, *Euprepes warthii* from Dehradun, Uttarakhand, India, based on a single specimen. Boulenger (1887a) in his catalogue of lizards in the British Museum synonymised all of these species [*Euprepes guentheri*, *Euprepes petersii*, and *Euprepes warthii*] with *Mabuia dissimilis*. Boulenger (1887a, 1890) further considered this species to be distributed in the Plains of Northern India, from Sind to Bengal, also in the Western Himalayas. Hora & Chopra (1923) reported *M. dissimilis* from Punjab and extended its distribution further west. Ingoldby & Procter (1923) reported this species from Waziristan, Pakistan. Later, Hora (1927), based on the holotype and three paratypes, described the Panjabi population of *Mabuia dissimilis sensu lato* as a new species, *Mabuya hodgarti*. However, Smith (1935) merged it with *Mabuya dissimilis*.

In the same publication, Smith (1935) resurrected *Mabuya trivittata* from the synonymy of *M. dissimilis* which was mistakenly synonymized by Boulenger (1887a) disregarding the priority principle. Besides, Smith (1935) synonymised Boulenger (1887a) species, *M. vertebralis* with *M. trivittata*. Mausfeld et al. (2002) and Mausfeld & Schmitz (2003) transferred the Asian *Mabuya* to the genus *Eutropis*. Subsequent authors extended the distribution of these species, *E. trivittata* and *E. dissimilis* based on several new records. *Eutropis dissimilis* has been considered to be widely distributed in Northern India (Tikader & Sharma, 1992; Vyas & Patel, 1992; Das, 1996; Pawar & Birand, 2001; Chandra & Gajbe, 2005; Bauer et al., 2008; Saikia et al., 2007; Manhas et al., 2016a,b; Patel & Vyas, 2019; Boruah et al., 2020; Deuti et al., 2020; Ingle, 2020; Sahi & Koul, 2020), Pakistan (Khan, 2004; Baig et al., 2008; Rais et al., 2015; Sahi & Koul, 2020), Afghanistan (Clark et al., 1969), Bangladesh (Husain and Ahmed, 1974; Islam et al., 2016, Khan et al., 2016; Rabbe et al., 2017), and Nepal (Zug & Mitchell, 1995; Bhattarai et al., 2017; 2018; Rawat et al., 2020). In addition, Zug et al. (1998) reported this species from North−central Myanmar. However, Datta-Roy et al. (2012, 2015) showed that "*Eutropis dissimilis*" from Myanmar is genetically allied to *Eutropis novemcarinata* (= now *Toenayar novemcarinata*) and phylogentically not allied to *Eutropis*, but to the arboreal skink genus *Dasia* Gray 1839. Deuti et al. (2020) considered *E. dissimilis* to be distributed throughout northern India including Kashmir, Punjab, Haryana, Rajasthan, Gujarat, Uttarakhand, Uttar Pradesh, Madhya Pradesh, Maharashtra, Chhattisgarh, Bihar, Jharkhand, Odisha, West Bengal, Sikkim, Assam, and Arunachal Pradesh. However, based on the body size of the individuals of this species across its distribution range [*fide* Sharma (2002), Schleich et al. (2002), Greer et al. (2004) vs. Khan (2006)], Bauer et al. (2008) suggested it is either a significant clinal variation in the western part of the species range or that there is an existence of more than one biological entity masquerading under the name *Eutropis dissimilis*. This was indicated by Minton (1966) and Amarasinghe et al. (2021) who stated that eastern (north-eastern India) and western (Pakistan) specimens of *E. dissimilis* were distinctly different in morphometry.

Eutropis trivittata on the other hand has been reported from Maharashtra State, as well as Karnataka, Andhra Pradesh, Jharkhand, Odisha, and north-eastern Tamil Nadu (Tikader & Sharma, 1992; Das, 1996; Rajasekaran et al., 2002; Sharma, 2002; Chikane, 2011; Seetharamaraju et al., 2011; Srinivasulu et al., 2014; Ashaharraza & Kaur 2018; Deuti et al., 2020). However, some of the above reports are in doubt due to the misidentification of the species involved because of the acceptance of the general overall superficial similarity with other close congeners. Such instances have caused confusion about not only the identity but also the

respective distribution, of the species involved—see discussion. Therefore, we here re-evaluate the taxonomic identity and distribution of *E. trivittata* along with the other five-lined *Eutropis* to more precisely define its geographic range and correct previous misidentifications.

Deuti et al. (2020) erroneously stated that NHMUK 1946.8.18.34 is the holotype of *E. trivittata*, but it is actually the holotype of *Mabuia vertebralis* collected from Belgaum, since the description of *Eutropis trivittata*, no type specimen has been recognised in any museum collection. The only available original material for this *nomen* is the original description written by Hardwicke & Gray (1827) and the illustration of the holotype depicted by Hardwicke in Gray (1834). In the present work, we compare Hardwicke's illustration with original descriptions and specimens (including types) of other congeners of the genus *Eutropis* and re-evaluate its taxonomic status. We re-asses the systematic status of the rest of five-lined *Eutropis* in Indian Peninsula based on both morphological and molecular evidences. Furthermore, based on the current distribution pattern, we conduct a Species Distribution Modelling (SDM) using the Maximum Entropy algorithm in the MaxEnt software to predict the habitat distribution of the species revised. We also update the conservation status of the species using the criteria of the IUCN Red List (IUCN Standards & Petitions Subcommittee, 2019).

2. Material and methods

2.1. Morphological, morphometric, and meristic characters

We examined all the type material (including types of synonyms) and voucher specimens of the *E. carinata* species complex (Appendix 1) in the collections of the Academy of Natural Sciences of Philadelphia, USA (ANSP), Bombay Natural History Society, Mumbai, India (BNHS), Madras Government Museum, Chennai, India (MAD), Muséum national d'Histoire naturelle, Paris, France (MNHN-RA), Natural History Museum, London, UK (NHMUK), Naturhistorisches Museum, Wien, Austria (NMW), Staatliches Museum für Naturkunde, Stuttgart, Germany (SMNS), Museum für Naturkunde, Berlin, Germany (ZMB), Zoologisches Museum Hamburg, Germany (ZMH), and Zoological Survey of India, Kolkata, India (ZSI). Museum acronyms follow Uetz et al. (2019) and acronyms in Ganesh (2010) and Ganesh et al. (2020). We compared the holotype of *Eutropis vertebralis* comb. nov. to all the congeners of the genus and relevant historical specimens of this species. We obtained morphometric and meristic data for the species and checked the external morphology of specimens under a stereomicroscope (Wild M3Z, M8, Zeiss DRC, AmScope SM-1BZ-RL). Sex was not determined unless the hemipenes were everted.

We scored specimens for the same morphological and morphometric characters used in recent descriptions by Amarasinghe et al. (2016a, b; 2017; 2018; 2020; 2021). Measurements were taken with Mitutoyo digital calipers to the nearest 0.1 mm, under a dissecting microscope, on the left side of the body for symmetrical characters; we measured snout–vent length (SVL, from tip of snout to anterior margin of vent), tail length (TAL, from the posterior margin of vent to the tip of tail), axilla–groin length (AG, from the posterior margin of the forelimb at its insertion point on the body to the anterior margin of the hind limb at its insertion point on the body), head length (HL, from posterior edge of mandible to tip of snout), head width (HW, maximum width of head at the angle of the jaws), orbit diameter (ED, the greatest horizontal diameter of the orbit); tympanum–eye length (TYE, from posterior border of orbit to anterior border of tympanum), snout length (ES, from anterior border of orbit to tip of snout), eye–nostril length (EN, from anterior border of orbit to the middle of narial opening), femur length (FEL, from the anterior margin of the hind limb at its insertion point on the body to the knee, while flexed), tibia length (TBL, from the posterior surface of the knee, while flexed, to the base of the heel), toe and finger length (TL and FL respectively, from tip of claw to the nearest fork). We counted supralabial and infralabial scales from the rictus to the rostral and mental plates (excluded), respectively. Our counts of ventrals include all scales from the postmental (excluded) to the last ventral scale bordering the vent (not including the anal scale). We counted paravertebral scales between the postparietal (included) to the posterior margin of the thigh, in a straight line immediately left of the vertebral column. Subdigital lamellae on toe IV were counted from the first proximal enlarged scansor wider than the width of the largest palm scale to the distal-most lamella at the base of the claw. We counted the number of longitudinal scale rows (ventral and dorsal combined) at midbody.

2.2. Morphometric analysis

Statistically informative tests could not be performed on separate sexes because the animals were not sexed unless hemipenes were everted, and also the small sample sizes rendered insufficient numbers for this purpose. Therefore, 70 adult voucher specimens of the species which have five, prominent, longitudinal, dark-margined pale stripes along the dorsum and lateral body were used for the statistical analysis: *E. beddomei* ($n = 21$); *E. bibronii* ($n = 38$); *E. nagarjunensis* ($n = 6$); and *E. vertebralis* comb. nov. ($n = 5$) (Appendix 1). A detailed analysis and comparison of all other congeners of the *E. carinata* group will be discussed elsewhere (Amarasinghe et al. in review). These samples include (i) the syntypes of *E. bibronii* including the types of the synonym, *Euprepis trilineatus* Gray, 1846, (ii) the holotype and paratypes of *E. nagarjunensis*, (iii) the holotype of *E. vertebralis* comb. nov., and (iv) the holotype of *E. beddomei* including the types of the synonym, *Euprepes septemlineatus* Blanford 1870 in order to the morphometric variation and taxonomic disparity. Juveniles were excluded from the statistical analysis to avoid the bias of allometry. We performed the Kruskal–Wallis univariate analysis of variance tests on seven different morphometric ratios (HW/SVL, ES/HW, TYE/HW, ED/HW, ED/ES, TYE/ES, and TBL/SVL) in order to detect any morphometric differences between the above four species. Each morphometric ratio was treated as the dependent variable and the population as the predictor variable.

Principal Components Analysis (PCA) was also performed on the same morphometric ratios above to reduce the highly correlated multidimensional data matrix into a few uncorrelated variables [*i.e.*, principal components (PC)]. We used the princomp and k-means functions in the R statistical software program (v4.0.4; R Core Team, 2021) based on a correlation matrix of seven morphometric ratios. Biplots of the first two principal component scores were used to examine the morphometric differentiation between the populations. All the distribution records are based on the data associated with the museum specimens examined.

2.3. Phylogenetic analysis

Molecular data for the mitochondrial gene fragments 16S rRNA and 12S rRNA were taken from published studies (Datta-Roy et al., 2012; 2015; Srinivasulu et al., 2016; Table 1). Two species of the genus *Emoia* were used as outgroup and the resultant phylogeny is congruent with results recovered in earlier studies of the "Peninsular Indian clade" of *Eutropis* (Datta-Roy et al., 2012; 2015; Srinivasulu et al., 2016). Sequences were aligned in MegaX (Kumar et al., 2018) using ClustalW (Thompson et al., 2003) with default settings. The aligned sequences were concatenated using SequenceMatrix (Vaidya et al., 2011). The aligned dataset was subject to

Table 1
Genbank accession numbers for sequences used in molecular phylogenetic analysis; — not available.

Species	Locality	12S	16S
Dasia johnsinghi	Mundanthurai plateau, Tamil Nadu, India	JN990817	JN990812
Dasia vittata	Matang, Borneo	AB028771	AB028782
Emoia caeruleocauda	Palau Islands	AB028801	AB028813
Emoia cyanura	Sigatoka, Fiji	AY218018	AY217968
Eutropis allapallensis	Bondla WLS, Goa, India	JQ767975	JQ767959
Eutropis cf. *allapallensis* 1	Sharavathi valley WLS, Karnataka, India	JQ767976	JQ767960
Eutropis cf. *allapallensis* 2	Satkosia WLS, Orissa, India	JQ767977	JQ767961
Eutropis beddomei	Deomali, Orissa, India	JQ767970	JQ767965
Eutropis bibronii	Rushikulya, Orissa, India	JQ767979	JQ767963
Eutropis borealis	Luzon, Philippines	AY159052	AY159081
Eutropis carinata	Kodaikanal, Tamil Nadu, India	AY070336	AY070354
Eutropis clivicola	Parambikulam WLS, Kerala, India	JQ767978	JQ767956
Eutropis cumingi	Luzon, Philippines	DQ239218	DQ238896
Eutropis trivittata	Thatta, Thatta District, Sindh, Pakistan	–	KX364958
Eutropis trivittata	Bankura, West Bengal, India	KT633602	KT633604
Eutropis indeprensa	NW Panay, Philippines	AY159047	AY159076
Eutropis longicaudata	Phong Nha-Ke Bang, Vietnam	AY070341	AY070359
Eutropis macrophthalma	Java, Indonesia	AY159048	AY159077
Eutropis macularia	Bagdogra, West Bengal, India	JQ767973	JQ767957
Eutropis cf. *macularia*	Ponmudi, Kerala, India	JQ767974	JQ767958
Eutropis madaraszi	Sri Lanka	AY159051	AY159080
Eutropis multifasciata	Kaziranga WLS, Assam, India	JQ767981	JQ767964
Eutropis nagarjunensis	Nagarjunasgar, Andhra Pradesh, India	JQ767972	JQ767952
Eutropis quadricarinata	Chattin, Myanmar	AY159060	AY159089
Eutropis rudis	Bogani Nani Wartabone NP, Sulawesi	AB028779	AB028790
Eutropis rugifera	Mt. Harriat, Andaman Is. India	AY159050	AY159079
Eutropis vertebralis	Satara, Maharashtra, India	JQ767971	JQ767951
Eutropis tytleri	Mt. Harriat, Andaman island, India	AY159045	AY159074
Toenayar novemcarinata	Myanmar	KT633603	KT633605
Trachylepis hoeschi	Namibia	AY218013	AY217963
Trachylepis spilogaster	Erongo region, Namibia	AY218009	AY217959

phylogenetic analysis with the IQ-TREE (http://iqtree.cibiv.univie.ac.at/) online portal (Minh et al., 2020). Sequence substitution model was selected using the auto parameter with provision for FreeRate heterogeneity and the analysis was run with an ultrafast bootstrap option for 1000 iterations to assess clade support (Kalyaanamoorthy et al., 2017). The partitioning scheme was TIM2+F+I+G4 and TIM+F+I+G4 for 12S and 16S respectively. The tree was visualized and edited in FigTree (Rambaut, 2012). Uncorrected *p*-distance was calculated in MegaX and missing data or gaps were dealt with the pairwise-deletion option.

2.4. Habitat prediction

We conducted a Species Distribution Modelling (SDM) using the Maximum Entropy algorithm in the MaxEnt software (Phillips et al., 2004). We used 60 locality records for *E. trivittata* (previously *E. dissimilis*) and 20 locality records for *E. vertebralis* comb. nov. (previously *E. trivittata*). We used 17 bioclimatic variables (Table 2) sourced from the WordlClime Database (Hijmans et al., 2005) for each species. We sourced geocoordinates in decimal degree format, corrected up to four decimal places, from GoogleEarth software, by plotting the published data points (see maps in Ashaharraza & Kaur 2018; Deuti et al., 2020). We rendered the output files (GRD and GRI files) from the MaxEnt in DIVA-GIS software and rounded off the logistic values of the predictions to the nearest increment of 5 to obtain a map depicting the spatial distribution.

3. Results

3.1. Taxonomy

We revisited the Peninsular Indian records of *Eutropis trivittata*, a species described from “Bengal” (precisely from Dum Dum near Kolkata in northeastern India), but especially those reported to be from the western and southern parts of the country. We examined the *Eutropis* collections at Zoological Survey of India and other European museums where the type may have been available, but we were not able to trace any type specimens of *Tiliqua trivittata*. It is hence considered lost. Therefore, the only available original explanation for this nomen is the original description and the illustration of the holotype depicted (iconotype; Fig. 1) by Hardwicke in Gray (1834). The textual description given by Hardwicke & Gray (1827) did not provide enough diagnostic characters to separate the species from any of its congeners. There cannot be any doubt about the type locality of *Eutropis trivittata* as it was given with precision in the original description.

Here we compare that original illustration (Fig. 1) with all the known congeners of *Eutropis* and based on our comparison, the illustration of Hardwicke perfectly matches that of *E. dissimilis*, which was described by Hallowell (1857), also from West Bengal. Closer scrutiny of Hardwicke's illustration of the species revealed the following characters: (1) dark brown dorsum, laterally paler, (2) only two keels depicted on the dorsal scales, (3) presence of a pale vertebral and a dorsolateral stripe, but absence of a lateral stripe of the body, (4) both vertebral and dorsolateral stripes start from the nape but do not reach the head, (5) a prominent dark-margined subocular stripe on supralabials, (6) continuous dark spots besides the vertebral and dorsolateral stripes along the body, and (7) some dark scattered markings on the flanks. The combination of the above characters perfectly and undoubtedly matches that of the specimens previously treated as *E. dissimilis*.

Therefore, it is clear that the two nominal taxa *E. trivittata* and *E. dissimilis* both refer to the same species and one must be placed in synonymy. In agreement with the principle of priority, Article 23 of the Code (ICZN 1999), *E. trivittata* has priority over *E. dissimilis*, therefore we synonymise *E. dissimilis* with *E. trivittata*. Simultaneously, the distinct population of *Eutropis*, which differs from *E. dissimilis* [now *E. trivittata*] and is distributed in western India,

Table 2
Percentage contribution of bioclimatic and physiographic variables to the model for *Eutropis vertebralis* comb. nov. and *E. trivittata*; — not assessed.

No	Variable	*Eutropis vertebralis*		*Eutropis trivittata*	
		Percent contribution	Permutation importance	Percent contribution	Permutation importance
1	Elevation in meters above sea level	10.7	0	–	–
2	Annual mean temperature	–	–	8.3	1.8
3	Mean diurnal range (mean of max-min temperature)	0.5	0	1.7	2
4	Isothermality	6.1	0	1.9	55.8
5	Temperature seasonality	25.9	66.4	20.1	0.8
6	Max temperature of warmest month	5.3	7.6	–	–
7	Min temperature of coldest month	2.3	8.9	–	–
8	Temperature annual range	0.5	0	–	–
9	Mean temperature of wettest quarter	0.2	0.9	5.9	2
10	Mean temperature of driest quarter	2.5	0	–	–
11	Mean temperature of warmest quater	–	–	7.9	0.1
12	Mean temperature of coldest quarter	6.1	1.5	1.2	0.3
13	Annual precipitation	14.1	1.9	–	–
14	Precipitation of wettest month	0.4	0	36	2.7
15	Precipitation of driest month	10.9	0.1	–	–
16	Precipitation seasonality	6.1	6.9	10.4	0.1
17	Precipitation of wettest quarter	–	–	2.1	0
18	Precipitation of driest quarter	2.4	1.4	–	–
19	Precipitation of warmest quarter	4.7	1.1	–	–
20	Precipitation of coldest quarter	1.9	3.2	1.7	0.4

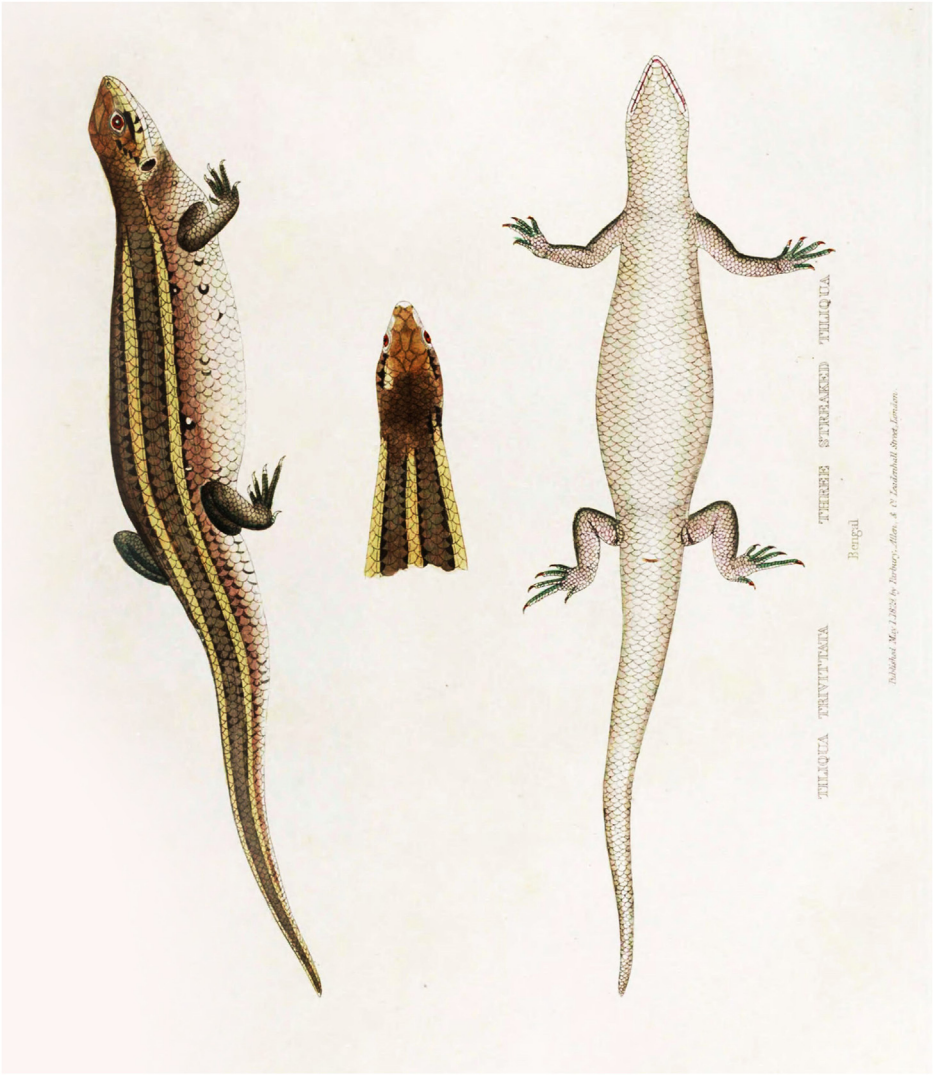

Fig. 1. Hardwicke's illustration of *Tiliqua trivittata* (probably of the lost holotype) in Gray (1834); reprinted from Gray, 1834 [Illustrations of Indian Zoology, chiefly selected from the collection of Major General Hardwicke II, London: pl. 75].

requires a nomen. Hence the historical nomen available for this population, *Mabuia vertebralis* Boulenger 1887a (type locality: Belgaum, Karnataka, India), currently in synonymy with *E. trivittata*, is resurrected and applied to the western population, as a species of the genus *Eutropis*. We redescribe hereafter *E. vertebralis* comb. nov. based on its holotype, and *E. trivittata* based on the syntypes of its oldest junior synonym, *E. dissimilis*.

3.2. Morphometric analysis

The morphometric ratio mean comparisons using Kruskal–Wallis test between *E. vertebralis* comb. nov. ($n = 5$) and *E. beddomei* ($n = 21$) showed significant differences with P value <0.001 in HW/SVL ($\chi^2 = 20.35$), ES/HW ($\chi^2 = 34.6$), TYE/ES ($\chi^2 = 35.38$), and TBL/SVL ($\chi^2 = 32.96$). Between *E. vertebralis* comb. nov. and *E. beddomei*, the highly correlated character ratios are ES/HW and HW/SVL (Fig. 2). The ES/HW of *E. vertebralis* comb. nov. was significantly smaller, indicating a relatively wider head and shorter snout than that of *E. beddomei* (Fig. 2A). Additionally, HW/SVL of *E. vertebralis* comb. nov. was significantly higher, indicating a relatively shorter body than that of *E. beddomei* (Fig. 2B). Also, the same character ratio indicates the relatively robust and shorter body habitus of *E. vertebralis* comb. nov. compared to that of *E. beddomei* which has a relatively slender and long body.

Principal component analysis also showed overall differences in morphometric characters between *E. vertebralis* comb. nov. and *E. beddomei* with more or less overlapping clusters (Fig. 3). However, *E. bibronii* + *E. nagarjunensis* and *E. vertebralis* comb. nov. are morphometrically distinct, and *E. vertebralis* comb. nov. is non-overlapping in cluster with *E. nagarjunensis* (Fig. 3). Principal components 1 and 2 (PC1 vs. PC2) collectively explained 66.7% of the variation in the morphometric data matrix (Table 3) with largely overlapping clusters between *E. vertebralis* comb. nov. and *E. beddomei* (Fig. 3A), while Principal components 2 and 3 (PC2 vs. PC3) collectively explained 46.6% (Table 3) with slightly overlapping clusters (Fig. 3B). Morphometric ratios HW/SVL, ED/HW, ED/ES, and TBL/SVL loaded positively with principal component 1 while ES/HW, TYE/HW, and TYE/ES loaded negatively with principal component 1.

3.3. Phylogenetic analysis

Molecular phylogenetic analysis was conducted on mitochondrial DNA sequences comprising of 866bp of 12S rRNA (407bp) and 16S rRNA (459bp). The clade containing *E. carinata* and the striped species from Peninsular India form a moderately supported clade from other congeners (ML bootstrap 97). *E. carinata* is basal in relationship to the members of the clade, which also contain *E. vertebralis* comb. nov., *E. ashwamedhi*, *E. beddomei*, and *E. trivittata* (ML bootstrap 79). Two representatives of *E. trivittata*, one each from the north-eastern India and Pakistan are genetically similar (ML bootstrap 100) and are recovered as sister to the clade containing *E. vertebralis* comb. nov., *E. ashwamedhi* and *E. beddomei* (ML bootstrap 91) (Fig. 4). *E. vertebralis* comb. nov. is sister to *E. nagarjunensis* with high support (ML bootstrap 99).

3.4. Habitat prediction for E. vertebralis comb. nov.

Our SDM analysis with 20 locality points (Fig. 5, Table 2) revealed an extensive area in western India covering the northern Western Ghats and parts of the Deccan Plateau, as the potential distribution envelope of *Eutropis vertebralis*. The highest prediction is in the northern Western Ghats, consisting of the Nashik-Pune-Kaas-Satara area where there is a prediction of an 80–100% for *E. vertebralis*. Other high predictions occur around the geographical blocks of Mudumalai-Bandipur-Gundlupet, the Shivamogga, and the Belgaum-Gokak. However, some areas where there are recorded localities still reveal rather low predictions. Examples include the coastal record from Ratnagiri (40–60% predictions) and the much distant, easterly records spanning Khamgaon-Pauni (60–80% predictions). Surprisingly, high predictions (80–100%) showed up in large areas (500 km) devoid of any records, both historical and recent, between Belgaum and Gundlupet, covering much of the leeward slopes of the Central Western Ghats in Karnataka State, especially near Hassan-Davangere and to some extent near Hubli. This whole ensemble of high prediction areas was embedded within a zone of moderate (60–80%) prediction that almost covers the entire Western Ghats from Coimbatore to Vadodara. Overall, the SDM exercise yielded results that are partly consistent with our expectations of *E. vertebralis* being a species predominantly inhabiting the northern Western Ghats, but also revealing a potentially new location on the leeward slopes of the Malnad region, so far devoid of *E. vertebralis* records, where the prediction is even higher than the much-recorded eastern parts of Maharashtra (see Ashaharraza & Kaur, 2018). The Area Under the Curve (AUC) value was 95% in training data and 50% in random prediction. The bioclimatic variables that contributed most to these results were Temperature Seasonality (25.9%), Annual Precipitation (14.1%),

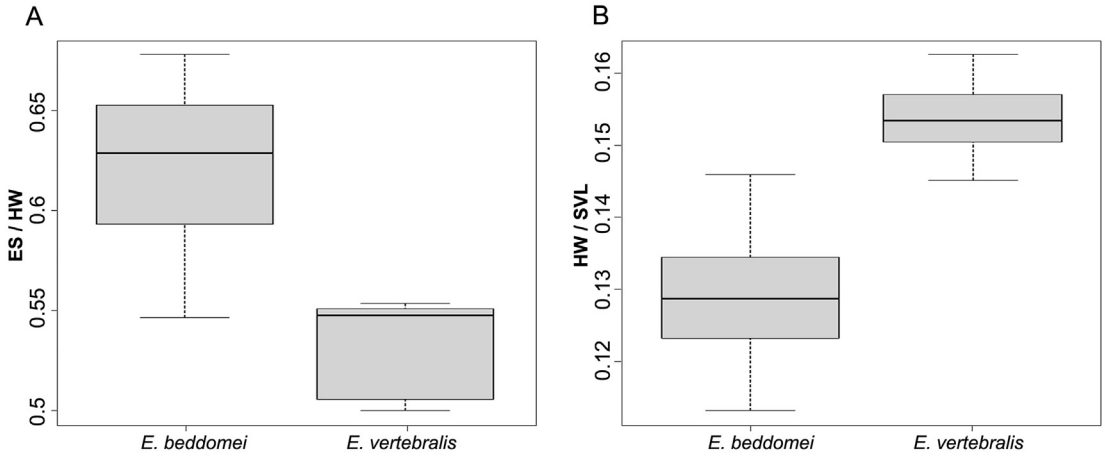

Fig. 2. Boxplots of two morphological character ratios (A) ES/HW and (B) HW/SVL, whose distributions did not overlap between *E. vertebralis* ($n = 5$) and *E. beddomei* ($n = 21$); top, middle and bottom lines of the boxes indicate 75th percentile, median and 25th percentile, respectively.

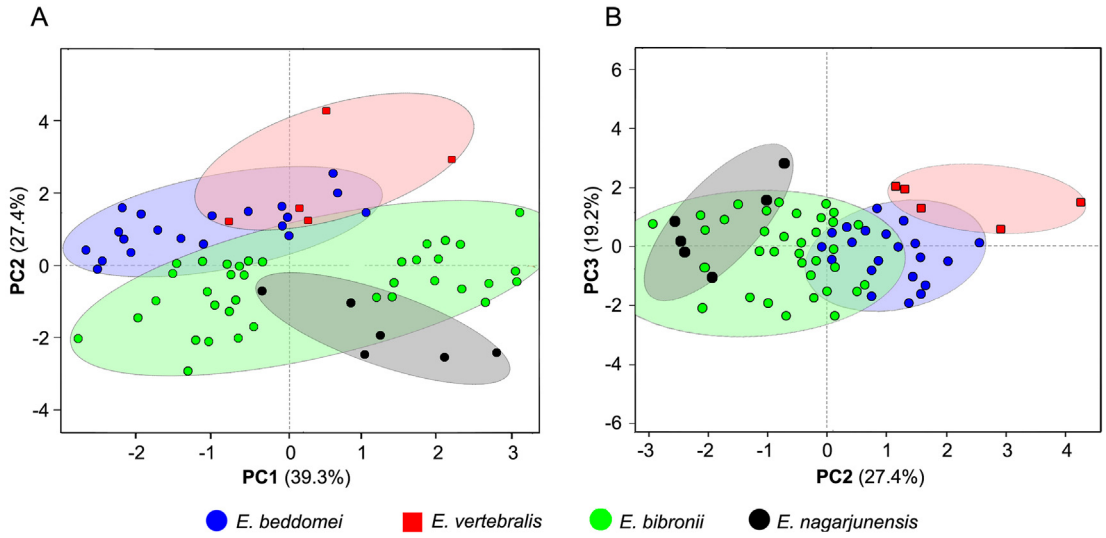

Fig. 3. (A) PC1 vs PC2 and (B) PC2 vs PC3 of *E. bibronii*, *E. nagarjunensis*, *E. beddomei*, and *E. vertebralis* from different locations in India, each point represents a specimen; and the relative distances between two points represent the similarity.

Table 3
Principal Components Analysis (PCA) and loadings. Principal components (PC) 1 and 2 collectively explained nearly 66.7% of variation. SVL = snout–vent length; HW = head width; ED = eye diameter; ES = snout length; TYE = eye – tympanum distance; TBL = tibia length.

PCA variable	PC1	PC2	PC3	PC4	PC5	PC6	PC7
Standard deviation	1.6583	1.3844	1.1607	0.8251	0.5446	0.0818	0.0480
Proportion of variance	0.3928	0.2738	0.1925	0.0973	0.0424	0.0010	0.0003
Cumulative proportion	0.3928	0.6666	0.8591	0.9563	0.9987	0.9997	1.0000
Loadings							
HW/SVL	0.3740	0.0756	0.4541	−0.5915	−0.5460	0.0140	0.0032
ES/HW	−0.1155	−0.6490	−0.2512	0.0777	−0.4701	−0.3924	0.3483
TYE/HW	−0.5196	−0.0512	−0.3152	−0.3939	−0.2017	0.0198	−0.6570
ED/HW	0.3873	0.0014	−0.6514	−0.0749	−0.1787	0.6104	0.1243
ED/ES	0.4122	0.3774	−0.4295	−0.0998	0.0671	−0.6867	−0.1307
TYE/ES	−0.4554	0.3615	−0.1498	−0.4599	0.1149	−0.0255	0.6435
TBL/SVL	0.2224	−0.5453	−0.0067	−0.5117	0.6249	−0.0235	−0.0160

Precipitation of the Driest Month (10.9%) and Elevation in Meters above Sea Level (10.7%).

3.5. Habitat prediction for E. trivittata

Our SDM analysis with 60 locality points (Fig. 6, Table 2) revealed a very large area in the northern part of the Indian subcontinent covering the Indus Valley of Pakistan in the west, the Indo-Gangetic Plains, the Terai Plains of India–Nepal on to the Brahmaputra Basin of India–Bangladesh, extending south up to the Bastar plateau in the Indian Peninsula. While this large region is projected as the realized range of this species, the highest (70–100%) prediction of its occurrence is densely concentrated in the single contiguous block of the Indo-Gangetic Plains extending roughly across Jammu-Gwalior-Faizabad. The next range of prediction (50–70%) covered areas from Peshawar near the Kashmir hills in the west all the way through the Sikkim-Bhutan border in the east, extending south up to the Bastar Plateau in the Indian Peninsula. But for the Kashmir region, this range of prediction was totally absent in areas west of Gwalior, indicating that the dry North-Western Frontier zone is not that suitable for this species. Records from the Indus Valley tracts in the far western edge of its range, abutting Gujarat near the Gulf of Kutch are all present outside the optimal prediction envelope (>50%). Similarly, most of the records in the Far East along the Indo-Burma border in the Eastern Himalaya-Purvanchal Hill complex are also present outside the optimal prediction envelope. Likewise, in the south, the southernmost records from Chattisgarh, just north of the Godavari River are also outside the optimal prediction envelope. Overall, the SDM exercise yielded results that are partly consistent with our expectations of this species predominantly inhabiting Northern India and adjacent regions in the Indus Valley (Pakistan) to the Eastern Himalaya (Bhutan). The Area Under the Curve (AUC) value was 99% in training data and 50% in random prediction. The bioclimatic variables that contributed most to these results were Precipitation of wettest month (36%), Temperature Seasonality (20.1%) and Precipitation Seasonality (10.4%). Most importantly, the type locality 'Dum Dum' falls within the higher (50–70%) prediction envelope, supporting the hypothesis of conspecificity between *E. trivittata* and *E. dissimilis sensu auctorum*.

Eutropis vertebralis (Boulenger 1887a) comb. nov.
(Figs. 2–5, 7–10; Tables 1–5).

Lacerta rufescens Shaw 1802 [*Partim*].
Tiliqua trivittata — Jerdon, 1853; Theobald 1868.
Euprepes trivittatus — Blanford, 1870; Stoliczka 1872; Theobald 1876.
Eumeces trivittatus — Anderson, 1871.
Mabuia vertebralis Boulenger 1887a.
Mabuia vertebralis — Boulenger, 1890.

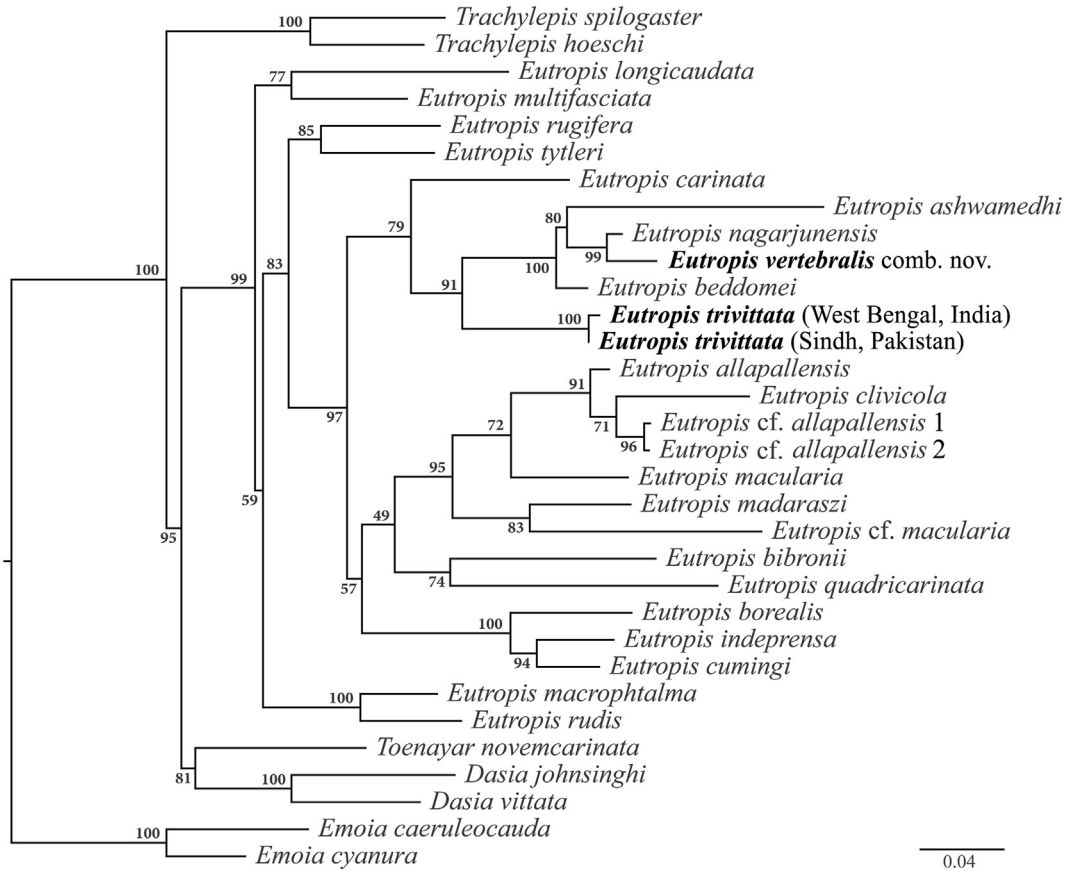

Fig. 4. Maximum likelihood phylogeny based on mitochondrial 12S rRNA and 16S rRNA for selected members of Scincidae. Numbers at nodes represent bootstrap support for clades based on 1000 bootstrap replicates from an ultrafast search method.

Mabuya trivittata — Smith, 1935; Chopra, 1964; Tikader & Sharma, 1992; Das, 1996; Rajasekaran et al., 2002; Sharma 2002. *Eutropis trivittata* — Mausfeld et al., 2002; Mausfeld & Schmitz, 2003; Chikane, 2011; Seetharamaraju et al., 2011; Datta-Roy et al., 2012, 2015; Srinivasulu et al., 2014; Ashaharraza & Kaur, 2018; Deuti et al., 2020; Amarasinghe et al., 2021.

Holotype.—Adult male, NHMUK 1946.8.18.34 (formerly 1933.6.25.1), SVL 64.4 mm, collected from Belgaum (15°50′58.90″N, 74°29′51.63″E, datum = WGS84; 763 m above sea level), Karnataka, India, by Andrew Leith Adams—see the discussion, probably between 1849 and 1854 [Deuti et al. (2020) mistakenly identified this specimen as the holotype of *Eutropis trivittata*].

Diagnosis.—A combination of the following characters distinguishes *Eutropis vertebralis* comb. nov. from all other congeners: adults SVL up to 78.7 mm, presence of vertebral, dorsolateral, and lateral longitudinal black-edged, white stripes, tri-to quinquecarinate mid dorsal scales, absence of nuchal pair, four preauricular lobules, absence of transparent disc on the lower eyelid, 33–36 midbody scale rows, 57–63 ventrals, 50–55 paravertebrals, 12–14 lamellae beneath forth toe, absence of postnasal scale, and keeled temporal scales.

Comparison.—A species of *Eutropis* inhabiting parts of the Deccan Plateau, characterised as follows: differs from various regional congeners in having a vertebral stripe (vs. absent in *E. carinata*, *E. innotata*, *E. macularia*, *E. allapallensis*); differs from congeners with a vertebral stripe as follows: flanks between the creamy dorsolateral and lateral stripes brown, same as general body colour (vs. flanks covered by a distinct black band in *E. beddomei*); keeled temporals (vs. smooth); nuchals absent (vs. present); *E. vertebralis* comb. nov. has generally more ventrals (57–63) than *E. beddomei* (53–59); lacks transparent disc on the lower eyelid (vs. disc present in *E. bibronii* and *E. nagarjunensis*), postnasal absent (vs. present), nuchals absent (vs. present), and having four pre-auricular lobules (vs. three), fourth toe subdigital lamellae 12–14 (vs. > 15), paravertebrals 50–55 (vs. < 41), ventrals 57–63 (vs. < 52); absence of distinct subocular stripe (vs. present in *E. trivittata*/*E. dissimilis*); stripes extending across nuchal region (vs. nuchal region rather uniform and devoid of stripes).

Redescription of holotype.—Head moderately long, HL 21.7% of SVL, narrow, HW 60.0% of HL, HW 13.0% of SVL, indistinct from neck; snout short, ES 35.0% of HL, ES 58.3% of HW, slightly convex in lateral profile; rostral shield large, hemispherical, distinctly visible from above, posterior margin of midpoint rounded; frontonasal completely separated from rostral; frontonasal wide, lateral border narrowly touching first loreal; prefrontals narrowly separated, contacting frontal and frontonasal, shorter than frontonasal in length, laterally contacting both loreal scales, posterior border contacting first supraciliary, first supraocular and frontal; frontal large, elongate, subtriangular, rounded posteriorly, length equal to frontoparietals and interparietal combined; frontoparietals two, in contact, larger than interparietal; parietals large and completely separated by interparietal, contacting pretemporal scales anterolaterally; all head scales smooth; nuchals absent. Nostril large and placed posterior of nasal plate; supranasal single, widely in contact; loreals two, anterior contacting nasal, supranasal, frontonasal, prefrontal, posterior loreal, and first and second supralabials;

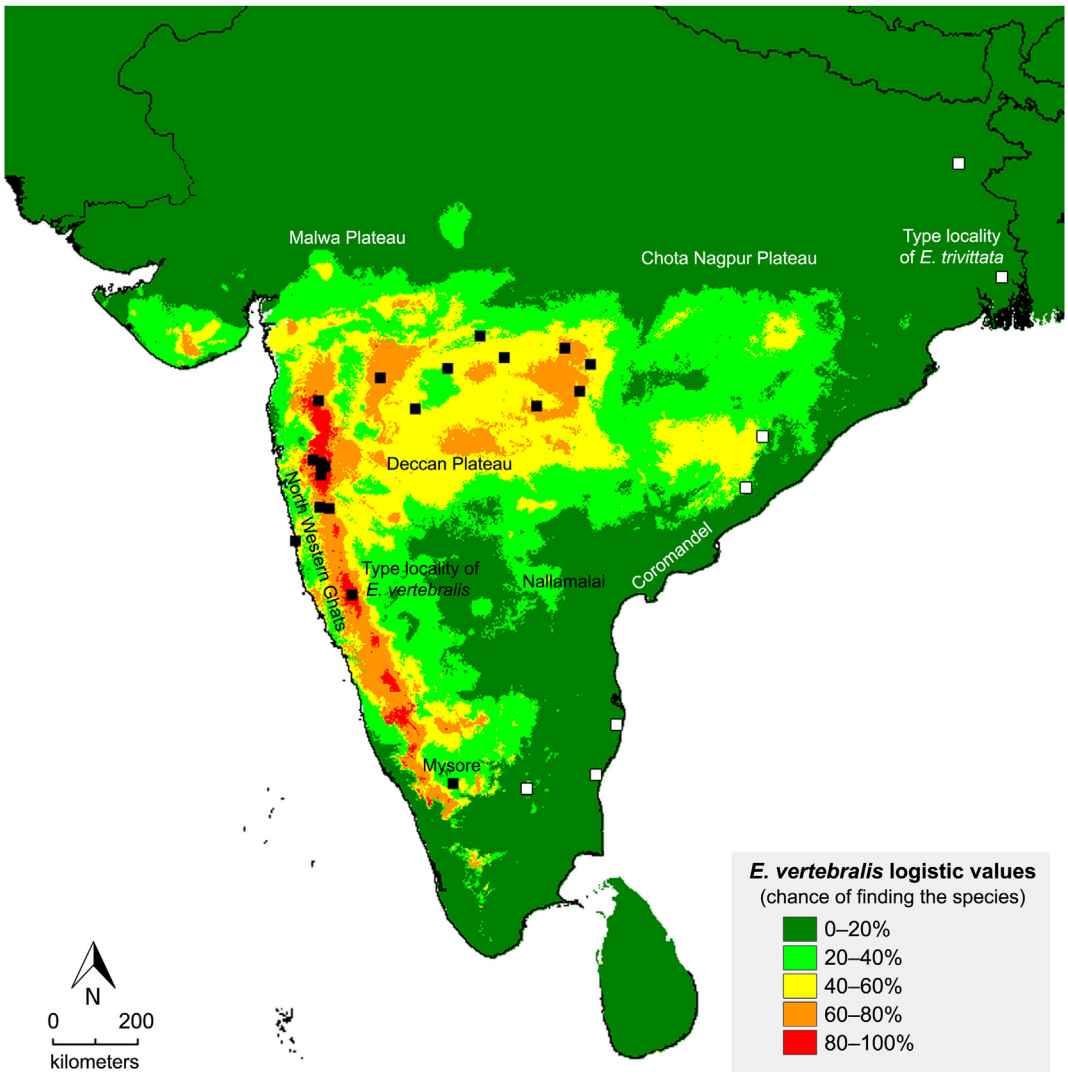

Fig. 5. The recorded (black squares) and predicted (coloured) distribution range of *Eutropis vertebralis* comb. nov. as calculated by Distribution Modelling in MaxEnt overlaid on a DIVA-GIS output map; different colours show the percentage probability (see figure legend) of finding the species in a random locality within the range; the misidentified specimen localities in previous publications are shown in white squares. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

posterior loreal longer than anterior loreal in the longitudinal axis, contacting prefrontal, first supraciliary, preocular, anterior presubocular, second and third supralabials; presuboculars two; eye large, ED 20.7% of HL; eye diameter smaller than eye–tympanum distance, ED 74.3% of TYE, pupil rounded; interorbital distance broad; postoculars three, small; supraoculars four, all wide, second longest in the longitudinal axis and widest in the transverse axis, 1st supraocular in contact with prefrontal and frontal, 2nd in contact with frontal and frontoparietal, 3rd in contact with frontoparietal, 4th in contact with frontoparietal and parietal; supraciliaries seven; eyelid moveable, lower eyelid scaly mostly covered with three enlarged scales.

Supralabials seven, fifth largest at the mid orbit position, and contacting granular scales of lower eyelid; temporals keeled, single pretemporal; two primary temporals, secondary temporals three; infralabials six; ear opening large, approximately one fifth ED, deep, nearly round; three tiny pre-auricular lobules on anterior tympanum, first two larger and prominent. Mental large; postmental single, large; two pairs of chin shields, each pair separated in midline by gular scales, first chinshield in contact with second and third infralabial scales, the second pair in contact with third and fourth infralabials.

All dorsal scales are slightly quinquecarinate (three median keels prominent) but varies from three to seven keels along the body; all scales slightly imbricate; body slender, elongate; midbody scale rows 33; paravertebral scales 50; ventrals 58; preanal scales enlarged, five.

Forelimbs short, hind limbs relatively long, FEL 18.8% of SVL, TBL 15.1% of SVL; thigh longer, TBL 80.2% of FEL; dorsal surfaces of fore and hind limbs slightly quinquecarinate; subdigital lamellae of toe IV: 13; relative length of fingers IV> III> II> V> I; those of toes IV> III> V> II> I.

Tail broken, median scale row of subcaudals subequal on the remaining part of the tail.

Coloration of holotype.—After more than 130 years in preservative, dorsal head, body and tail light brownish gray, limbs paler; two white dorsolateral stripes beginning over the eye to the end of the remaining part of tail; another similar white stripe below, beginning at supralabials and continuing until tail across the tympanum and over the limbs, the upper stripe with dark brown

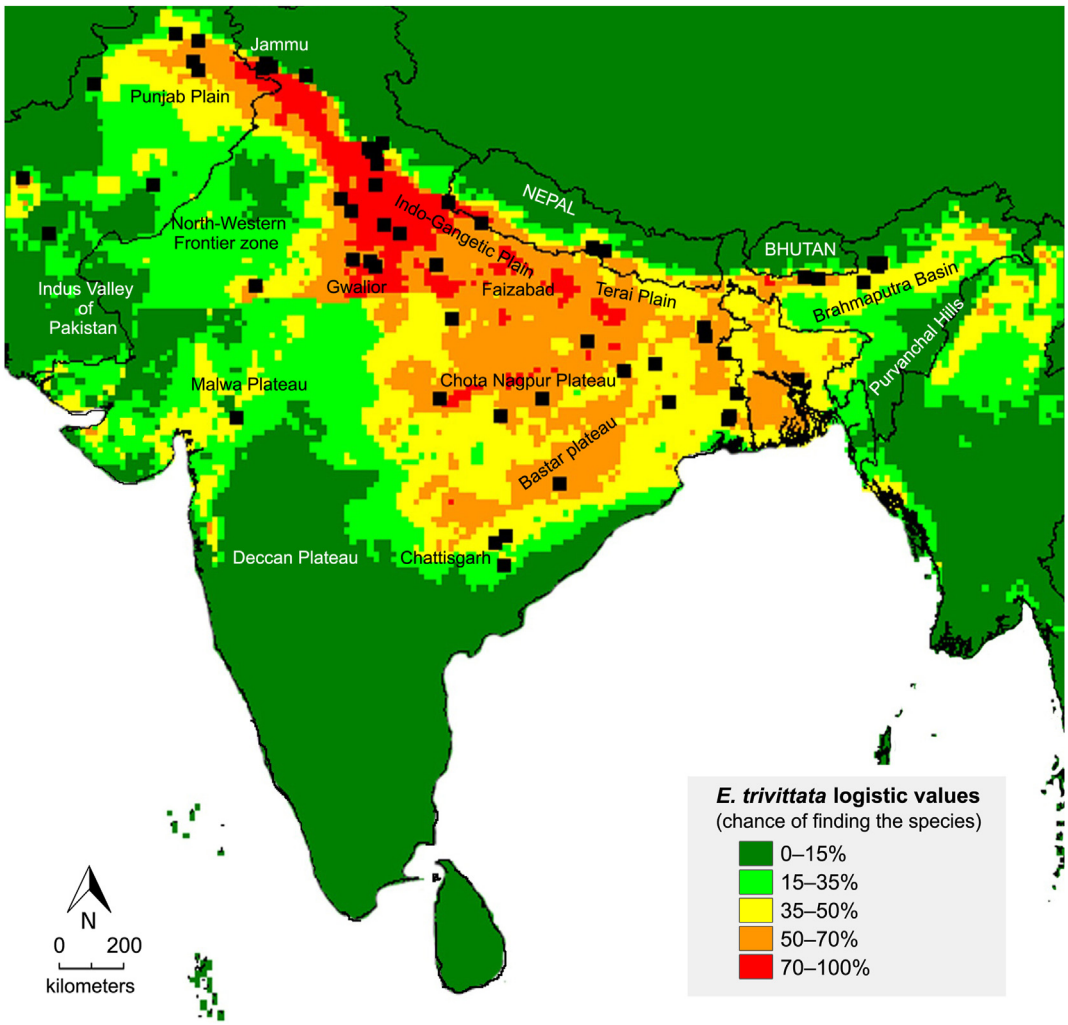

Fig. 6. The recorded (black squares) and predicted (coloured) distribution range of *E. trivittata* as calculated by Distribution Modelling in MaxEnt overlaid on a DIVA-GIS output map; different colours show the percentage probability (see figure legend) of finding the species in a random locality within the range . (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

margins, and the lower stripe not margined or already faded, therefore slightly visible on cream ventrolateral body; a white vertebral stripe starts behind parietal and continues until the remaining part of tail; venter cream.

Coloration in life.—based on live individuals (not collected), dorsum of head, body, limbs and tail varies from pale coffee brown to dark even blackish brown; dark (rarely black) margined pale whitish, yellowish or cream colour prominent mid dorsal stripe starting from just behind the parietal until tail tip, but fading on the tail and disappears gradually on the distal half of the tail; another two similar pale stripes on dorsolateral and lateral surfaces of the body; dorsolateral stripe starts from posterior part of the eye (rarely visible until snout over the eye and along the canthus), and lateral stripe starts from the supralabials and runs across the tympanum, above shoulders until tip of the tail, at the position of hind limb joint to the body, the line may be interrupted partially, or, rarely, fully; all these five longitudinal stripes (single mid dorsal, two dorsolateral, and two lateral) have dark margins; the background body colour in between these dark-margined pale stripes is always uniform, either light or dark coloured (see Fig. 8A of dark morph); pale spots on the hind limbs, prominently on posterior thigh; dorsal surfaces of palm and foot usually light copper brown; dorsal head scales usually dark margined; labials, ventrolateral body, and venter uniform cream.

Distribution and habitat.—*Eutropis vertebralis* is known from 16 localities (total 20 sightings) since its description in 1887 (Fig. 9). Among these, only eight sightings [but without collected specimens except for Datta-Roy et al. (2012) from Satara, Maharashtra] were made during the last decade. The remaining 12 sightings were reported over half a century ago. Since most of these were based on collected specimens, their identities could be accurately re-evaluated by us. Based on the reliable localities for this species (at least with photographic evidence), it occurs only in deciduous forests above 300 m a.s.l and lateritic plateaus. The predicted distribution range of this species is much narrower than its published locations so far; especially as seen in the reports from Jharkhand, Orissa, Andhra Pradesh and Tamil Nadu which are erroneous—see description of habitat prediction.

Conservation status.—The current conservation status of this species is Least Concern (LC, Srinivasulu et al., 2013), which was determined with the inclusion of the erroneously identified sightings of *E. beddomei* (e.g. Kalaiarasan & Kanakasabai, 1999; Seetharamaraju et al., 2011). The application of the IUCN Red List criteria (IUCN Standards & Petitions Subcommittee, 2019) with the

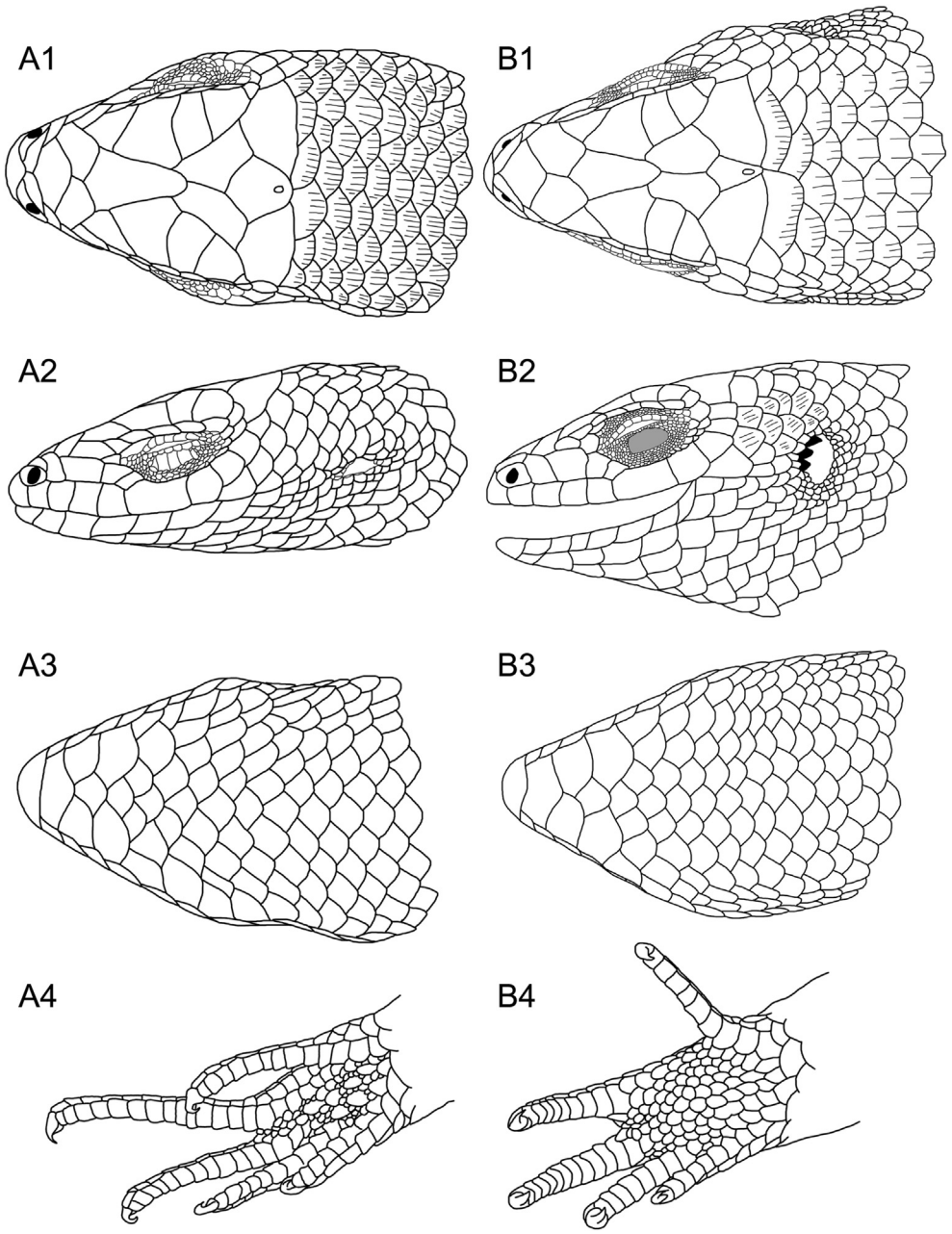

Fig. 7. (A) *Eutropis vertebralis* holotype (NHMUK 1946.8.18.34) and **(B)** *Eutropis dissimilis* (right; now junior synonym of *E. trivittata*) syntype (ANSP 9538): Head in (1) dorsal, (2) lateral, (3) ventral aspect, and (4) foot and toes.

updated distribution data shows that *E. vertebralis* comb. nov. is restricted to an area of occupancy (AOO) of 64 km^2 recorded from 16 localities within a 397,506 km^2 extent of occurrence (EOO). Within the known distribution range of *E. vertebralis*, there are many protected areas such as the Chandoli National Park (Maharashtra), Raigad Fort Nature Reserve (Maharashtra), and Koyna Wildlife (Maharashtra), Shri Bhimashankar Jyotirlinga Wildlife (Maharashtra), Gautala Autramghat Wildlife (Maharashtra), Kalsubai Harishchandragad Wildlife (Maharashtra), Tipeshwar Wildlife (Maharashtra), and Bhimgad Wildlife (Karnataka) Sanctuaries, plus the Bandipur (Karnataka), Melghat (Maharashtra), and Tadoba-Andheri (Karnataka) Tiger Reserves. Habitat in the forests of the northern Western Ghats has become degraded, but not to a large extent, and recent increase in the number of Protected Areas has alleviated the issue to a certain extent (Panigrahy et al., 2010). Therefore, the rate of habitat destruction across the entire species range would be an insufficient explanation indicating a population decline of >30% over the last three generations (*i.e.*, the threshold for consideration of under Criterion A). Given the wider extent of occurrence and the widespread distribution of the deciduous forests and associated woodlands, and the wider range of habitat predictions (even less than 60% chance of finding the species), *E. vertebralis* may still be considered as a "Least Concern" (LC) species.

However, we stress that *E. vertebralis* is not as common as it was considered prior to our revision because previous assessments included misidentified sightings of *E. beddomei* and *E. bibronii* (see Fig. 7 and discussion). Ashaharraza & Kaur (2018) thought that conversion of forests to agriculture and pasture lands was a major

Fig. 8. A live individual of **(A)** *Eutropis vertebralis* from Amravati, Maharashtra (not collected, note the partly regenerated tail) © Photo: Khan Ashaharraza; **(B)** *Eutropis trivittata* from Orang National Park, Assam (not collected); © Photo: M. Firoz Ahmed.

threat to this species. Although many of the protected areas mentioned above have a lot of deciduous woodlands, the habitat of *E. vertebralis* is known to be wetter forests above the 300 m elevation level (Ashaharraza & Kaur, 2018). Given the lower area of occupancy, the lower range of habitat predictions (above 60% chance of finding the species), its distribution in wetter forests above 300 m elevation, and the conversion of wetter forests as a threat to *E. vertebralis*, here we suggest classifying it as a "Vulnerable" (VU) species.

Eutropis trivittata (Hardwicke & Gray 1827).
(Figs. 1, 4, 6–10; Tables 1, 2, 4 and 6).

Tiliqua trivittata Hardwicke & Gray 1827.
Euprepis dissimilis Hallowell 1857.
Euprepes monticola Günther 1864.
Euprepes petersii Steindachner 1867.
Tiliqua monticola — Theobald, 1868.
Euprepes monticola — Stoliczka, 1872.
Euprepes petersii — Theobald, 1876.
Euprepes guentheri Blanford et al. 1879 (*Nomen novum* for *Euprepes monticola* Günther 1864).
Euprepes warthii Fischer 1885.
Mabuia dissimilis — Boulenger, 1887a; 1890; Hora & Chopra, 1923; Ingoldby & Procter, 1923.
Mabuia hodgarti Hora 1927.
Mabuya dissimilis — Smith, 1935; Clark et al., 1969; Husain and Ahmed, 1974; Tikader & Sharma, 1992; Vyas & Patel, 1992; Zug & Mitchell, 1995; Das, 1996; Pawar & Birand, 2001; Sharma, 2002; Khan, 2004; Chandra & Gajbe, 2005; Saikia et al., 2007; Manhas et al., 2016a, b.
Eutropis dissimilis — Mausfeld and Schmitz, 2003; Bauer et al., 2008; Baig et al., 2008; Datta-Roy et al., 2012; 2015; Rais et al., 2015; Islam et al., 2016; Khan, 2006; Bhattarai et al., 2017; 2018; Rabbe et al., 2017; Patel & Vyas, 2019; Boruah et al., 2020; Ingle 2020; Deuti et al., 2020; Rawat et al., 2020; Sahi & Koul 2020; Amarasinghe et al., 2021.

Iconotype.—An illustration by Hardwicke in Gray (1834: plate 75; see Fig. 8 in this paper) based on an adult male from Bengal [precisely from Dumdum (22°38′31.24″N, 88°25′52.21″E, datum = WGS84; 6 m above sea level), West Bengal, India *fide* Hardwicke & Gray (1827)].

Diagnosis.—A combination of the following characters distinguishes *Eutropis trivittata* from all other congeners: adults SVL of 92.1 mm, presence of vertebral and dorsolateral longitudinal white stripes, bicarinate (rarely tri-) mid dorsal scales, absence of nuchal pair (rarely first row of paravertebrals merged and visible as nuchals), three pre-auricular lobules, presence of transparent disc on the lower eyelid, 34–36 midbody scale rows, 54–64 ventrals, 48–54 paravertebrals, 13–16 lamellae beneath forth toe, absence of postnasal scale, and keeled temporal scales.

Redescription based on the syntypes of *E. dissimilis*.—Characters of one of the syntypes (ANSP 9538) is followed, when appropriate, by those of the other syntype (ANSP 9537) in parenthesis.

Head moderately long, HL 23.0% of SVL (24.1%), narrow, HW 62.7% of HL (63.2), HW 14.4% of SVL (15.2%), indistinct from neck; snout short, ES 36.3% of HL (35.4%), ES 57.9% of HW (56.1%), slightly convex in lateral profile; rostral shield large, hemispherical, distinctly visible from above, posterior margin of midpoint rounded; frontonasal completely separated from rostral; frontonasal wide, lateral border touching first loreal; prefrontals widely in contact, separating frontal and frontonasal, longer than frontonasal length, laterally contacting both loreal scales, posterior border contacting first supraciliary, first and second supraoculars and frontal; frontal large, elongate, subtriangular, rounded posteriorly, length equal to frontoparietals and interparietal combined; frontoparietals two, in contact, larger than interparietal; parietals large and completely separated by interparietal, contacting pretemporal scales anterolaterally; all head scales smooth; a single pair of nuchals. Nostril large and placed middle of nasal plate; supranasal single, widely in contact; loreals two, anterior contacting nasal, supranasal, frontonasal, prefrontal, posterior loreal, and first and second supralabials; posterior loreal longer than anterior loreal in the longitudinal axis, contacting prefrontal, first supraciliary, preocular, anterior presubocular, second and third supralabials; presuboculars two; eye large, ED 19.8% of HL (19.5%); eye diameter smaller than eye–tympanum distance, ED 67.7% of TYE (68.2%), pupil rounded; interorbital distance broad; postoculars three, small; supraoculars four, all wide, second longest in the longitudinal axis and widest in the transverse axis, 1st supraocular in contact with prefrontal, 2nd in contact with prefrontal, frontal and frontoparietal, 3rd in contact with frontoparietal, 4th in contact with frontoparietal and parietal; supraciliaries eight; eyelid moveable, lower eyelid covered with a transparent disc.

Supralabials seven, fifth largest at the mid orbit position, and contacting granular scales of lower eyelid; temporals keeled, single pretemporal; two primary temporals, secondary temporals three; infralabials eight; ear opening large, approximately one fourth ED, deep, oval; three tiny pre-auricular lobules on anterior tympanum.

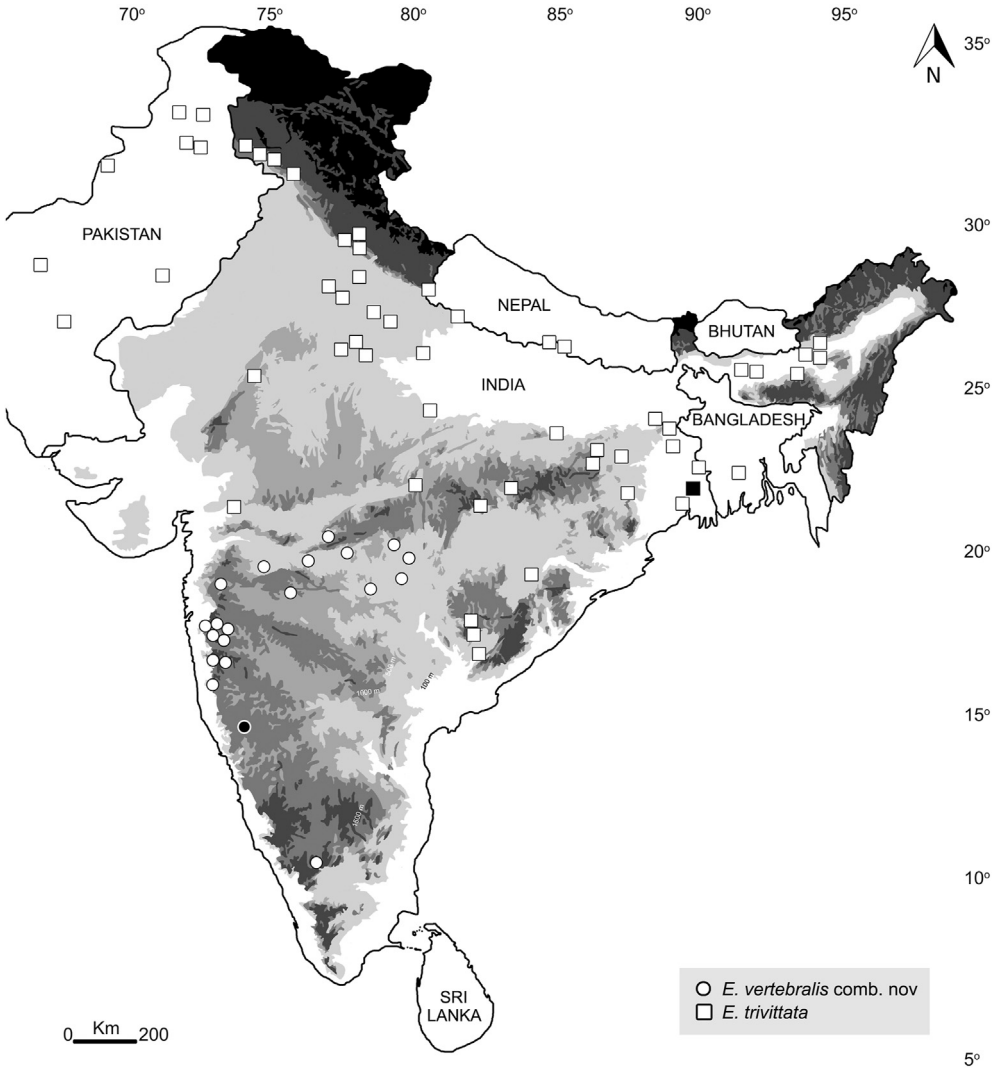

Fig. 9. Map of India showing the current known distribution (based on museum specimens and published literature) of *E. vertebralis* comb nov. (open circles) and *E. trivittata* (open squares); type localities of respective species are indicated in filled symbols.

Mental large; postmental single, large; two pairs of chin shields, each pair separated in midline by gular scales, first chinshield in contact with second and third infralabial scales, the second pair in contact with third and fourth infralabials.

All dorsal scales are bicarinate but varies from three to several keels along the lateral body, temporal region, and nuchals; all scales slightly imbricate; body slender, elongate; midbody scale rows 36 (38); paravertebral scales 49 (50); ventrals 54 (55); preanal scales not enlarged, six.

Forelimbs short, hind limbs relatively long, FEL 14.0% of SVL (10.1%), TBL 11.4% of SVL (10.5%); thigh longer, TBL 81.4% of FEL (95.8%); dorsal surfaces of fore and hind limbs slightly bicarinate; subdigital lamellae of toe IV: 14 (13); relative length of fingers IV> III> II> V> I; those of toes IV> III> V> II> I.

Tail broken, median scale row of subcaudals subequal on the remaining part of the tail.

Coloration of syntype, ANSP 9538. After more than 160 years in preservative, dorsal head and anterior body beige colour; mid body and posteriorly brownish, limbs paler; two white dorsolateral stripes starting post tympanum to the end of the remaining part of tail; a paler vertebral stripe starts from the level of axilla and continues until the remaining part of tail; all these three stripes margined in pale chestnut brown; scattered white spots on the lateral body, some are margined in pale chestnut brown; venter pale yellow.

Coloration in life.—based on live individuals (not collected), dorsum of head, body, limbs and tail varies from pale beige to dark chestnut brown; dark margined (mostly broken) pale whitish, yellowish or cream colour prominent dorsolateral stripes starting from post temporal region (usually above tympanum) until tail tip, but fading on the tail and disappears gradually on the distal half of the tail; a similar stripe, usually paler and wider on vertebral line along the body until tail tip; vertebral line starts from post nuchal region (usually at the level of axilla), margined with broken dark line (usually dark brown or black), and these marginal line mostly visible as spots along the vertebral line; no lateral pale stripe, but rarely can be visible as broken stripe or a line of spots; several dark margined white or cream spots on cheek, neck, lateral body, lateral tail, and on limbs; a dark margined prominent white streak below the eye, usually starts from the level of anterior border of eye until tympanum; dorsal head scales usually dark margined and usually paler in colour (beige or olive gray); throat, ventrolateral body, and venter uniform cream or white.

Distribution and habitat.—*Eutropis trivittata* is known from 58 localities (over 75 sightings) since its description in 1827 (Fig. 9). Among these, around half of the sightings (mostly without

Table 4
Un-corrected *p*-distance (pairwise sequence divergence) for selected members of Scincidae calculated for the mitochondrial 16S rRNA gene. 'I' represents sample from India and 'P' from Pakistan.

	Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	*Emoia caeruleocauda*																
2	*Emoia cyanura*	0.07															
3	*Dasia johnsinghi*	0.16	0.13														
4	*Dasia vittata*	0.16	0.13	0.09													
5	*Trachylepis hoeschi*	0.16	0.14	0.10	0.12												
6	*Trachylepis spilogaster*	0.14	0.12	0.13	0.11	0.06											
7	*Eutropis rudis*	0.16	0.14	0.12	0.11	0.11	0.11										
8	*Eutropis longicaudata*	0.14	0.13	0.10	0.09	0.11	0.11	0.08									
9	*Eutropis cumingi*	0.15	0.14	0.11	0.13	0.12	0.13	0.09	0.10								
10	*Eutropis carinata*	0.14	0.12	0.11	0.11	0.11	0.11	0.08	0.10	0.08							
11	*Eutropis ashwamedhi*	0.22	0.19	0.18	0.19	0.18	0.19	0.15	0.16	0.16	0.13						
12	*Eutropis tytleri*	0.16	0.13	0.11	0.12	0.12	0.12	0.09	0.09	0.09	0.07	0.14					
13	*Eutropis rugifera*	0.14	0.13	0.09	0.10	0.09	0.11	0.08	0.08	0.08	0.06	0.13	0.05				
14	*Eutropis quadricarinata*	0.18	0.15	0.14	0.14	0.13	0.14	0.10	0.11	0.10	0.11	0.16	0.11	0.09			
15	*Toenayar novemcarinata*	0.13	0.12	0.09	0.10	0.09	0.10	0.10	0.11	0.10	0.09	0.18	0.10	0.08	0.12		
16	*Eutropis nagarjunensis*	0.17	0.15	0.14	0.13	0.12	0.14	0.11	0.12	0.11	0.07	0.10	0.09	0.09	0.11	0.12	
17	*Eutropis multifasciata*	0.15	0.13	0.10	0.09	0.10	0.09	0.09	0.08	0.09	0.09	0.15	0.09	0.06	0.11	0.09	0.11
18	*Eutropis madaraszi*	0.17	0.15	0.13	0.13	0.13	0.14	0.09	0.10	0.10	0.11	0.14	0.09	0.08	0.12	0.13	0.11
19	*Eutropis macularia*	0.15	0.14	0.14	0.13	0.12	0.13	0.08	0.10	0.10	0.10	0.14	0.10	0.10	0.10	0.12	0.10
20	*Eutropis macrophthalma*	0.15	0.12	0.12	0.10	0.11	0.11	0.06	0.08	0.10	0.09	0.16	0.10	0.08	0.10	0.09	0.12
21	*Eutropis indeprensa*	0.15	0.13	0.12	0.14	0.13	0.14	0.10	0.11	0.05	0.09	0.16	0.09	0.09	0.10	0.11	0.12
22	*Eutropis clivicola*	0.19	0.17	0.16	0.15	0.15	0.15	0.12	0.14	0.13	0.11	0.18	0.11	0.12	0.13	0.15	0.12
23	*Eutropis* cf. *macularia*	0.18	0.16	0.14	0.15	0.15	0.15	0.12	0.13	0.12	0.12	0.16	0.13	0.12	0.13	0.14	0.12
24	*Eutropis borealis*	0.15	0.13	0.11	0.12	0.12	0.13	0.10	0.09	0.05	0.08	0.16	0.08	0.07	0.10	0.10	0.11
25	*Eutropis bibronii*	0.17	0.16	0.13	0.13	0.12	0.14	0.10	0.10	0.09	0.09	0.16	0.10	0.08	0.10	0.12	0.10
26	*Eutropis beddomei*	0.17	0.15	0.12	0.12	0.13	0.14	0.10	0.10	0.11	0.07	0.10	0.09	0.08	0.11	0.12	0.04
27	*Eutropis allapallensis* 2	0.18	0.15	0.15	0.14	0.14	0.14	0.10	0.12	0.11	0.10	0.17	0.10	0.10	0.12	0.13	0.12
28	*Eutropis allapallensis* 1	0.18	0.15	0.15	0.14	0.14	0.14	0.10	0.12	0.11	0.11	0.17	0.10	0.10	0.12	0.13	0.11
29	*Eutropis allapallensis*	0.16	0.14	0.14	0.14	0.13	0.13	0.08	0.11	0.10	0.09	0.15	0.09	0.09	0.10	0.12	0.10
30	*Eutropis trivittata* (P)	0.17	0.15	0.12	0.13	0.13	0.14	0.11	0.10	0.08	0.06	0.12	0.10	0.08	0.10	0.11	0.06
31	*Eutropis vertebralis*	0.17	0.15	0.14	0.13	0.14	0.15	0.12	0.12	0.11	0.09	0.12	0.10	0.10	0.11	0.12	0.04
32	*Eutropis trivittata* (I)	0.16	0.14	0.11	0.12	0.12	0.13	0.11	0.10	0.08	0.05	0.11	0.09	0.08	0.10	0.10	0.06

	Species	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	*Emoia caeruleocauda*															
2	*Emoia cyanura*															
3	*Dasia johnsinghi*															
4	*Dasia vittata*															
5	*Trachylepis hoeschi*															
6	*Trachylepis spilogaster*															
7	*Eutropis rudis*															
8	*Eutropis longicaudata*															
9	*Eutropis cumingi*															
10	*Eutropis carinata*															
11	*Eutropis ashwamedhi*															
12	*Eutropis tytleri*															
13	*Eutropis rugifera*															
14	*Eutropis quadricarinata*															
15	*Toenayar novemcarinata*															
16	*Eutropis nagarjunensis*															
17	*Eutropis multifasciata*															
18	*Eutropis madaraszi*	0.11														
19	*Eutropis macularia*	0.10	0.07													
20	*Eutropis macrophthalma*	0.08	0.09	0.09												
21	*Eutropis indeprensa*	0.11	0.11	0.10	0.12											
22	*Eutropis clivicola*	0.13	0.11	0.08	0.12	0.13										
23	*Eutropis* cf. *macularia*	0.14	0.09	0.08	0.12	0.13	0.13									
24	*Eutropis borealis*	0.11	0.10	0.11	0.11	0.08	0.14	0.12								
25	*Eutropis bibronii*	0.12	0.10	0.08	0.10	0.10	0.11	0.10	0.09							
26	*Eutropis beddomei*	0.11	0.10	0.10	0.11	0.10	0.11	0.12	0.10	0.10						
27	*Eutropis allapallensis* 3	0.11	0.10	0.06	0.11	0.11	0.06	0.12	0.11	0.09	0.11					
28	*Eutropis allapallensis* 2	0.11	0.10	0.06	0.11	0.11	0.07	0.11	0.11	0.09	0.11	0.00				
29	*Eutropis allapallensis* 1	0.11	0.08	0.05	0.10	0.10	0.07	0.11	0.11	0.09	0.10	0.03	0.03			
30	*Eutropis trivittata* (P)	0.11	0.10	0.09	0.11	0.11	0.11	0.11	0.08	0.09	0.06	0.10	0.11	0.09		
31	*Eutropis vertebralis*	0.12	0.12	0.11	0.13	0.13	0.13	0.13	0.10	0.11	0.06	0.13	0.13	0.11	0.08	
32	*Eutropis trivittata* (I)	0.10	0.10	0.09	0.10	0.10	0.11	0.11	0.07	0.08	0.05	0.10	0.10	0.09	0.00	0.07

collected specimens) were made during the last decade. The remaining sightings were reported over half a century ago. Since most of these were based on collected specimens, their identities could be accurately re-evaluated by us. Based on the reliable localities for this species (at least with photographic evidence), it mostly occurs in deciduous forests, scrublands, open jungles including home gardens and agricultural lands up to 1,000 m a.s.l.

Table 5
Some morphometric (in mm), meristic, and morphological characters of the *Eutropis* species which have five, prominent, longitudinal, dark-margined pale stripes along the dorsum and lateral body; –– not applicable/not evaluated.

Character	*E. vertebralis* comb. nov.		*E. beddomei* ($n = 42$)	*E. bibronii* ($n = 54$)	*E. nagarjunensis* ($n = 6$)
	holotype NHMUK 1946.8.18.34	other ($n = 9$)			
head length	14.0	8.2–19.0	5.5–12.8	8.5–11.9	11.6–13.4
head width	8.4	8.4–12.8	5.9–7.7	4.8–6.8	7.0–7.3
eye–nostril length	3.5	2.7–4.3	2.4–3.4	2.1–3.5	3.2–4.1
snout length	4.9	4.4–6.4	3.5–4.7	3.2–4.6	4.6–5.3
eye–tympanum length	3.9	3.9–5.8	2.6–4.5	2.1–3.4	3.0–3.1
orbit diameter	2.9	2.8–5.3	1.9–3.2	1.5–3.0	2.4–3.5
snout–vent length	64.4	55.4–78.7	43.4–59.3	31.0–47.9	46.4–48.6
tibia (shank) length	9.7	4.7–11.0	5.5–7.9	4.5–7.5	7.6–8.4
femur (thigh) length	12.1	4.4–9.7	5.1–7.9	4.4–7.8	5.8–7.8
toe IV length	6.2	3.9–6.4	4.9–6.5	5.0–7.9	7.1–8.2
Midbody scale rows	33	34–36	29–34	28–30	32–35
Ventrals	58	57–63	53–59	46–52	51
Paravertebrals	50	50–55	48–54	37–41	37–41
Lamellae on toe IV	13	12–14	12–16	15–19	20–24
No. of dorsal keels (prominent)	5 (5)		5 (3)	5	5
No. of nuchal pairs	0		1	2	2
No. of pre-auricular lobules	4		4	3	3
Transparent disc on lower eyelid	absent		absent	present	present
Temporal scales	keeled		smooth	keeled	smooth
Nuchals	–		smooth	keeled	keeled
Parietals	smooth		smooth	keeled	smooth
Postnasal	absent		absent	present	present

The predicted distribution range of this species is much wider than its published locations so far (see description of habitat prediction).

Conservation status.—The conservation status of this species has not been assessed. The application of the IUCN Red List criteria (IUCN Standards & Petitions Subcommittee, 2019) with the updated distribution data shows that *E. trivittata* is restricted to an area of occupancy (AOO) of 240 km^2 recorded from over 60 localities within a 1,739,766 km^2 extent of occurrence (EOO). Within the

Table 6
Some morphometric (in mm), meristic, and morphological characters of the type materials (including synonyms) and voucher specimens of *Eutropis trivittata*; –– not applicable/not evaluated.

	Eutropis trivittata									
	Tiliqua trivittata	*Euprepis dissimilis*		*Euprepes guentheri* (nom. nov. for *E. monticola*)		*Euprepes petersii*			*Euprepes warthii*	*Mabuia hodgarti*	*Eutropis trivittata*
Type locality	West Bengal	Bengal		Sikkim	Himalayas	Chamba and Rangna (West Himalayas)			Dehradun (Uttarakhand)	Punjab	
Type specimen(s)	Iconotype	Syntypes		Syntypes		Syntypes			Holotype	Holotype	Other
Character	Hardwicke's plate 75	ANSP 9537	ANSP 9538	NHMUK 1946.8.18.39	NHMUK 1946.8.18.7	NMW 9417	NMW 9419-1	NMW 9419-2	SMNS 1264	ZSI 1980	($n = 35$)
Head length	–	22.0	21. 2	18.7	20.9	15.8	13.2	17.0	8.7	8.3	13.3–19.7
Head width	–	13.9	13.3	10.8	13.7	10.8	8.9	9.6	6.8	–	8.4–13.1
Eye–nostril length	–	5.3	5.2	4.2	5.1	4.9	4.1	4.8	3.8	–	3.0–5.6
Snout length	–	7.8	7.7	7.4	7.6	5.2	5.7	5.5	4.0	–	4.8–7.7
Eye–tympanum length	–	6.3	6.2	5.5	6.1	4.9	5.2	4.6	2.8	–	3.2–7.0
Orbit diameter	–	4.3	4.2	3.6	4.0	4.2	3.8	4.2	3.0	–	2.4–4.4
Snout–vent length	114.3	91.3	92.1	78.3	94.5	80.9	77.1	60.3	41.0	29.2	53.5–85.7
Tibia (shank) length	–	9.6	10.5	7.4	12.0	12.2	10.0	9.9	5.5	–	7.3–10.5
Femur (thigh) length	–	9.2	12.9	6.2	10.6	9.2	9.9	9.0	6.0	–	6.3–10.5
Toe IV length	–	–	–	9.1	8.4	7.8	6.9	6.3	3.2	–	4.5–8.5
Midbody scale rows	–	36	36	34	34	36	35	36	36	36	32–36
Ventrals	68	55	54	54	55	63	64	61	58	62	54–64
Paravertebrals	48	49	50	48	52	54	53	51	50	52	46–54
Lamellae on toe IV	–	13	14	14	13	14	15	13	13	16	12–16
No. of nuchal pairs	–	0, 1		0	0	0	0	0	1	0	0, 1
No. of pre-auricular lobules	–	3		3	4	4	4	5	5	4	3–5
No. of dorsal keels (prominent)	2	2									
Transparent disc on lower eyelid	–	present									
Temporal scales	–	keeled									
Nuchals (if present)	–	keeled									
Parietals	–	smooth									
Postnasal	–	absent									

known and highest prediction (70–100%) distribution range of *E. trivittata*, there are many protected areas: INDIA—Kalesar (Haryana), Rajaji (Uttarakhand), Corbett (Uttarakhand) National Parks, and Sukhna Wildlife (Chandigarh), Jhajjar Bachauli Wildlife (Punjab), Palpur Kuno Wildlife (Madhya Pradesh) Sanctuaries, Pilibhit Tiger Reserve (Uttar Pradesh); PAKISTAN—Chumbi Surla Wildlife Sanctuary; and NEPAL—Shuklaphanta and Bardiya National Parks. Within the next high-prediction range (50–70%), essentially covering the Chota Nagpur Plateau of India, the following protected areas are present: INDIA—Valmiki (Bihar), Similipal (Odisha) Tiger Reserves and Hazaribagh Wildlife (Jharkhand), Dalma Wildlife (Jharkhand) Sanctuaries; NEPAL—Chitwan National Park and Parasa Wildlife Reserve. Although the rate of habitat destruction across the entire species range would be insufficient to indicate a population decline of >30% over the last 3 generations (*i.e.*, the threshold for consideration of under Criterion A), given the wider extent of occurrence and the widespread distribution of the deciduous forests and associated woodlands, open jungles, well maintained home gardens and agricultural lands, and the wider range of habitat predictions, *E. trivittata* can be considered as a "Least Concern" (LC) species.

4. Discussion

Molecular phylogenetic relationships recovered herein are congruent with those of previous studies however only a subset of the dataset from previous studies was employed for the analysis. The Sequence divergence (pairwise *p*-distance) for 16S rRNA between *Eutropis vertebralis* and other members of the clade (*i.e.*, *E. beddomei* and *E. nagarjunensis*) is 4–6% (Table 4). Sequence divergence between *E. trivittata* and other members of the clade is 5–7% (Table 4). The two representative sequences of *E. trivittata* (formerly *E. dissimilis*), one each from the type locality (West Bengal, India) and Thatta District in Pakistan are identical (0% *p*-distance). This is remarkable as the distance between the two localities is 1,958 km (linear distance). Although there are several synonyms involved, the morphological comparison of different populations in between north-eastern India and Pakistan also revealed that there is no significant diagnostic character to distinguish any populations. Although Minton (1966) stated the differences in appearance (especially body size) between eastern and western specimens of *E. trivittata*, the available phylogenetic and morphological results revealed that the nomen *E. trivittata* represents a single species and the differences in body size suggest a significant clinal variation within the species range (also see Bauer et al., 2008). Therefore, all the current junior synonyms of *E. trivittata*: *Euprepis dissimilis*, *Euprepes guentheri* (replacement name for *Euprepes monticola*, *Euprepes petersii*, *Euprepes warthii*, and *Mabuia hodgarti*) will remain junior synonyms. Having less distinctive morphological characters with narrow phylogenetic divergence for widespread *Eutropis* has been proven in several previous studies (e.g. Amarasinghe et al., 2017; 2018).

In addition to the lower sequence divergences within the species, a morphological and mtDNA analysis (584 bp of 16S rRNA) of *E. rugifera* from different biogeographic regions (see Amarasinghe et al., 2017) revealed that *Eutropis rugifera* from the Nicobar Islands (India) and Bali Island (Indonesia) comprise a monophyletic species, and the observed *p*-distances among members of *E. rugifera* species throughout the wide biogeographic region varied from just 2.8%–4.3% of substitutions. Amarasinghe et al. (2018) studied another widespread skink, *E. multifasciata* and revealed the morphological indistinctiveness between the populations from Assam (India) and Java (Indonesia), and their phylogenetic analyses of two nuclear and protein-coding loci indicated that *E. multifasciata* is a monophyletic species. However, the sequence of *E. ashwamedhi* shows an intraspecific divergence of 10–12% for 16S rRNA which is quite high and is likely not reliable. We warrant additional molecular work to confirm such a high divergence, which could be an artifact of poor quality sequences.

The confusion about the species identity of *Tiliqua trivittata* began with its description. The authors, Hardwicke & Gray (1827), themselves doubted the species status as mentioned "Is this the *S. trilineatus*, Schneid. ii. 202.?" at the end of the description [Note: *Scincus trilineatus* Schneider 1801; not *Euprepis trilineatus* Gray, 1846]. However, as an experienced artist, Hardwicke, illustrated this species in detail, depicting important diagnostic characters. Therefore, without any ambiguity, we were able to assign it to the genus *Eutropis* and compare it with the known congeners.

Euprepis dissimilis was described by Hallowell (1857) based on two specimens collected from West Bengal, India. As we also have no doubt with the type locality of *Tiliqua trivittata*, it is highly probable that Hardwicke & Gray (1827) had described the same species which was later named as *E. dissimilis*. Moreover, Boulenger (1887a) also recognized that the species described by Hardwicke & Gray (1827) was identical with *E. dissimilis*. However, Boulenger, omitting the priority principle, mistakenly synonymized *Mabuia trivittata* with *M. dissimilis*, and it should have been the other way around. As Boulenger was clearly aware of the publication dates of these two species—see the chresonyms listed in the account of *M. dissimilis* in Boulenger (1887a, page 175), we believe this is simply a mistake unnoticed by Boulenger. *Tiliqua trivittata* was described in 1827 prior to the description of *Euprepis dissimilis* which was in 1857; hence the nomen *E. trivittata* has the priority over *E. dissimilis*. As there are no morphological characters to distinguish *E. dissimilis* from *E. trivittata* (*fide* Plate 75 of Hardwicke in Gray, 1834), we consider *E. dissimilis* to be a junior synonym of *E. trivittata*.

With the above taxonomic action, the distinct populations of *Eutropis* distributed in north-western India which differ from *E. dissimilis* [now *E. trivittata*] and so far have been treated as *E. trivittata* required a new nomen. The specimen (NHMUK 1946.8.18.34) used by Boulenger (1887a) to describe *Mabuia vertebralis* is distinct from Hardwicke's illustration, and perfectly matches the above population [formerly treated as *E. trivittata*]. Based on the museum (NHMUK) registry, *Mabuia vertebralis* was collected from Belgaum, Karnataka, India by "Dr. Leith", most probably by Dr. Andrew Leith Adams (1827–1882) who was a Scottish physician and a famous naturalist who joined the Regiment in India as a military physician from 1849 to 1856 (Gaston, 1989). Another Leith, Mr. Andrew Henderson Leith Fraser (1848–1919), born in Bombay (Maharashtra, India) (Islam, 2012), also was a British officer in the Indian Civil Service [not a physician or philosopher] joined in 1871, but he had no involvement in natural history collections. In contrast, Dr. Andrew Leith Adams (known as Dr. Leith) was involved in several animal and fossil collections. There are several species described based on Dr. Leith's collections, including some species that were named after him, e.g. *Nilssonia leithii* (Gray 1872) and *Psammophis leithii* Günther 1869. Lydekker (1895) also named a new genus of an extinct giant dormouse (Mammalia: Rodentia) honouring Dr. Leith as *Leithia*. Therefore, we believe the collector of the holotype of *Mabuia vertebralis* is Andrew Leith Adams. Here we combine *Mabuia vertebralis* with the genus *Eutropis* following Mausfeld et al. (2002) and Mausfeld & Schmitz (2003).

Deuti et al. (2020) mistakenly considered Boulenger's specimen (*i.e.*, holotype of *Mabuia vertebralis*) as the holotype of *E. trivittata* despite stating Dum Dum to be the type locality. They further provided a specimen (ZSI 16405) from Rajmahal Hills, Jharkhand which is around 300 km north of Dum Dum, identified as *E. trivittata*, following Smith (1935). However, after a closer examination we identified it as a specimen of *E. beddomei* based on the diagnostic characters provided in Table 3. *Eutropis vertebralis* [formerly

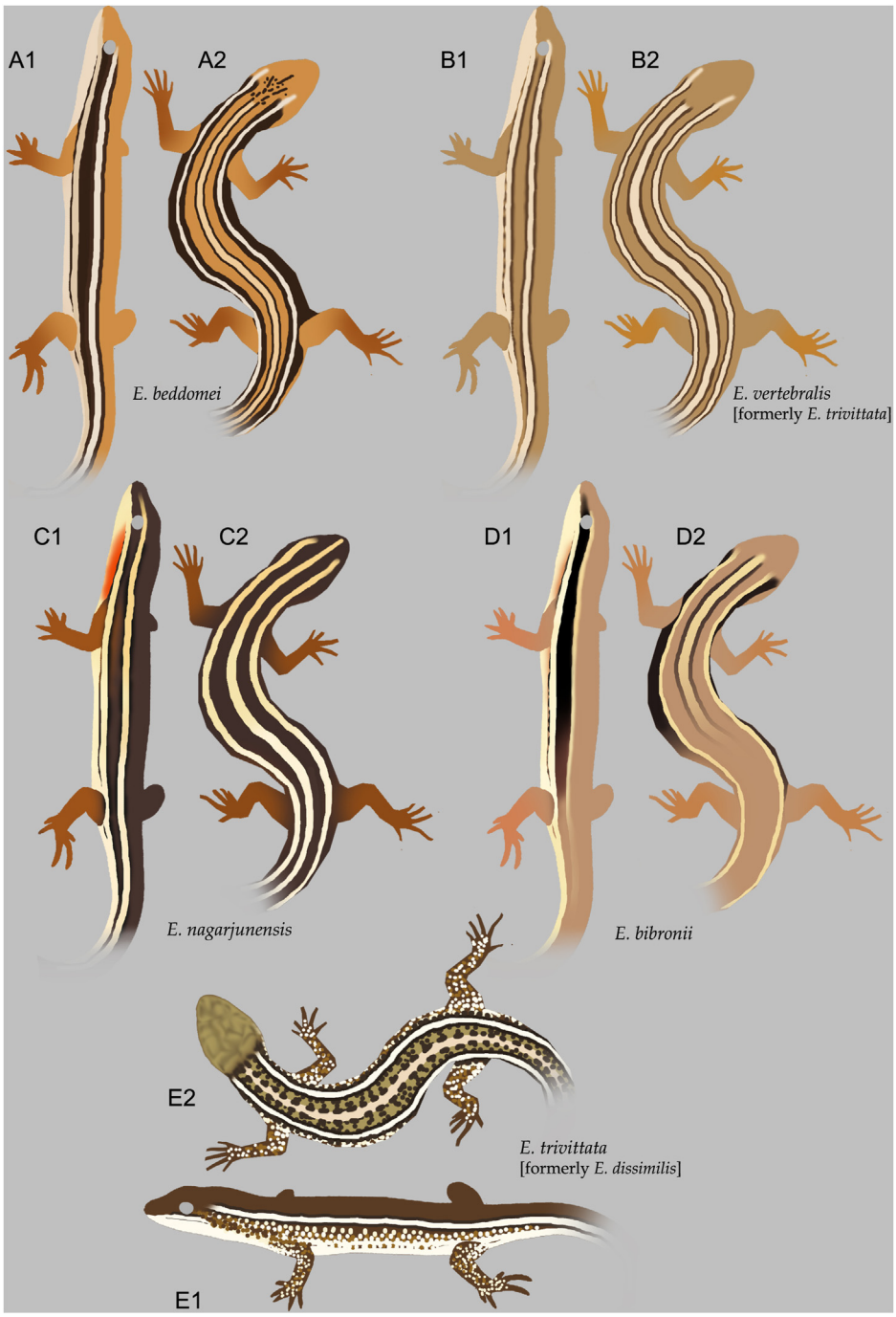

Fig. 10. Dorsolateral and lateral stripes **(A1–E1)**; vertebral and dorsolateral stripes **(A2–E2)** and body colouration of *Eutropis beddomei* group [**(A)** *E. beddomei*, **(B)** *E. vertebralis* [formerly *E. trivittata*], and **(C)** *E. nagarjunensis*)]; **(D)** *E. bibronii*; and **(E)** *E. trivittata* [formerly *E. dissimilis*] © Illustration: A.A.T. Amarasinghe.

treated as *E. trivittata*] is closely allied to *E. beddomei* in morphological and morphometric traits; hence this specimen was erroneously identified by Smith (1935) as *E. trivittata* and Deuti et al. (2020) followed him. Although, most of the recent accurate sightings of *E. vertebralis* [in previous publications as *E. trivittata*] have been in western India (see Chikane, 2011; Ashaharraza & Kaur, 2018), it was Anderson (1871) who first created the confusion by reporting *E. trivittata* [now *E. vertebralis*] from outside its geographic range, from Madras (now Chennai), Tamil Nadu, and Smith (1935) followed him. This record was again followed by other workers (Kalaiarasan & Kanakasabai, 1999) who misidentified the Southeast Indian population of *E. beddomei* as "*E. trivittata*". Subsequently, Ganesh and Asokan (2010) misreported specimens labelled as *E. beddomei* from the Eastern Ghats (MAD 17.IX.1923, Chittoor, Andhra Pradesh) and the Coromandel Plains (MAD uncatalogued specimen, Tirupathur, Tamil Nadu) as "*E. trivittata*". Our re-examination of the Madras Government Museum's misidentified specimens and examination of materials from near Cheneglpet-Gingee attest to the fact that those specimens indeed represent *E. beddomei* (based on the characters listed in Table 3) and not *E. trivittata* [now *E. vertebralis*] as claimed by Kalaiarasan & Kanakasabai (1999). Later, Seetharamaraju et al. (2011) reported a

range extension of "*E. trivittata*" based on a misidentified specimen (NHM.OU.REP.2-2009) of *E. beddomei* from Araku, Andhra Pradesh. These specimens clearly exhibit a dark (usually black) lateral band along the body (*vs* absence in *E. vertebralis*; see Figs. 8 and 10 and the comparison given under *E. vertebralis* account above). Deuti et al. (2020) further reported another two misidentified specimens from Selam, Tamil Nadu (BNHS 1451), and Mandapam Beach, Tamil Nadu (BNHS 1736) as "*E. trivittata*". However, here we identify them as *E. beddomei* and *E. bibronii* respectively based on the diagnostic characters listed in Table 3.

We concur with all the precise historic records (e.g. Jerdon, 1853; 1870; Blanford, 1870; Stoliczka, 1872; Boulenger, 1887a) as well as recent records and personal observations that the distribution of *E. vertebralis* is restricted to the western Indian tableland (including Maharashtra and adjoining parts of Karnataka and Madhya Pradesh) as far as the southernmost authentic record from Gundlupet, Mysore (*fide* Boulenger, 1887a) (also see the habitat prediction section and Figs. 4 and 9). In effect, our current clarification of the identities of the western Indian populations, now resurrected as *E. vertebralis* (Boulenger 1887a) comb. nov. and the southeastern Indian populations, now re-identified as *E. beddomei* and *E. bibronii*, has practically de-listed *E. trivittata* from both western and southern India. We hope that the present partial treatment of the taxonomy of five-lined skinks on the Indian Peninsula will help further resolve the systematics of the *Eutropis carinata* species complex (Amarasinghe et al., in review).

5. Conclusion

The five-lined *Eutropis* in Indian Peninsula are composed of four species: *E. beddomei*, *E. vertebralis*, *E. bibronii*, and *E. nagarjunensis*. Although, these four species are morphologically similar, *E. bibronii* is an evolutionary divergent species from the rest of three. After placing *E. dissimilis* in the synonymy of *E. trivittata* and resurrecting *E. vertebralis* from the synonymy of *E. trivittata*, the populations previously treated as (i) *E. dissimilis* must be assigned as *E. trivittata*, and (ii) *E. trivittata* must be assigned as *E. vertebralis*. Our study also shows the influence of distribution modeling and its narrow correspondence with species delimitation. We further suggest that whenever possible, such modeling should be associated in integrative studies describing new taxa or revisions of species clades. The conservation status of *E. trivittata* will remain as Least Concern (LC) while *E. vertebralis* can be treated as a Vulnerable (VU) species.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix 1. Comparative material

***Eutropis beddomei* ($n = 50$): India:** Mysore, Karnataka: NHMUK 1946.8.19.17 (holotype); Berar, Madhya Pradesh ZSI 2354–6 (syntypes of *Euprepes septemlineatus*); Kerala: NHMUK 1874.4.29.1296b–d, ZSI 4355–7, 21871–2, 21873a–b; Maharashtra: NHMUK 1874.4.29.1452, ZSI 21514; Odisha: ZSI 23265, 26646–8, 26699–704, 26810–12; Tamil Nadu: NHMUK 1882.5.22.106–108; 1874.4.29.141–145, ZSI 12921, 21953, BNHS 1451, CSPT/S 21a–b; MAD uncat., SACON/VR 33e; Andhra Pradesh: MAD 17.IX.1923; SACON/VR 33a–d; Jharkhand: ZSI 16405.

***Eutropis bibronii* ($n = 60$): India:** MNHN-RA 2940, 7076 (syntypes); Tamil Nadu: NHMUK 1946.8.19.8–12 (syntypes of *Euprepis trilineatus*), MNHN-RA 1948.0229–30, ZSI 15357–8, 15360, 15362–5, 19730a–b, 22221a–c, 23533a–b, 26346, 26352, BNHS 1736, CSPT/L 29, MAD uncat, SACON-L 35b–h; Andhra Pradesh: SACON-L 25a; Karnataka: ZSI 4385; Kerala: ZSI 4363; Odisha: ZSI 16711, 23413a–b, 23415, 26666, 26742–53, 26754, 26798–801.

***Eutropis carinata* ($n = 204$): India:** Tamil Nadu: ZMB 1253 (lectotype), 24383a–b, 24963, 26343, 26351, 26401, 26508–9, 26517, 26520; Andhra Pradesh: ZMB 8090, 77406, 24265, 24273, 24310, 24413, 24438, 24457a–b, 24463a–c, 24495, 24511, 24962, 26293; Bihar: ZSI 16587, 16591, 23622, 24325, 24447, 24482, 24550, 25077, 25080, 25087, 25624a–d; Chhattisgarh: ZSI 25709, 26060; Goa: ZSI 22223a–d, 22265a–e, 22277, 23829–30; Gujarat: ZSI 24897, 24923, 24935, 24937a–d, 24938a–d, 24939a–b; Jharkhand: ZSI 21959, 23603a–b, 24291a–b; Karnataka: ZSI 22288; Kerala: ZMB 42566; Maharashtra: ZSI 25748, 26148; Madhya Pradesh: ZSI 22341, 23860, 23944, 24156, 24157a–b, 24193, 24205a–b, 24173, 24203a–i, 24206a–f, 24312a–e, 24618, 24621, 25450, 25456, 26255a–h, 26256, 26561; Odisha: ZSI 22614, 22645–6, 22867a–b, 22868, 22869a–b, 22895–7, 22928–33, 23048a–c, 23300, 23318, 23321, 23373, 23386–7, 23390, 23414, 23716, 23718, 25886, 26171, 16172–4, 26176–7, 26215–6, 26730–39; Punjab: ZSI 26311; Telangana: ZSI 26283, 26286; Uttar Pradesh: ZMH R-05190; West Bengal: ZSI 2305, 4631, 22392, 23466, 23805a–c, 23806, 23899a–b, 23906, 23910a–b, 24031, 24123, 24138a–b, 24140, 24145, 24700, 25603, 26225, 2637.

***Eutropis trivittata* ($n = 54$): India:** West Bengal: ANSP 9537–8 (syntypes of *Euprepis dissimilis*), ZSI 2348, 5429; Odisha: ZSI 22894, 23302, 26518; Jharkhand: ZSI 2349, 24476, NHMUK 1880.11.10.186–187; Bihar: ZSI 5585, 19737; Madhya Pradesh: ZSI 24209a–d, 25313, NHMUK 1934.11.2.16–17; Uttar Pradesh: ZSI 11459, 21088, 21089a–b, 21093, NHMUK 1937.3.3.1; Uttarakhand: SMNS 1264 (holotype of *Euprepes warthii*), ZSI 13221; Sikkim: NHMUK 1946.8.18.39, 1946.8.18.7 (syntypes of *Euprepes monticola*); Jammu: ZSI 21677–9, 23186; Rajasthan: ZSI 13487, NHMUK 1882.4.14.1, 1880.11.10.45; Punjab: ZSI 19801 (holotype of *Mabuya hodgarti*), 19803–5 (paratypes of *Mabuya hodgarti*), 19351, 19353–4, 19372–3, 24050, NHMUK 1933.7.3.6; Himachal Pradesh: NMW 9417, 9419-1, 9419-2 (syntypes of *Euprepes petersii*);

Pakistan: Waziristan: NHMUK 1921.12.2.4; Sind: NHMUK 1891.9.11.10; **Nepal:** NHMUK 1984.1214.

***Eutropis innotata* (*n* = 5): India:** Maharashtra**:** "Pem Ganga Valley, S.E. Berár" (=Penganga Valley, Yavatmal): NHMUK 1946.8.19.2 (holotype), ZSI 2358, ZSI/R 284, ZSI/R 1078; Chhattisgarh: ZSI 2390.

***Eutropis nagarjunensis* (*n* = 6): India:** Andhra Pradesh: ZSI 21170 (holotype), 21171–2 (paratypes), 24698a–b; ZSI/FBS 1164.

***Eutropis quadricarinata* (*n* = 2): India:** Assam: ZSI 2357 (holotype of *Mabuia anakular*), 25807.

***Eutropis vertebralis* (*n* = 9): India:** Karnataka: NHMUK 1946.8.18.34 (holotype), 1977.480; Maharashtra: NHMUK 1933.7.3.5, ZSI 2359, 21512–3, 21620, ZSI/R 942, 1080.

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