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Taxonomy and predicted distribution of a rare Indian skink, *Eutropis innotata* (Blanford, 1870) (Reptilia: Scincidae) with the redescription of its holotype

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Abstract

We examined the holotype of *Euprepes innotatus* Blanford, 1870 which was presented to the Natural History Museum, London (NHMUK) by Blanford himself, and is redescribed herein. Based on the morphological similarity, we placed *Eutropis innotata* within the *E. carinata* group (*contra* Blanford, 1870), as it is closely allied to *E. dissimilis* and *E. carinata* in morphological and morphometric traits. Based on the current distribution pattern, we conducted Species Distribution Modelling using the Maximum Entropy algorithm and the distribution range of this species was predicted to be wider than the currently known limits within the south-central parts of the Deccan plateau. Furthermore, we updated the conservation status of *E. innotata* using the criteria of the IUCN Red List, and suggested it be considered as a species of Least Concern.

Key words: Deccan plateau, habitat prediction, holotype, *Mabuya*, morphometric, taxonomy

Introduction

The Oriental skink genus *Eutropis* Fitzinger, 1843 is distributed in the Indian Peninsula, with 12 species representing the genus (Uetz *et al*. 2021). The peninsular Indian clade of the genus *Eutropis* is mostly composed of two major subclades (or species complexes): *E. macularia* (Blyth, 1853) and *E. carinata* (Schneider, 1801), with the latter complex being identified as endemic to the Indian subcontinent and Sri Lanka (Datta-Roy *et al*. 2015; Batuwita *et al*. 2020), except *E. quadricarinata* (Boulenger, 1887), which is also distributed in the Indochinese subregion (Myanmar) through the 'gateway' of Assam (Datta-Roy *et al*. 2012). Initially, Mausfeld & Schmitz (2003) included *E. quadricarinata* as the sister to the subclade of the Philippine taxa, but Datta-Roy *et al*. (2015) later placed this species within the *E. carinata* subclade. Datta-Roy *et al*. (2012) further included a large number of samples of *Eutropis* from the Peninsular Indian clade in their phylogenetic analysis. However, those samples were represented

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by ten species, and four of them were placed within the *E. carinata* subclade: *E. carinata sensu lato*, *E. trivittata* (Hardwicke & Gray, 1827), *E. beddomei* (Jerdon, 1870), and *E. nagarjunensis* (Sharma, 1969). In addition, they recognised a few populations of *Eutropis* cf. *carinata* which are genetically distinct. However, these species are yet to be described morphologically, probably with solving the taxonomic issues that exist within this complex. Later, Datta-Roy *et al*. (2015) added three more species: *E. bibronii* (Gray, 1839), *E. dissimilis* (Hallowell, 1857), and *E. quadricarinata* to the *E. carinata* subclade. Srinivasulu *et al*. (2016) assigned *Riopa ashwamedhi* (Sharma, 1969) to the genus *Eutropis* and placed it within the *E. carinata* subclade. Recently, Batuwita *et al*. (2020) elevated the Sri Lankan subspecies *E. carinata lankae* (Deraniyagala, 1953) to species level, and placed it along with his new species, *E. resetarii* into the *Eutropis carinata* complex based on morphological evidence. Thus, currently the *E. carinata* complex is composed of ten described species. Among these species, only three have a transparent disc on the lower eyelid: *E. dissimilis*, *E. bibronii*, and *E. nagarjunensis*. In addition to these three species, *E. innotata* also has a transparent disc, but has not yet been placed within any of the existing clades due to the absence of genetic data.

The quinquecarinate skink, *Euprepes innotatus* was described by Blanford (1870) based on a single specimen collected from "Pem Ganga valley, S.E. Berár" (Penganga Valley), a branch of the Godavari River basin in the Yavatmal District, Maharashtra, India. Blanford (1870) remarked that *E. innotatus* was similar to specimens in the *E. macularius* group, and went on to acknowledge Dr. Anderson for calling his attention to *E. innotatus* which Blanford had overlooked, among many *E. macularius* specimens. Boulenger (1887) redescribed *Mabuia innotata* based on the same specimen presented by Blanford, but stating the location as only "Godavery Valley". Smith (1935) mentioned that he examined three specimens of *Mabuya innotata* from (i) S.E. Berár, (ii) Koba (=Korba), Bilaspur deposited at the Indian Museum (currently ZSI, Kolkata), and (iii), which is probably the specimen from Pem Ganga valley (Godavari Valley). Tikader & Sharma (1992) considered this species as a rare skink distributed in the Madhya Pradesh and the adjoining area of the Maharashtra state of India based on the two specimens deposited at ZSI. Later, Mausfeld *et al*. (2002) and Mausfeld & Schmitz (2003) transferred the Asian *Mabuya* to the *Eutropis* genus. Sharma's (2002) report from Bilaspur, Chhattisgarh, also referred to the same specimen at ZSI. Thus, *Eutropis innotata* was known by only three collected specimens, until Rao *et al*. (2010) collected the fourth specimen from the Gundla Brahmeswaram Metta Sanctuary in Andhra Pradesh. Recently, Deuti *et al*. (2020) listed two additional specimens from Melghat Tiger Reserve and Bhimashankar Wildlife Sanctuary in Maharashatra. However, Das *et al*. (1998) and Deuti *et al.* (2020) mentioned ZSI 2358, which was collected from "S.E. Berár", as the holotype of *Eutropis innotata*, in error.

We examined the correct holotype of *Eutropis innotata*, which was presented to the Natural History Museum, London (NHMUK) by Blanford himself, and is redescribed herein. Based on the morphological similarity, here we place *E. innotata* (Blanford, 1870) within the *E. carinata* complex (*contra* Blanford, 1870) which is closely allied to *E. dissimilis* in morphological and morphometric traits. Based on the current distribution pattern we conducted Species Distribution Modelling (SDM) using the Maximum Entropy algorithm in the MaxEnt software to predict the habitat distribution of *E. innotata*. Furthermore, we updated the conservation status of *E. innotata* using the criteria of the IUCN Red List (IUCN Standards and Petitions Subcommittee 2019).

Materials and methods

Morphological, morphometric, and meristic characters. We compared the holotype of *Eutropis innotata* to all the congeners of the genus and relevant historical specimens of this species. We also compared them to all the congeners of the *carinata* species complex. Museum acronyms are those of Uetz *et al*. (2019). We examined specimens in the collections of the Muséum national d'Histoire naturelle, Paris, France (MNHN-RA) Natural History Museum, London, UK (NHMUK), Museum für Naturkunde, Berlin, Germany (ZMB), Zoologisches Museum Hamburg, Germany (ZMH), and the Zoological Survey of India, Kolkata, India (ZSI). 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 from specimens unless the hemipenes were everted.

When redescribing the species, we scored specimens for the same morphological and morphometric characters used in recent descriptions by Amarasinghe *et al*. (2016a,b, 2017, 2018, 2020). Measurements were taken with Mitutoyo digital calipers to the nearest 0.1 mm, under a dissecting microscope, and 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

(TL, 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 scales (excluded), respectively. Our counts of ventrals include all scales from the postmental 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) at midbody.

Morphometric analysis. Statistically informative tests could not be performed on separate sexes because the smaller sample sizes rendered insufficient numbers for this purpose. Therefore, 80 adult voucher specimens of the species which have transparent discs on lower eyelid: *E. dissimilis* (*n*=32), *E. bibronii* (*n*=38), *E. nagarjunensis* (*n*=7), and *E. innotata* (*n*=3) were used for the statistical analysis. A detailed analysis and comparsion of all the congeners of the *E. carinata* group/clade will be discussed elsewhere (Amarasinghe *et al*. 2021, in review). These samples include the syntypes of the *E. bibronii*, holotype and paratypes of *E. nagarjunensis*, the holotype of *E. innotata*, and voucher specimens of *E. dissimilis* (including type locality) to assess morphometric variation and taxonomic disparity. Juveniles were excluded to avoid the bias of allometry for the statistical analysis. We performed 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) to detect the 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. A biplot of the first two principal component scores were used to examine the morphometric differentiation between the populations. All statistical analyses were conducted using the R statistical software program v4.0.4: R Core Team 2021. All the distribution records are based on the data associated with the museum specimens examined.

Habitat prediction. We conducted Species Distribution Modelling (SDM) using the Maximum Entropy algorithm in the MaxEnt software (Philips *et al*. 2004). We used all the 10 bioclimatic variables (Table 1) sourced from the WorldClim Database (Hijmans *et al*. 2005). We sourced geocoordinates in decimal degree format, correct up to 4 decimal places, from GoogleEarth software, by plotting the published data points (see maps in Rao *et al*. 2010; 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 better defined predictions of spatial distributions.

Results

Morphometric analysis. The morphometric ratio mean comparisons, except HW/SVL and ES/SVL, showed significant differences among *E. innotata*, *E. dissimilis*, *E. bibronii*, and *E. nagarjunensis*: TYE/HW (χ^2 21.45, *P*=0.00), ED/HW (χ^2 24.66, *P*=0.00), ED/ES (χ^2 26.34, *P*=0.00), TYE/ES (χ^2 21.73, *P*=0.00), and TBL/SVL (χ^2 11.7, *P*=0.01). Among *E. innotata* and *E. dissimilis*, the highly correlated character ratios are TYE/HW and ED/ES (Fig. 1). The TYE/HW of *E. innotata* was significantly smaller indicating a relatively wider head and shorter eye–tympanum distance than that of *E. dissimilis* (Fig. 1A). Additionally, ED/ES of *E. innotata* was significantly higher indicating a relatively shorter snout than that of *E. dissimilis*. Also, the same character ratio indicates the relatively larger eye of *E. innotata* compared to that of *E. dissimilis* (Fig. 1B).

Multivariate analysis by principal component analysis also showed distinct overall differences in morphometric characters among *E. innotata* and *E. dissimilis* with a distinct non-overlapping cluster for the typical form of *E. dissimilis* (Fig. 2A). However, *E. bibronii*, E. *nagarjunensis* and some populations of *E. dissimilis sensu lato* are morphometrically less distinctive and overlap in cluster with *E. innotata* (Fig. 2B). Principal components 1 and 2 collectively explained nearly 80% of the variation in the morphometric data matrix (Table 2; Fig 2). Morphometric ratios ES/HW, TYE/HW, and TYE/ES loaded positively with principal component 1 while HW/SVL, ED/HW, ED/ES, and TBL/SVL loaded negatively with principal component 1.

TABLE 1. Percentage contribution of bioclimatic and physiographic variables (from Hijmans *et al*. 2005) to the model for *Eutropis innotata*

Variable	**Percent contribution**	**Permutation importance**
Elevation in meters above sea level	14.9	32.4
Isothermality	0.9	0.1
Temperature seasonality	1.9	0
Max temperature of warmest month	0.5	3.1
Min temperature of coldest month	1	39.5
Mean temperature of coldest quarter	64.3	1.8
Precipitation of driest month	0.4	3.3
Precipitation seasonality	0.4	1.8
Precipitation of warmest quarter	0	0.3
Precipitation of coldest quarter	15.7	17.7

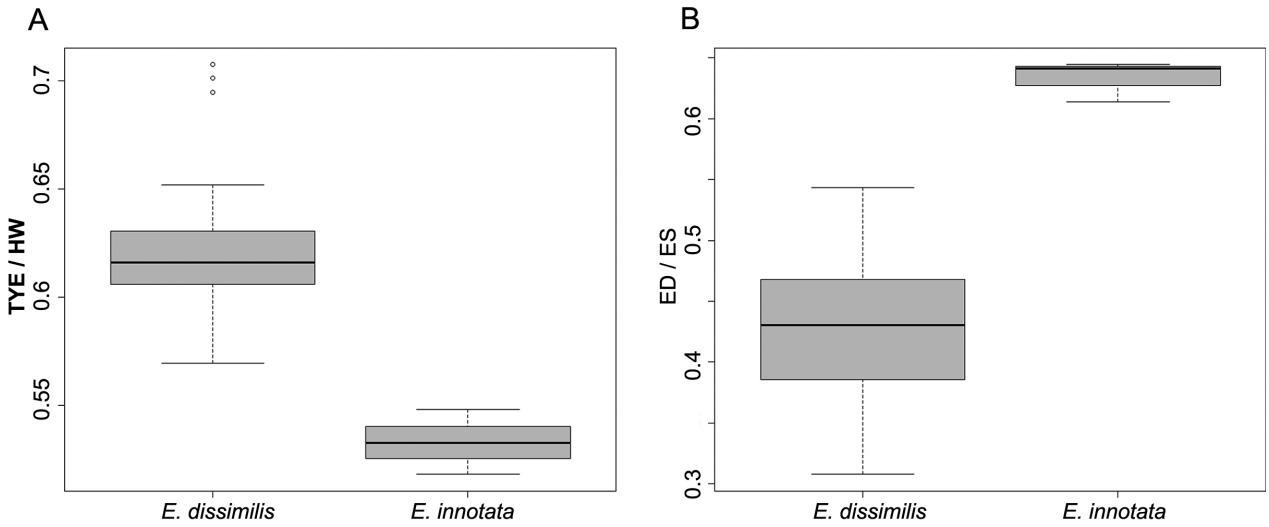

FIGURE 1. Boxplots of two morphological character ratios (A) TYE/HW and (B) ED/ES, whose distributions did not overlap between *E. innotata* (*n*=3) and *E. dissimilis sensu stricto* (*n*=23); top, middle and bottom lines of the boxes indicate 75th percentile, median and 25th percentile, respectively.

Habitat prediction. Our SDM analysis with seven locality points (Fig. 3, Table 1), revealed an extensive area in central India covering the northwestern parts of the Deccan Plateau, southeastern parts of the Malwa Plateau and western parts of the Chota Nagpur Plateau as the potential distribution envelope of *Eutropis innotata*. The highest prediction for a point chosen or random within the red areas of Figure 3 in the south-central parts of the Deccan plateau, consisting of the Hampi-Hosptete-Sandur block and the much larger Kunool-Raichur-Mahbubnagar Plateau, is that there will be a 70 to 100% chance of finding the species. The same result predicts the presence of *E. innotata* along the laterite ridges of the North Western Ghats, approximately between Malwan to Mahabaleshwar. The same results were also obtained in areas surrounding the type locality, including the place that has two adjacent records (S.E. Berar = Yavatmal, Maharashtra). Lower predictions, between 50% and 70% chance of finding the species, cover almost the whole of the rest of the Deccan plateau extending from Mysore, westwards to the Konkan, north-

eastwards to the Chota Nagpur Plateau. This means that there is a 50 to 70% chance of finding this species throughout a very large range. Surprisingly, moderate predictions showed up in the Coromandel or the East Coast between Vijayawada and Visakhapatnam. This is more or less in line with our expectations as the known elevation range of *E. innotata* ranges from 339–615 m a.s.l. On the whole, despite the denser representation of records in much higher latitudes (18.5–22.5'N), predictions were highest in southerly latitudes (15.5–18.5'N). This large envelope with the highest prediction essentially covers the southwestern parts of the known range of *E. innotata* (also see Rao *et al.* 2010). The Area Under the Curve (AUC) value was 90% in training data and 50% in random prediction. The bioclimatic variables that contributed most to these results were found to be the mean temperature of the coldest quarter (64.3%), precipitation of the coldest quarter (15.7%) and elevation in meters above sea level (14.9%).

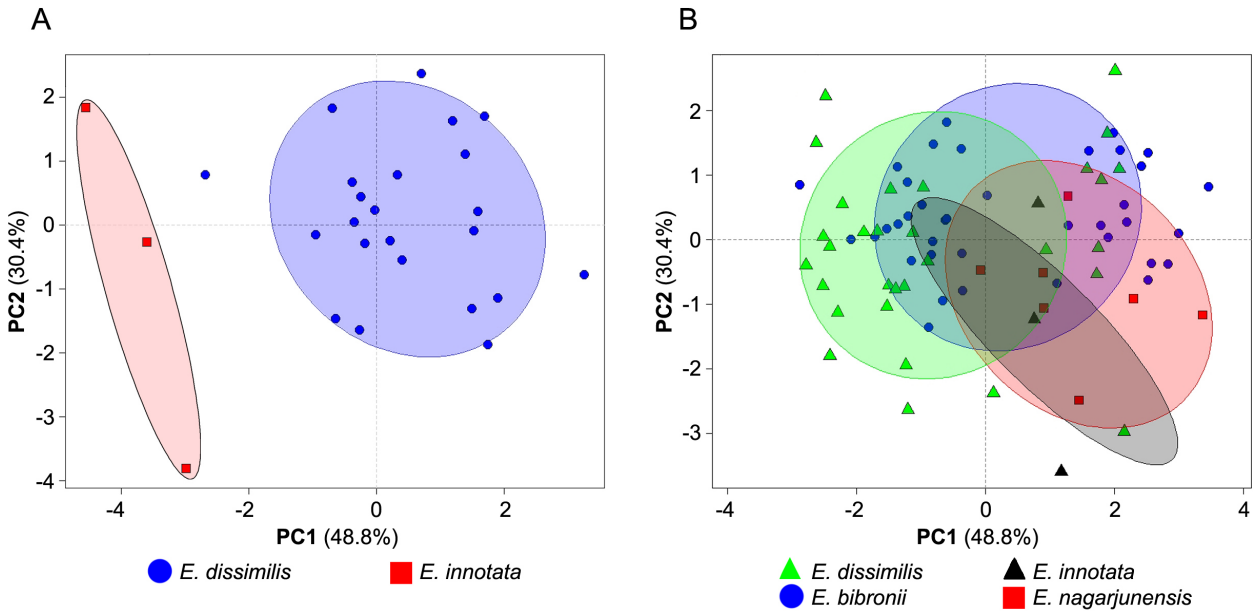

FIGURE 2. PCA ordination plot (PC1 vs. PC2) of the morphometric variation of (A) *Eutropis dissimilis sensu stricto* (blue circles) and *E. innotata* (red squares); (B) *E. bibronii* (blue circles), *E. nagarjunensis* (red squares), *E. dissimilis* sensu lato (green triangles), and *E. innotata* (black triangles) from different locations in India, each point represents a specimen; and the relative distances between two points represent the similarity.

TABLE 2. Principal Component Analysis (PCA) and loadings. Principal components (PC) 1 and 2 collectively explained nearly 80% 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	1.8268	1.3847	0.8832	0.8174	0.5420	0.0529	0.0242
Proportion of variance	0.4767	0.2739	0.1114	0.0954	0.0419	0.0004	0.0000
Cumulative proportion	0.4767	0.7507	0.8621	0.9575	0.9995	0.9999	1.0000
Loadings							
HW/SVL	-0.3910	0.3404	0.2161	-0.2836	0.7771	0.0142	-0.0090
ES/HW	0.4210	-0.2827	0.5399	-0.1875	0.1156	-0.2770	-0.5710
TYE/HW	0.4292	0.2368	0.5303	0.2907	0.0782	-0.0039	0.6228
ED/HW	-0.3795	-0.3921	0.4220	0.3557	-0.0194	0.6209	-0.1085
ED/ES	-0.4891	-0.2159	0.1535	0.3710	-0.0440	-0.7332	0.1162
TYE/ES	0.0267	0.6359	-0.0127	0.5751	-0.0578	0.0059	-0.5105
TBL/SVL	-0.3189	0.3788	0.4228	-0.4527	-0.6092	-0.0022	0.0036

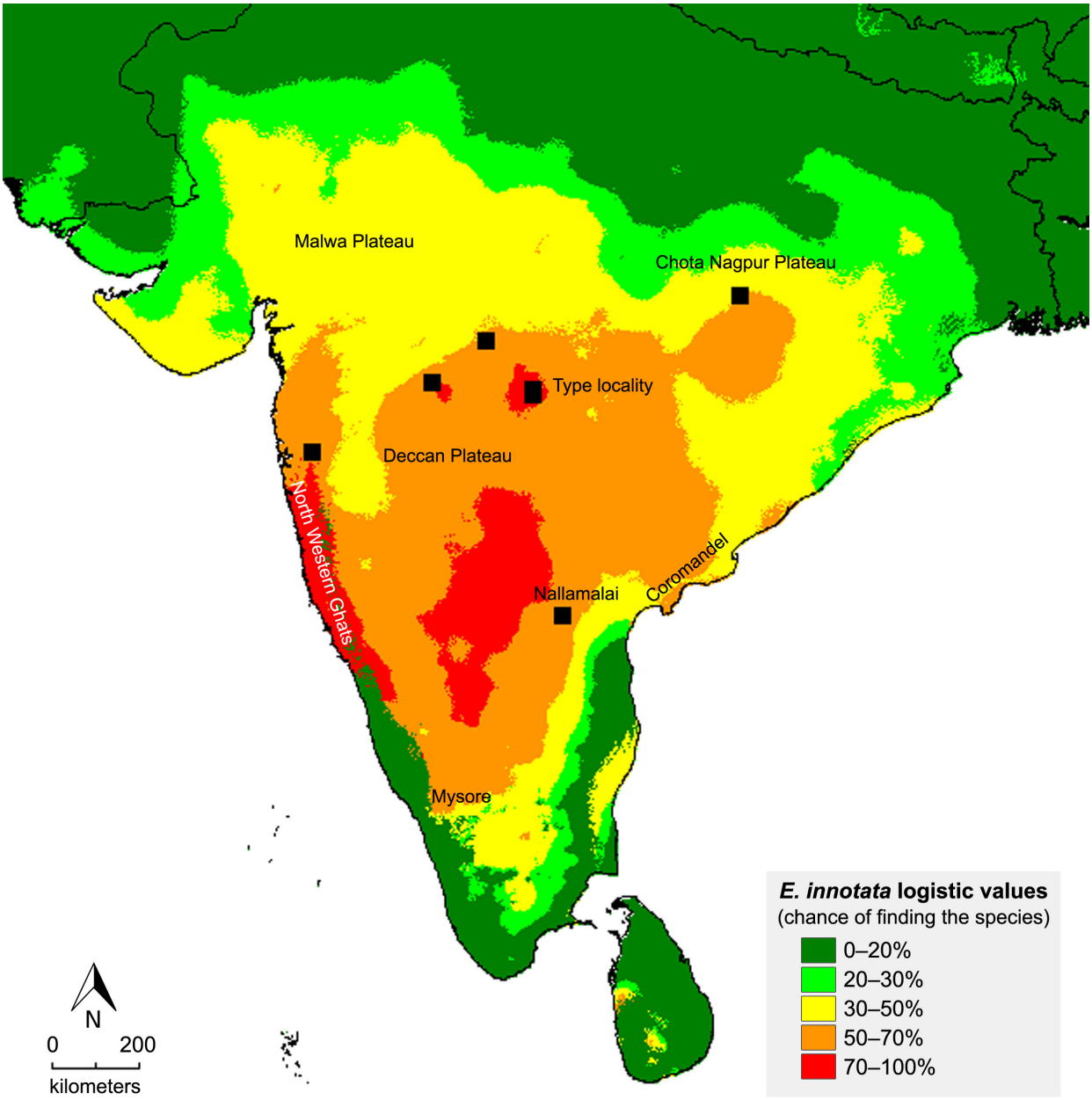

FIGURE 3. The recorded (squares) and predicted (coloured) distribution range of *Eutropis innotata* as calculated by Distribution Modelling in MaxEnt overlaid on a DIVA-GIS output map; different colours show the percentage probability (see figure legend) of finding the species in a random locality within the range.

Taxonomy

Eutropis innotata (Blanford, 1870)

(Figs. 4, 5; Table 3)

Euprepes innotatus Blanford, 1870
Euprepes innotatus—Theobald 1876
Mabuia innotata—Boulenger 1887, 1890
Mabuya innotata—Smith 1935, Tikader & Sharma 1992, Sharma 2002
Mabuya innotatus (*sic*.)— Das 1996, Chandra & Gajbe 2005
Eutropis innotata—Mausfeld *et al*. 2002, Mausfeld & Schmitz 2003, Rao *et al*. 2010, Srinivasulu *et al*. 2014, 2016, Deuti *et al*. 2020

Holotype. Adult male, NHMUK 1946.8.19.2, tail broken, SVL 54.7 mm, collected from "Pem Ganga Valley, S.E. Berár" (=Penganga Valley of Godavari River Basin, Yavatmal District, Maharashtra), India, by Dr. W.T. Blanford, date unknown [Note: the locality is recorded in the museum registry as "Godavery Valley"].

Diagnosis. A species of *Eutropis* inhabiting parts of the Deccan plateau, characterised as follows: morphologically most similar to *E. dissimilis* in body colouration, but lacks vertebral striping (a pair of black and white vertebral stripes in *E. dissimilis*); five keels on the mid dorsal scales (two), a nuchal pair (absent). In addition, *E. innotata* is similar to *E. bibronii* and *E. nagarjunensis* by having a transparent disc on the lower eyelid, but is distinguishable from those two species by having no vertebral stripes (present), and having 32–34 midbody scale rows (28–30 in *E. bibronii*), 56–60 ventrals (less than 52 ventrals), 45–50 paravertebrals (less than 41), 14–18 lamellae beneath the forth toe (20–24 in *E. nagarjunensis*), a single pair of smooth nuchals (two pairs of keeled nuchals), smooth temporals (keeled in *E. bibronii*), and absence of postnasal scale (present). Furthermore, *E. innotata* can be distinguished from any other known *Eutropis* species by having the following combination of characters: adult SVL of 54.7 mm, absence of mid dorsal longitudinal stripes, five keels on the mid dorsal scales, a smooth nuchal pair, three pre-auricular lobules, a transparent disc on the lower eyelid, 32–34 midbody scale rows, 56–60 ventrals, 45–50 paravertebrals, 14–18 lamellae beneath forth toe, absence of postnasal scale, and smooth temporal scales.

Redescription of holotype. Head moderately large, HL 23.3% of SVL, narrow, HW 55.8% of HL, HW 13.0% of SVL, indistinct from neck; snout short, ES 31.8% of HL, ES 57.1% of HW, slightly convex in lateral profile; rostral shield large, hemispherical, distinctly visible from above, posterior margin of midpoint rounded; frontonasal slightly contacting rostral; frontonasal wide, lateral border narrowly touching first loreal; prefrontals widely separated, contacting frontal and frontonasal, length equals frontonasal length, laterally contacting both loreal scales, posterior border contacting first supraciliary, first supraocular and frontal; frontal large, longer than wide, rounded posteriorly, length slightly shorter than frontoparietals and interparietal combined; frontoparietals two, in contact, longer than interparietal; parietals large and completely separated by interparietal, contacting pretemporal scales anterolaterally; all head scales smooth; single pair of smooth nuchals, overlapping middorsally. Nostril large and placed posterior of nasal; supranasal single, slightly 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 25.9% of HL; eye diameter greater than eye–tympanum distance, TYE 92.4% of ED, pupil rounded; interorbital distance broad; postoculars two, 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 frontal and frontoparietal, 3rd in contact with frontoparietal, 4th in contact with frontoparietal and parietal; supraciliaries seven; eyelid moveable, lower eyelid covered with a transparent disc.

Supralabials seven (eight on right side), fifth largest and at the mid orbit position, and contacting granular scales of lower eyelid; temporals smooth, single pretemporal; two primary temporals, secondary temporals three; infralabials six; ear opening large, approximately one third ED, deep, nearly round; three tiny pre-auricular lobules on anterior tympanum, below two larger and prominent. Mental large; postmental single, large; two pairs of chin shield, each pair separating 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 keels prominent) but varies from three to five keels along the body; all scales slightly imbricate; body slender, elongate; midbody scale rows 33; paravertebral scales 50; ventrals 58; preanal scales enlarged, four.

Forelimbs short, hind limbs relatively long, FEL 19.4% of SVL, TBL 11.1% of SVL; thigh longer, TBL 57.0% of FEL; dorsal surfaces of fore and hind limbs slightly tricarinate; subdigital lamellae of toe IV: 17; relative length of fingers IV> III> II> V> I; those of toes IV> III> V> II> I.

Tail broken (89.0 + 8.4 mm), median scale row of subcaudals subequal.

Coloration. After more than 150 years in preservative, dorsal head, body and tail light olive green, limbs light brown; a white dorsolateral stripe starting over the eye to the shoulder level, disappearing afterwards; another similar white stripe below beginning at supralabials and ending at the shoulder, these stripes with brown margins, and the area in between these stripes dark brown visible as a lateral band, fading after shoulder level; rest of the dorsum uniform without any colour patterns or vertebral stripes, a few rows of anterior body scales with darker margins; venter white, except limbs which are brownish.

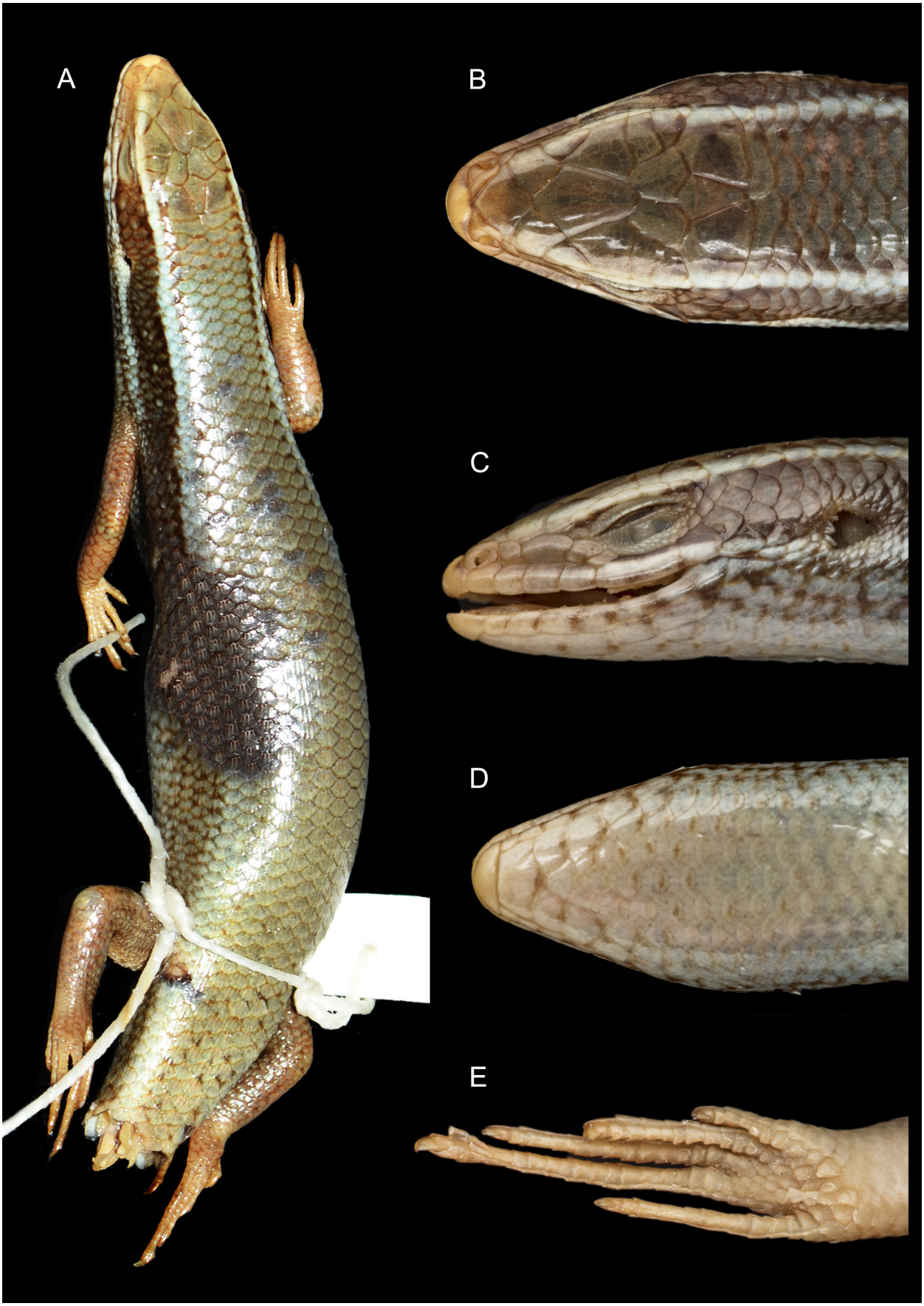

FIGURE 4. *Eutropis innotata* holotype (NHMUK 1946.8.19.2): **(A)** full body in dorsolateral aspect; head in **(B)** dorsolateral, **(C)** lateral (note the transparent disc on the lower eyelid), and **(D)** ventral aspects; and **(E)** foot and toes.

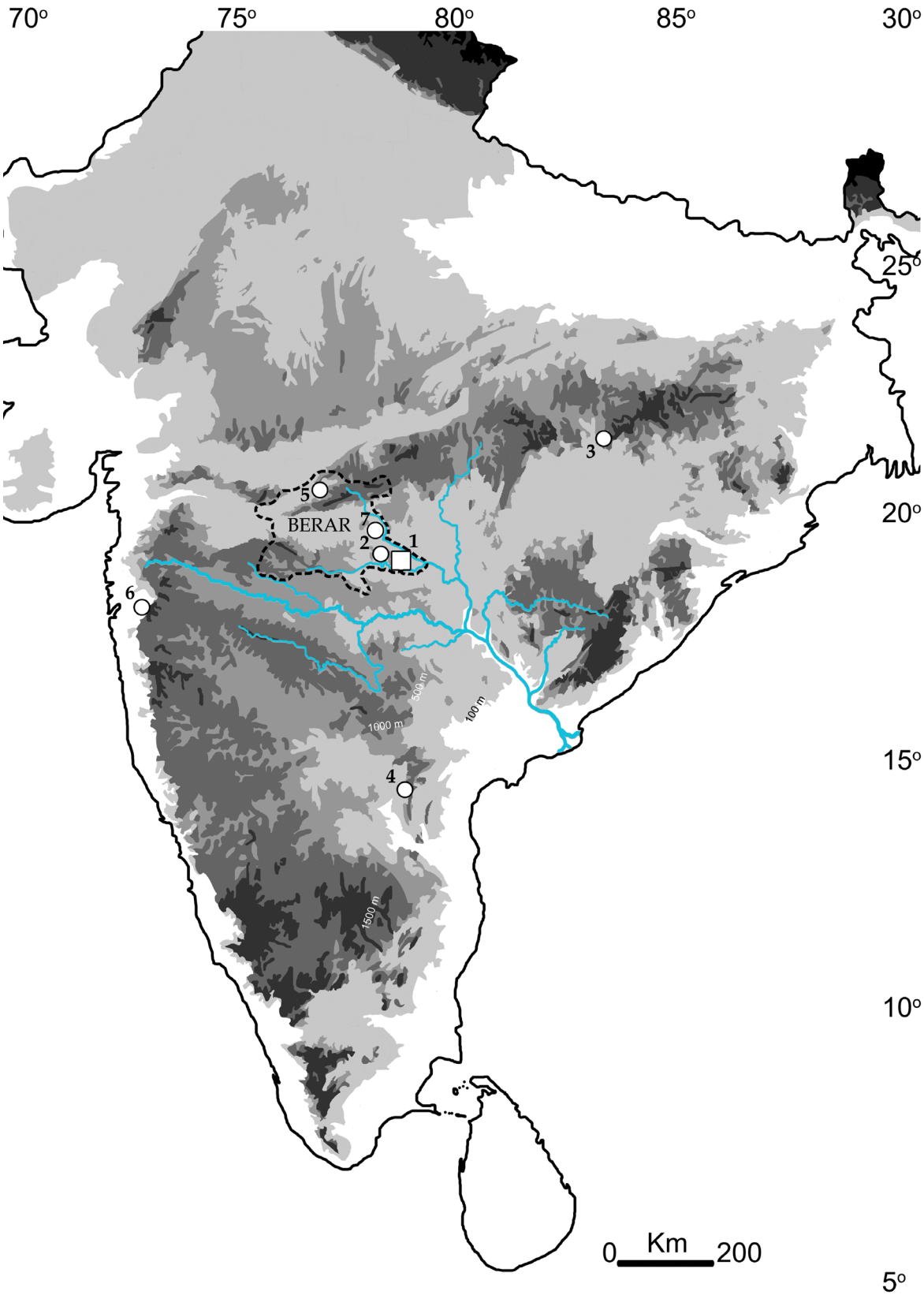

FIGURE 5. The map of India showing the Godavari River Basin and the current known distribution of *E. innotata* based on museum specimens and published literature: [1]Type locality, "Pem Ganga valley, S.E. Berár" (Penganga Valley, Yavatmal), [2]S.E. Berár (Yavatmal District), [3]Korba, Bilaspur, [4]Chinnamanthanala, Gundla Brahmeswaram Metta Sanctuary, [5]Melghat Tiger Reserve, [6]Bhaka Devi, Bhimashankar Wildlife Sanctuary, [7]Yavatmal (locality of recent photograph published in Deuti *et al.* 2020).

The live colouration is unknown, except for the colour description provided by Rao *et al*. (2010), who stated "Overall colouration of the skink was light golden brown, dorsal side without vertebral markings or streaks. A black dorso-lateral stripe between the eyes and base of the tail present, and the same was bordered by white line, which gradually faded posteriorly. Venter of the specimen was yellowish-white". In addition, Deuti *et al*. (2020) provided a colour image of a live individual of this species from Yavatmal, Maharashtra, but the white margin of the black dorso-lateral stripe is not as prominent as in the holotype specimen.

Distribution and habitat. *Eutropis innotata* is only known from five localities (seven sightings) since its description in 1870 (Fig. 5). Among these, four sightings (including collected specimens) were made recently: specimens, ZSI/R 284 and 1078 were collected in 1994, specimen ERMR-45a collected in 2002 [not examined by us, reported in Rao *et al*. (2010)], and the recent photograph in Deuti *et al*. (2020). Based on the reported localities of this species, it occurs in dry deciduous forests and scrublands. The predicted distribution range of this species is much wider than its known locations, especially in the south-central parts of the Deccan plateau (see under the habitat prediction).

Conservation status. The current conservation status of this species is Data Deficient (DD), which was correctly determined a decade ago (Sept 2010), but with the suggestion that this species may occur in many more localities than was known at the time (Srinivasulu & Srinivasulu 2013). The application of the IUCN Red List criteria (IUCN Standards and Petitions Subcommittee 2019) with the updated distribution data shows that *E. innotata* is restricted to an area of occupancy (AOO) of 175 km^2 recorded from seven localities within a 325,000 km^2 extent of occurrence (EOO). Given the extent of occurrence, the widespread distribution of dry deciduous forests and scrubland habitats, and the wide range of habitat predictions, *E. innotata* should be considered as a "Least Concern" (LC) species. Also, we opine that the reason for low reporting rates of this species is due to it being overlooked. The low reporting rate for *E. innotata* seems more likely to be due to the dorsum colour pattern exactly resembling that of *E. carinata* (see Fig. 4 and Discussion). Within the known distributional range of *E. innotata*, there are many protected areas such as Gundla Brameshwaram Sanctuary (Andhra Pradesh); Kanha National Park, Pench National Park (Madhya Pradesh); Yavatmal Wildlife Sanctuary, Melghat Tiger Reserve, Bhimashankar Jyothirlinga Wildlife Sanctuary (Maharashtra); and Amarkantak-Achanakmar Wildlife Sanctuary (Chhattisgarh). While we do not deny the on-going habitat degradation outside protected areas, the conditions appear stable inside protected areas (Malavia *et al*. 2010; Reddy *et al*. 2015). Recent studies on the conservation status of the habitat as a whole reveal degradation threats that are not as alarming as they might be (Agarwala *et al*. 2016; Neelakantan *et al*. 2019; Sahu *et al*. 2008; Yadav *et al*. 2012), largely due to it being the stronghold of a tiger population (Joshi *et al*. 2013; Sharma *et al*. 2013). Therefore 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 under Criterion A). Also we believe that there are more than 1,000 individuals within the predicted geographic range, and therefore it doesn't qualify under Criterion D. As we do not have the population decline information to consider Criterion C, at the moment, our description relates mostly to Criterion B.

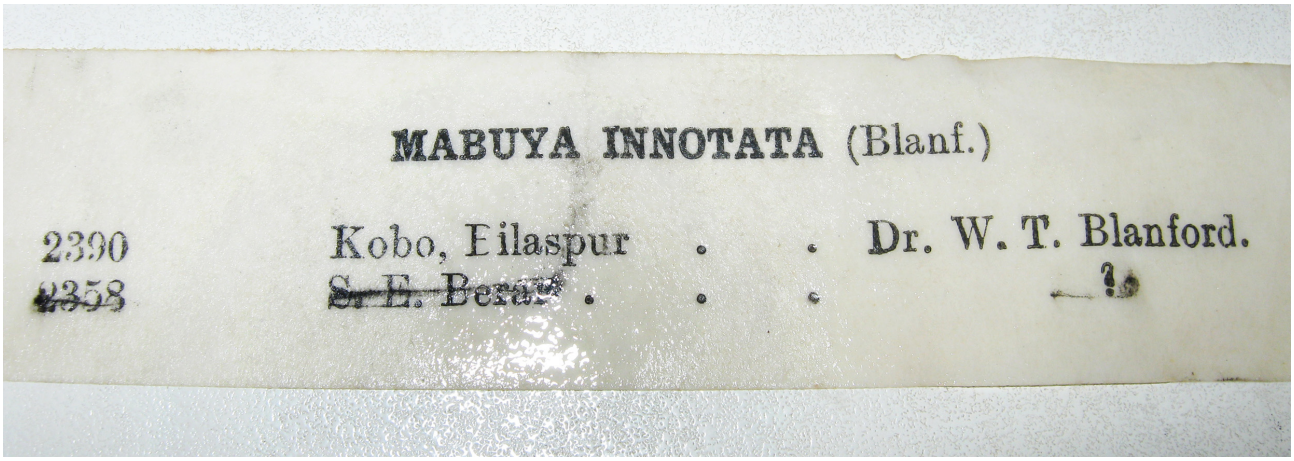

FIGURE 6. The original label of the two voucher specimens of *Eutropis innotata* (ZSI 2390, 2358) collected by Dr. W.T. Blanford (after the description of species), currently deposited at the Zoological Survey of India (ZSI), Kolkata.

TABLE 3. Some morphometric, meristic, and morphological characters of the *Eutropis* species which have transparent disc on lower eyelid; —not applicable / not evaluated.

Character	*E. innotata*		*E. dissimilis*	*E. bibronii*	*E. nagarjunensis*
	holotype NHMUK 1946.8.19.2	other (*n*=4)	(*n*=34)	(*n*=54)	(*n*=6)
head length	12.7	7.4–9.1	11.8–24.6	8.5–11.9	11.6–13.4
head width	7.1	5.6–7.7	9.4–13.3	4.8–6.8	7.0–7.3
eye–nostril length	3.1	2.7–3.6	3.9–6.5	2.1–3.5	3.2–4.1
snout length	4.1	3.9–4.5	5.8–8.4	3.2–4.6	4.6–5.3
eye–tympanum length	3.0	2.9–4.1	4.4–7.3	2.1–3.4	3.0–3.1
orbit diameter	3.3	2.5–2.9	3.2–6.0	1.5–3.0	2.4–3.5
snout–vent length	54.7	37.2–47.8	29.2–98.7	31.0–47.9	46.4–48.6
tibia (shank) length	6.0	4.8–7.5	10.4–15.3	4.5–7.5	7.6–8.4
femur (thigh) length	10.6	6.0–9.7	8.3–13.7	4.4–7.8	5.8–7.8
toe IV length	—	4.8–5.5	4.7–7.6	5.0–7.9	7.1–8.2
Midbody scale rows	33	32–34	32–36	28–30	32–35
Ventrals	58	56–60	54–59	46–52	51
Paravertebrals	50	45–49	46–50	37–41	37–41
Lamellae on toe IV	17	14–18	12–15	15–19	20–24
No. of dorsal keels	5		2	5	5
No. of nuchal pairs	1		0	2	2
No. of pre-auricular lobules	3		3	3	3
Temporal scales	smooth		smooth	keeled	smooth
Nuchals	smooth		—	keeled	keeled
Parietals	smooth		smooth	keeled	smooth
Postnasal	absent		absent	present	present

Discussion

The quinquecarinate skink, *Euprepes innotatus* was described by Blanford (1870) based on a single specimen collected from "Pem Ganga valley, S.E. Berár" (Penganga Valley). In the original description, Blanford (1870) clearly stated that he had only one specimen in hand "In the only specimen procured…". Thus, if there is any other specimen of *E. innotata* collected by William Thomas Blanford (1832–1905) himself, this must have been collected after the description of *Euprepes innotatus* was made. Currently there are two specimens originally labeled together at the Zoological Survey of India (ZSI), Kolkata, under the catalog numbers ZSI 2390 collected from "Kobo, Bilaspur" and ZSI 2358 collected from "S.E. Berar". Both specimens were collected by Dr. W.T. Blanford and the label clearly states the name "*Mabuya innotata* (Blanf.)". Thus, it is obvious that these two specimens were collected after the description of the species, and neither of them are types. There exists no indication on the label or in the jar that these specimens were ever recognized as types. Smith (1935) also only mentioned these two specimens as two out of the three specimens he examined. The third specimen must therefore be the holotype he examined. Usually, new labels for type materials were added by Malcolm Arthur Smith (1875–1958) in his own hand writing, whilst he examined specimens at the Indian Museum (Now Zoological Survey of India) for the completion of his book series "The Fauna of British India, Including Ceylon and Burma" in 1931–1943. However, in this case this was not done. There are no labels added by M.A. Smith indicating any of the type specimens. Thus, this left us in doubt as to the status of ZSI 2358, the supposed holotype of *Eutropis innotata*, as indicated by Das *et al*. (1998) and Deuti *et al*. (2020). Boulenger (1887) redescribed the species based on a single same specimen at the British Museum, now Natural History Museum, London (NHMUK) collected from the "Godavery Valley" and interestingly, it was presented by Dr. W.T. Blanford. Although Boulenger (1887) did not mention the specimen as the "type" in his catalogue, the NHMUK

museum registry clearly mentions it as the type of *Euprepes innotatus*. According to the NHMUK museum logbook, Dr. W.T. Blanford presented the type specimen and it was registered on 10 November 1880 (old catalogue number: BMNH 1880.11.10.66). The locality only reads "Godavery Valley", because at the time of presenting the specimen to NHMUK, Blanford probably provided the locality as such. Actually, the locality mentioned in the original description "Pem Ganga valley, S.E. Berár" (Penganga Valley), is also a tributary of the Godavari River Basin in the Yavatmal District, Maharashtra, India (see Fig. 5). Furthermore, the specimen (NHMUK 1946.8.19.2) clearly catalogued as the "type" is in agreement with the original description given by Blanford (1870) in every aspect (see the redescription); e.g. the SVL given in the original description is 2.25 inches (~57 mm), and the holotype at NHMUK has SVL ~55 mm, but ZSI 2358 has SVL only ~43 mm. Hence there is no doubt of its status and here we accept NHMUK 1946.8.19.2 as the correct holotype of *Eutropis innotata*.

Southeast Berar (S.E. Berar), along the Penganga Valley in Central India has been surveyed by many researchers in the 19th and 20th centuries; see Jerdon (1853), Stoliczka (1870, 1872) and Schmidt (1926) who dealt with the areas falling within the known distribution range of *E. innotata* (see also Deuti *et al*. 2020), including Jalna, Korba, Bilaspur, Jashpur, Bhandara, Chanda, Udaipura and Allapalli, but apparently *E. innotata* has never been recorded except in Korba and Bilaspur. The recent finding by Rao *et al*. (2010) from Gundla Brameshwaram, in central Nallamalai Hills, indicates its presence in the intervening areas such as Amarabad, Nalgonda, Nizamabad and Adilabad Plateaus. Despite fieldwork targeting rare skinks of the Deccan, in parts of Nallamalai (Seetharamaraju *et al*. 2009; Srinivasulu *et al*. 2016) as well as in Nashik (Datta-Roy *et al*. 2017), *E. innotata* has never been recorded. Given the fact that Blanford (1870) himself almost missed noticing this species; from within collections of other, better-known congeners, it is not impossible to rule out that unrecognized or unidentified sightings of *E. innotata* might exist. Observing the still well preserved, body coloration of the holotype, there seems little doubt that even an experienced naturalist may identify this species in the field as an individual of *E. carinata*. We believe the reason for the lack of reporting of this species is due to its close resemblance to a few sympatric congeners such as *E. carinata sensu lato* (see this work), *E. macularia sensu lato* (see Blanford 1870) and *E. dissimilis sensu lato* (see Rao *et al*. 2010; this work). These works support our above statement. We therefore believe that a careful reexamination of the bulk of *E. carinata* specimens in museum collections may yet yield more specimens of this cryptic species. The realized range of *E. innotata* (this work) is shared by sympatric, range-restricted congeners such as *E. nagarjunensis* and *E. ashwamedhi* (in Nallamalai), *E. trivittata* (in Pune), *E. beddomei* (Jerdon, 1870) and *E. dissimilis* (very much throughout the range). The natural climatic vegetation types in areas of known distribution ranging from dense scrublands to deciduous woodlands, underscores the potential increase in the known distribution of *E. innotata* across the semi-arid, elevated table land of the Deccan plateau.

Our specific allocation of *Eutropis innotata* to the *Eutropis carinata* complex is based on morphological evidence (specifically colour pattern), plus morphometric (Fig. 2), and meristic (Table 3) traits. Additionally, it is evident that Blanford (1870) was unfortunately incorrect in mixing up *E. innotata* with *E. macularia sensu lato*, rather than with the *E. carinata* group. Judging by the holotype of *E. innotata*, it is clear the photo depicted as *E. innotata* in Deuti *et al*. (2020), lacking yellowish dorsolateral stripes along forebody and trunk, may be a misidentification prompted by Blanford's allusion with *E. macularia*. It is also probable that phylogenetic results may show a different placement of *E. innotata*. Due to such placements, morphological positions and phylogenetic traits do not always closely match. For example, *E. bibronii* and *E. nagarjunensis* are very similar in morphological and morphometric traits (see Amarasinghe *et al*. 2016b), but phylogenetically *E. nagarjunensis* is sister to *E. trivittata*, while *E. bibronii* is allied to *E. quadricarinata* (see Datta-Roy *et al*. 2012, 2015; Srinivasulu *et al*. 2016). Similarly, morphologically *E. beddomei* is similar to *E. trivittata* (see Amarasinghe *et al*. 2016a), but phylogenetically *E. nagarjunensis* is sister to *E. trivittata*. Thus, even though *E. innotata* and *E. dissimilis* or *E. carinata* are morphologically close; phylogenetically they each may cluster with different species. However, to facilitate the study of subgroups in this genus, we tentatively place *E. innotata* within the *E. carinata* species group, especially considering the transparent lower eye disc which is so far a unique character for some species of this group.

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APPENDIX 1. Comparative materials.

***Eutropis beddomei* (*n*=42): 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; **Sri Lanka:** NHMUK 1905.3.25.21, NMSL uncat.; Kachchai: NMSL RSK 30.

***Eutropis bibronii* (*n*=54): 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; Karnataka: ZSI 4385; Kerala: ZSI 4363; Odisha: ZSI 16711, 23413a–b, 23415, 26666, 26742–53, 26754, 26798–801; **Sri Lanka:** NMSL RSK 53, NMSL uncat.; Challani: NMSL RSK 51; Tabbowa: NMSL RSK 52; Chundikulam: NMSL RSK 157.

***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 dissimilis* (*n*=35): India:** West Bengal: ZSI 2348, 5429; Odisha: ZSI 22894, 23302, 26518; Jharkhand: ZSI 2349, 24476; Bihar: ZSI 5585, 19737; Madhya Pradesh: ZSI 24209a–d, 25313; Uttar Pradesh: ZSI 11459, 21088, 21089a–b, 21093; Uttarakhand: ZSI 13221; Jammu: ZSI 21677–9, 23186; Rajasthan: ZSI 13487; Punjab: ZSI 19801 (holotype of *Mabuya hodgarti*), 19803–5 (paratypes of *Mabuya hodgarti*), 19351, 19353–4, 19372–3, 24050.

***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 lankae* (*n*=36): Sri Lanka:** Polonnaruwa: NMSL RSK 20, 102; Dikkanda: NMSL RSK 21; Gammaduwa: NMSL RSK 23; Wanatavillu: NMSL RSK 55; Tunukai: NMSL RSK 104; Welioya: NMSL RSK 145; Batticaloa: NMSL RSK 147; Okada: NMSL RSK 149; Pothuwil: NMSL RSK 151; Alankulama: NMSL RSK 152; Kosgoda: NMSL RSK 153; Thabalagamuwa: NMSL RSK 117, 126, 154; Peradeniya: NMSL RSK 155; Vauniya: NMSL RSK 107; Vannayalumkulam: NMSL RSK 108; Hunugalla: NMSL RSK 110; Ollarakulam: NMSL RSK 133; Nikaweratiya: NMSL RSK 121, 125; Buttala: NMSL RSK 128; Taralanda: ZMB 77405; Sri Lanka: NMSL RSK 22, 24, 73-75, 77, 101, 123, 130, 146, 150, 156.

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

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

***Eutropis resetarii* (*n*=4): Sri Lanka:** Haggala: NMSL RSK 54, 109; Thalwakele: NMSL RSK 56, 148.

***Eutropis trivittata* (*n*=7): India:** Maharashtra: ZSI 2359, 21512–3, 21620, ZSI/R 942, 1080; Bihar: ZSI 16405.