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A NEW BLIND SKINK (REPTILIA: DIBAMIDAE: *Dibamus*) FROM BUTON ISLAND, INDONESIA

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Abstract

Blind skinks of the genus *Dibamus* are one of the least studied squamate taxa, only represented by a limited number of museum specimens. Here we study the taxonomy of *Dibamus novaeguineae* sensu lato in Indonesia by examining all the available museum specimens collected from Wallacea and mainland West Papua deposited at the Museum Zoologicum Bogorienese (MZB) and evaluate morphological and biogeographic evidence. We also include all published data on specimens that were attributed to that species. *Dibamus novaeguineae* is widely distributed throughout mainland Papua, Maluku, Sulawesi, and adjacent islands, the Lesser Sunda Islands, and the Philippines. We compare *D. novaeguineae* sensu stricto on Papua and sensu lato populations on the Lesser Sunda Islands and demonstrate that the *D.* cf. *novaeguineae* population on Buton Island represents a distinct endemic phenotype. Based on morphological and scalation differences, we here describe this isolated population on Buton, an island off the coast of southeastern Sulawesi, as a new species. We further discuss the biogeography of that new species.

Keywords: *Dibamus novaeguineae*, Lesser Sunda, Moluccas, Morphology, Sulawesi, Taxonomy

Introduction

The blind skinks of the genus *Dibamus* Dumeril & Bibron, 1839 have a wide distribution from southern Indochina to Papua New Guinea, including the Nicobar Islands and other transcontinental oceanic islands of the Indonesian and Sulu Archipelagos (Greer 1985, Das 1996, Honda *et al*. 1997, 2001, Das & Lim

2003, 2009, Neang *et al*. 2011, Quah *et al*. 2017, Uetz & Stylianou 2018, Koppetsch *et al*. 2019, Kliukin *et al*. 2023, 2024a,b). They represent an ancient group of limbless burrowing squamates dispersed from the Palaearctic to the Nearctic Beringian region in the Late Palaeocene to Eocene (Townsend *et al*. 2011). They are fossorial, sexually dimorphic, with a worm-like habitus, and degenerated eyes, which are covered by large scales, and they lack external ear openings (Greer 1985, Taylor 1962). The females of all species are limbless, and the males have small flaplike hind limbs (Greer 1985).

Currently, the genus *Dibamus* consists of 27 nominal species, 10 of which are endemic insular species distributed across the Indonesian Archipelago (Koppetsch *et al*. 2019). Only five species occur in Wallacea: *D. celebensis* Schlegel, 1858; *D. seramensis* Greer, 1985; *D. manadotuaensis* Koppetsch, Böhme & Koch, 2019; *D. novaeguineae* Duméril & Bibron, 1839; and *D. taylori* Greer, 1985. Among them, the last two species correspond to understudied, widely distributed species complexes consisting of multiple phenotypes. In addition, phylogenetic analyses have revealed two deeply divergent and geographically concordant clades of *Dibamus* with mainland Southeast Asian origin and Peninsular/insular origin (see Townsend *et al*. 2011). However, due to their rarity in collections, small body size, fossorial habit, the similarity of some distinct species, intraspecific variation, and difficulties of species identification, the exact distribution of each species and the real species diversity of the genus *Dibamus* are unresolved. Half of the species of this genus were described during the last three decades (Uetz & Stylianou 2018) due to more intensive fieldwork.

Dibamus novaeguineae was described based on two specimens (*i.e*., syntypes) from Papua New Guinea by Duméril & Bibron (1839). Twenty-five years after that first description, Peters (1864) named another related species from Ternate (Moluccas), *Typhloscincus martensii* based on two specimens, which was subsequently synonymized with *D. novaeguineae*. Greer (1985) designated one of the syntypes of *D. novaeguineae*, MNHN-RA 1994.0787 (formerly MNHN-RA 7156A) as the lectotype—see discussion for the taxonomic history of the species. *Dibamus novaeguineae* has long been considered a single widely distributed species throughout Papua (Duméril & Bibron 1839, Boulenger 1887, 1890, 1912, de Rooij 1915, de Jong 1926, Forcart 1953, Supsup *et al*. 2016), Lesser Sundas (de Rooij 1915, Darevsky 1964, Auffenberg 1980, Zug & Kaiser 2014, Kliukin *et al*. 2024a), Moluccas (Peters & Doria 1878, Boulenger 1890, Boettger 1895, 1900, Boettger 1900, de Rooij 1915, Dunn 1927, Brongersma 1948, Greer 1985, Kliukin *et al*. 2024a), Sulawesi (Boulenger 1890, Boettger 1900, Schenkel 1902, Roux 1911, de Rooij 1915, de Jong 1926, Kliukin *et al*. 2024a), southern Philippines and Palawan (Greer 1985, Brown & Alcala 1986, Supsup *et al*. 2016) until Borneo (de Rooij 1915, Lloyd & Inger 1968), Sumatra (Bleeker 1860, Boulenger 1890, Weber 1891, Boettger 1900, de Rooij 1915, 1917, 1922, Brongersma 1933, Smith 1935) and Peninsular Malaysia (Boettger 1900, Boulenger 1912, de Rooij 1922, Smith 1935, Tweedie 1950)—see discussion for geographic explanations. Based on type material and additional voucher specimens, after considering morphological and morphometric characters and the geographically restricted insular distribution of examined specimens, we concluded that the *D.* cf. *novaeguineae* population in Buton Island is an unnamed entity that we here describe as a new species.

Materials and Methods

We compared the type specimen of *Dibamus novaeguineae*, deposited at Muséum National d'Histoire Naturelle France (MNHN), with all the available *Dibamus* specimens from Indonesia (21) deposited at the Museum Zoologicum Bogorienese Indonesia (MZB; see Appendix). We obtained diagnostic morphological, morphometric, and meristic data for species comparisons (Greer 1985, Koppetsch *et al*. 2019), and updated distribution data from examined specimens and most recently published literature (Kliukin *et al*. 2023, 2024a,b). We did not consider the publication of Hoser (2012) in our work following the worldwide consensus among herpetologists (Kaiser *et al*. 2013).

Terminology for morphometric and meristic characters follows Greer (1985), Quah *et al*. (2017), and Koppetsch *et al*. (2019). We measured the following characters with a Mitutoyo digital caliper and dissecting microscopes in mm: snout–vent length (SVL, measured from tip of snout to anterior margin of vent); tail length (TL, measured from anterior margin of vent to tail tip); head length (HL, distance between posterior edge of the last supralabial and tip of snout); head width (HW, width at angle of jaw); eye–nostril distance (EN, distance between anterior most point of eye and posterior most point of nostril); snout length (ES, distance between anterior most point of eye and snout); internarial width (IN, least distance between nostrils); interorbital width (IO, least distance between upper margins of orbits); frontal scale width (FSW: widest transverse distance of frontal scale); frontal scale length (FSL: longest longitudinal distance of frontal scale); frontonasal scale width (FNSW: widest transverse distance of frontonasal scale); frontonasal scale length (FNSL: longest longitudinal distance of frontonasal scale); interparietal scale width (IPW: widest transverse distance of interparietal scale); width of nuchal scale contacting posterior interparietal (NW: greatest width of any scale contacting interparietal); body width (BW: greatest width of body at midbody). We also measured the length of the vestigial hind limb in males (VHL).

We counted the number of transverse scale rows just posterior to head (HSR), at midbody (BSR), and one head length anterior to the vent (VSR); the number of subcaudal scales from vent to tail tip; the number of ventral scales from postmental to the vent; postoculars, supralabials, infralabials, and preanal pores. Some of our meristic data will be self-explanatory; however, a few characters require further description here. We counted the number of nuchal scales bordering the interparietal (NIP). We also counted the number of chin scales on the posterior edges of the first infralabials (on both sides together) and the mental, including the medial chin scales (PIM; contrary to previous authors who counted only on one side, excluding or including the medial scale).

We evaluated the presence or absence of head sutures: medial rostral suture (MRS), lateral rostral suture (LRS), nasal suture (NS), and labial suture (LS). We also evaluated whether these sutures were complete or incomplete when present. Regarding the medial and lateral rostral sutures, we followed Kliukin *et al*. (2023) who identified two separate characters for the term “rostral suture”: (i) the medial rostral suture (MRS, the medial suture running from the anterior edge of frontonasal scale towards the snout); and (ii) the lateral rostral suture (LRS, paired sutures running from the lateral edges of frontonasal scale towards nostrils). The comparative sizes of frontal vs frontonasal (whether frontal was smaller or larger), interparietal vs. surrounding nuchal scales (whether the interparietal was larger or equal/smaller), and interparietal vs. frontonasal [whether interparietal was more or less similar in size (at least 75% of frontonasal) or distinctly smaller (50% or below of frontonasal size)]. Sex was determined by the presence of rudimentary flap-like hindlimbs in males only. The coloration was evaluated by the presence and absence of light transverse body bands (BB).

Character states and geographical distribution data for species of the genus *Dibamus* were obtained from literature sources: Angel (1935); Taylor (1962); Greer (1985); Darevsky (1992); Das (1996); Honda *et al*. (1997, 2001); Ineich (1999); Das & Lim (2003, 2005, 2009); Das & Yaakob (2003); Diaz *et al*. (2004); Neang *et al*. (2011); Quah *et al*. (2017); Koppetsch *et al*. (2019); Nguyen *et al*. (2021); and Kliukin *et al*. (2023, 2024a,b).

Statistically informative tests could not be performed on separate sexes due to the small sample sizes of females representing the different geographical areas. We performed separate Kruskal–Wallis one-way analysis of variance tests on eight morphometric characters (SVL, HL, HW, EN, ES, IN, IO, and BW) to evaluate any significant differences among the Wallacean (i.e. mainland Sulawesi and adjacent islands + islands in Moluccas + islands in Lesser Sundas) species/phenotypes of *Dibamus*: *D. celebensis* (*n*=5), *D. manadotuaensis* (*n*=3), *D. seramensis* (*n*=2), *D. novaeguineae* sensu lato from West Papua and Lesser Sundas (*n*=4), and *D.* cf. *novaeguineae* from Buton (*n*=5). We used this test due to the small sample sizes (Zar 2010). Juveniles were excluded to avoid the bias of allometry for the statistical analyses. Variation in adult size (the same 11 morphometric characters above) was normalized using the following equation: $\log X_{adj} = \log(X) - \beta(\log[SVL] - \log[SVL_{mean}])$, where X_{adj} = adjusted value; X = measured value; β = unstandardized regression coefficient for each population; and SVL_{mean} = overall average SVL of all populations (Lleonart *et al*. 2000, Chan & Grismer 2022) before multivariate analyses. The scale morphometrics were treated as the dependent variable and the population as the predictor variable.

Multivariate analysis was conducted using Principal Component Analysis (PCA) to reduce the highly correlated multidimensional data matrix into a few uncorrelated variables. We performed PCA analysis for three morphologically closely similar Wallacean phenotypes that shared the character of having a frontal scale that was smaller than the frontonasal: *D. celebensis* (*n*=5), *D. novaeguineae* sensu lato from West Papua and Lesser Sundas (*n*=4), and *D.* cf. *novaeguineae* from Buton (*n*=5). We used the princomp function in R (v4.3.1; R Core Team 2024). A biplot of the first two principal component scores was used to examine the morphometric differentiation between the populations. All statistical analyses were conducted using R.

Results

The snout length (ES) and body width (BW) comparison showed geographically significant differences between the Wallacean species/phenotypes of *Dibamus* ($\chi^2 = 11.76$, $P = 0.008$ and $\chi^2 = 11.65$, $P = 0.009$, respectively; Kruskal–Wallis test). A shorter ES and narrow BW of the Buton population indicated a relatively thinner body with a shorter head than that of *D. novaeguineae* sensu lato in West Papua and Lesser Sundas (Figs. 1A–C). Multivariate analysis by Principal Component Analysis (PCA) among the Wallacean populations also showed other differences between *D. novaeguineae* and Buton Island population in morphometric characters with a distinct non-overlapping cluster for lumped sexes (Fig. 1D). Principal Components 1 and 2 collectively explained 78.0% of the variation in the morphometric data matrix (Sup. Table 1). All the scaled measurements of the first component loaded negatively, while scaled HL, HW, IN, and IO loaded positively only on the second principal component.

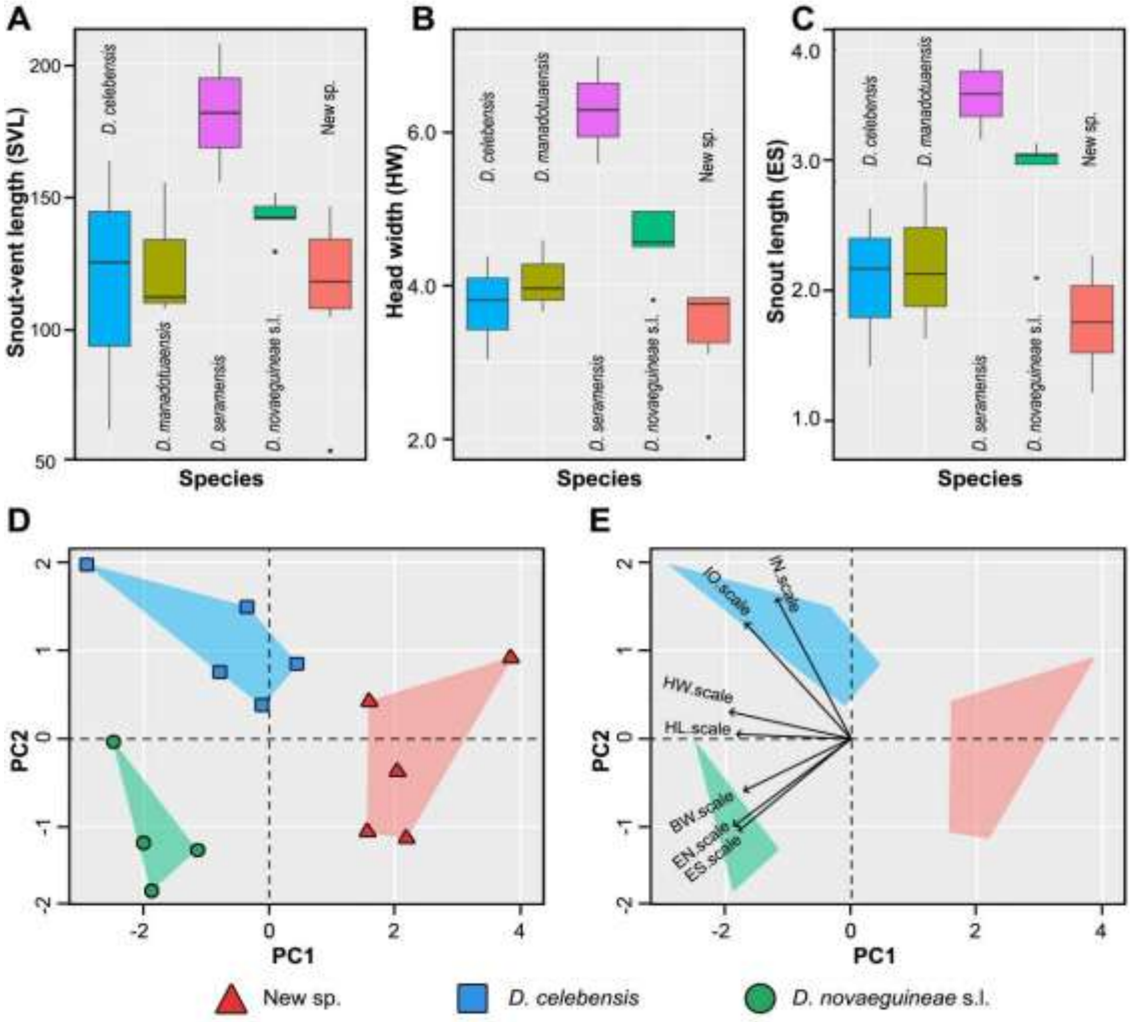

Figure 1. Boxplots of **(A)** snout–vent length, **(B)** head width, and **(C)** snout length indicating differences among the Wallacean members (except *D. taylori* due to lack of enough samples) of the genus *Dibamus* (note that sexes were combined); **(D)** Principal Component Analysis biplot of morphometric variation among the three morphologically closely similar Wallacean phenotypes that share the character of having a frontal scale that is smaller than frontonasal: *D. celebensis* (blue squares), *D. novaeguineae* sensu lato from West Papua and Lesser Sundas (green circles), and *D.* cf. *novaeguineae* (the new species) from Buton (red triangles); **(E)** the same base biplot with vectors associated with population clusters.

Morphologically, we confirm that the populations of *Dibamus novaeguineae sensu stricto* (based on its lectotype) are distributed in mainland Papua, evidently from Papua New Guinea and West Papua, and probably adjacent islands. Based on the morphometric analysis, *D. novaeguineae* samples from the Lesser Sunda represent a distinct nonoverlapped cluster with the samples from Buton Island. The further morphological comparison confirmed that *D. novaeguineae* samples from the Lesser Sunda are more similar to *D. taylori* from Sumba Island (in preparation). The Buton population also differs from all other known species in the genus concerning body scalation, morphometrics, and biogeographic island isolation; these differences are distinct enough to consider this population as an undescribed species, which we describe below. We assign the new species to the genus *Dibamus* based on the following combination of characters: worm-like body, absence of limbs in females, but males with small, flaplike hind limbs; absence of external ear-openings; vestigial eyes covered by a scale; large, plate-like scales on snout and mandible; body covered with smooth, cycloid scales (Greer 1985).

We present diagnostic morphological, morphometric, and meristic data taken for the holotype and five paratype specimens in Table 1. Morphological analyses revealed a suite of characteristics that allowed us to separate the population of Buton Island from all other known species of the genus *Dibamus* (Sup. Table 2). Based on morphological differences, we herein describe the *Dibamus* population from Buton as a new species.

Taxonomy

Dibamus oetamai sp. nov.

(Table 1, Sup. Table 2; Figs. 2, 3)

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Dibamus novaeguineae — Gillespie *et al.* 2005
Dibamus sp. nov. — Gillespie *et al.* 2015

Holotype. An adult male, MZB 4273 (SVL 103.4 mm), collected from Kakenauwe (5°10'59.10"S, 122°54'59.65"E, datum = WGS84 in all cases; 14 m above sea level), Lasalimu, Buton Island, Southeast Sulawesi, Indonesia, collected by G.R. Gillespie on 21 July 2002.

***Paratypes* (*n*=5).** Adult males, MZB 4276 (SVL 145.7 mm), MZB 4278 (SVL 117.0 mm); Juvenile male MZB 4272 (SVL 62.4 mm); Adult females, MZB 4274 (SVL 138.6 mm), MZB 4279 (SVL 117.2 mm); other collection data the same as holotype.

Diagnosis. A species of *Dibamus* only known from Buton Island which differs from all the nominal species by having the following combination of morphological characters: maximum SVL of 145.7 mm; tail comparatively short, TL comprising 12.0–14.8% of SVL; medial and lateral rostral sutures absent, labial and nasal sutures complete; frontal larger than frontonasal (relative size of frontonasal 0.75–1.04); interparietal distinctly smaller (half size of) than frontonasal; interparietal more or less similar in size to nuchals (relative size of nuchals 0.67–1.43) with 4–6 surrounding nuchal scales; two postocular scales; a single supralabial; 6–8 chin scales bordering the posterior edge of the first infralabials and mental; the medial sublabial scale not enlarged; 22–24 midbody scale rows; 24–26 transverse scale rows just posterior to head; 21–23 transverse scale rows just anterior to vent; 192–197 ventral scales in males, 214–221 in females; 40–42 subcaudal scales in males, 17–28 in females; and two or three light-coloured bands present on the body.

***Description of the holotype*.** An adult male, SVL 103.4 mm; head slightly wider (HL 2.9 mm) than long (HW 3.1 mm), slightly distinct from neck; snout rounded, projecting beyond jaw; teeth small, acute; nostril laterally oriented, slightly oval, situated closer to tip of snout (EN/ES ratio 0.74); medial and lateral rostral sutures absent; nasal sutures complete, extending from ocular to nostril; labial sutures complete, extending from anterior part of nasal suture to mouth; lateral rostral pad with some evenly distributed papillae; the rostral pad is bordered posteriorly by a supralabial, an ocular scale, and a frontonasal; posterior border of rostral slightly curved; eyes dimly visible through ocular scale; two scales posterior to supralabial; both frontonasal (FNSL/FNSW = 0.49) and frontal (FSL/FSW = 0.54) wider than long; frontal relatively large, 1.15 times the width of frontonasal; frontonasal bordered by frontal and ocular scales; interparietal single, not enlarged, narrower than frontonasal (FNSW/IPW = 3.75) and frontal (FSW/IPW = 4.33), bordered by frontal and four more or less relatively equal-sized nuchal scales; two postoculars, with one postocular scale contacting frontal on each side; supralabial single, elongated, bordering ocular dorsally; infralabials lanceolate, separated by a smaller, triangular mental; mental bordered by the first infralabial on each side; four chin scales including a medial scale behind the mental contacting the first infralabial.

Body wormlike, almost cylindrical (BW/SVL ratio 0.04); body scales smooth, subcycloid; 23 midbody scale rows; 26 scale rows just posterior to head; 22 scale rows anterior to vent; scales near vent thick; 197 ventrals; two pairs of enlarged scales with pores on preanal region, separated by a median scale, overlapping those on sides; covered by a pair of somewhat enlarged scales through which elongate pores are visible.

Hind limbs present, flap-like, flattened, curved inward, lacking toe pads, covered by imbricating scales; three scales between the base of hind limbs; three large dorsal scales on distal portion of hind limb.

Tail complete, short (14.4% of SVL), tip blunt, not bulbous, covered by a single rounded scale, smaller than rest of the tail including near preanal region; 40 subcaudal scales; All morphometric /meristic data are listed in Table 1.

Coloration. In preservation, rostral and mental pads opaque; dorsum and flanks pale-chestnut brown; ventral surface lighter brown; subcaudal region darker brown. The body band gray; body scales are brownish, dark centrally, and transparent or creamy on posterior edges.

Color in life (based on Fig. 3, not collected), dorsum and flanks pale-chestnut brown; ventral surface lighter brown; subcaudal region darker brown. The body band cream.

Variation. The female paratypes (MZB 4274, 4279) collected in syntopy with the male holotype agree in most characters, but the legs are absent as in all females of the genus. Other male paratypes (*n*=2) have a single pair of preanal pores vs. two in the holotype.

Etymology. The specific epithet is a singular noun in the genitive case, honoring Dr. Jakob Oetama (27 Sep 1931–9 Sep 2020), a renowned journalist and the co-founder of Kompas Gramedia—the largest media group in Indonesia, for his enormous contribution to Indonesian Journalism. Dr. J. Oetama also served as the advisor to the Central Board of the Indonesian Journalists Association and the ASEAN Journalists Confederation. We use the modern name "Oetama", formed in the case of singular masculine, adding the suffix (-*i*). English name: Buton blind skink. Indonesia: Kadal buta Buton.

Table 1. Morphometric (in mm) and meristic characters of the holotype and paratypes of *Dibamus oetamai* sp. nov.; M = male; F= female, J = juvenile; — = not applicable; + = damaged/broken

	Holotype	Paratypes				
character	MZB 4273	MZB 4276	MZB 4278	MZB 4272	MZB 4274	MZB 4279
sex	M	M	M	M (J)	F	F
snout-vent length (SVL)	103.45	145.71	117.01	62.37	138.59	117.25
tail length (TL)	14.93	8.2+	17.28	17.49	6.8+	10.1
head length (HL)	2.99	3.85	4.00	2.83	4.2.00	3.60
head width (HW)	3.10	3.81	3.83	2.62	3.69	3.83
eye–nostril distance (EN)	1.61	1.69	1.54	1.20	2.04	1.64
snout length (ES)	2.16	1.70	1.71	1.41	2.44	2.23
internarial width (IN)	0.85	1.07	0.85	0.85	1.00	0.92
interorbital width (IO)	1.78	2.27	2.30	1.67	2.31	2.86
frontal width (FSW)	1.95	2.27	2.27	1.59	1.94	1.42
frontal length (FSL)	1.05	0.83	1.00	0.63	0.89	0.78
frontonasal width (FNSW)	1.69	1.83	1.64	1.06	1.76	1.79
frontonasal length (FNSL)	0.83	0.77	0.75	0.49	0.72	0.43
interparietal width (IPW)	0.45	0.88	0.51	0.65	0.79	0.63
body width (BW)	4.15	3.86	4.21	2.55	3.76	3.93
hind limb length (VHL)	2.28	2.90	2.75	0.98	—	—
no of scale rows (H-B-V)	26-23-22	25-24-21	24-22-21	26-24-21	24-23-23	24-23-21
subcaudals	40	18+	41	42	17+	28
ventrals	197	192	194	?	214	221
preanal pores	2	1	1	?	—	—

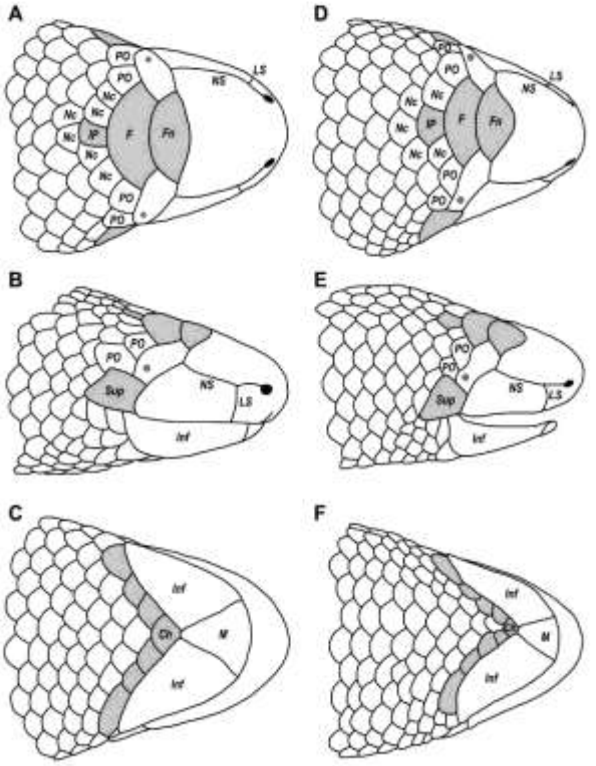

Figure 2. Dorsal, Lateral, and ventral head views of the holotype of *Dibamus oetamai* sp. nov. (MZB 4273; **A–C**) from Buton; and the lectotype of *D. novaeguineae* (MNHN-RA 1994.0787; **D–F**) from Papua New Guinea. Note the differences of nuchal scales (A vs. D) and chin scales (C vs. F) pattern; Illustrations by AATA (not to scale).

Figure 3. Adult male of *Dibamus oetamai* sp. nov. (not collected) in life from Lambusango Forest Protected Area, Buton Island. Photo by GRG.

Comparison. *Dibamus oetamai* sp. nov. is most similar to *D. novaeguineae* and *D. celebensis* (comparative characters indicated in parentheses), but it can be distinguished from those species by its lack of medial rostral sutures (incomplete sutures present in *D. celebensis*); two postoculars (three in *D. celebensis*); 22–24 midbody scale rows (26–30 in *D. celebensis*); two nuchal scales in contact with frontal (only a single nuchal scale in both species); 6 or 7 chin scales bordering the posterior edge of the first infralabials and mental (8 or 9 in *D. novaeguineae* and 10 or 11 in *D. celebensis*); 40–42 subcaudal scales in males (38–40 in *D. celebensis*), 17–28 subcaudal scales in females (35–42 in both species); and two or three light-colored bands on the body present (absent in both species).

Other congeners from Wallacea have suites of characters that distinguish them from *D. oetamai* sp. nov. Unlike the new species, *D. manadotuaensis*, *D. seramensis*, and *D. taylori* have frontals smaller than frontonasal (vs. frontal larger than frontonasal in *D. oetamai* sp. nov.). Furthermore, *D. manadotuaensis* and *D. seramensis* have four postoculars, and *D. taylori* has three postoculars (vs. two in *D. oetamai* sp. nov.).

The new species is unlikely to be confused with *D. bogadeki*, *D. booliati*, *D. bourreti*, *D. dalaiensis*, *D. dezwaani*, *D. floweri*, and *D. greeri* which all have a larger interparietal when compared to the surrounding nuchal scales (vs. equal or smaller in *D. oetamai* sp. nov.) and their interparietal more or less similar in size to their frontonasal (vs. more or less half the size of the frontal in *D. oetamai* sp. nov.).

Among the species having a closely similar head scalation, *D. deharvengi*, *D. deimontis*, *D. kondaoensis*, *D. montanus*, *D. smithi*, and *D. somsaki* have complete or incomplete medial rostral sutures (vs. totally absent in *D. oetamai* sp. nov.); *D. leucurus* has an incomplete lateral rostral suture (vs. absent); *D. tropcentr* and *D. vorisi* have no labial suture (vs. present); *D. alfredi*, *D. ingeri*, and *D. vorisi* have no preanal pores in males (vs. one or two present); *D. alfredi* and *D. smithi* have preanal pores in females (vs. absent).

Distribution and habitat. The new species is endemic to Buton Island and so far known only from one locality, Kakenauwe, and Lambusango Forest Protected Area on Buton Island (Fig. 4). The species occurs in monsoonal rainforests below 400 m elevation (Gillespie *et al*. 2015). All the specimens of the species were found in minimally or moderately disturbed forests associated with deep litter habitats within the forest and have never been found in riparian forests or coastal areas, so it is most likely a forest-dependent species (Gillespie *et al*. 2005, 2015).

Natural history. A fossorial species (Gillespie *et al*. 2005), nearly all individuals have been captured with pitfall traps. One individual was found 20 cm below ground while installing a pitfall trap. This species is either rare or highly cryptic; only 28 individuals were detected in over 70,000 pitfall trap nights over 13 years in central Buton Island (see Gillespie *et al*. 2015).

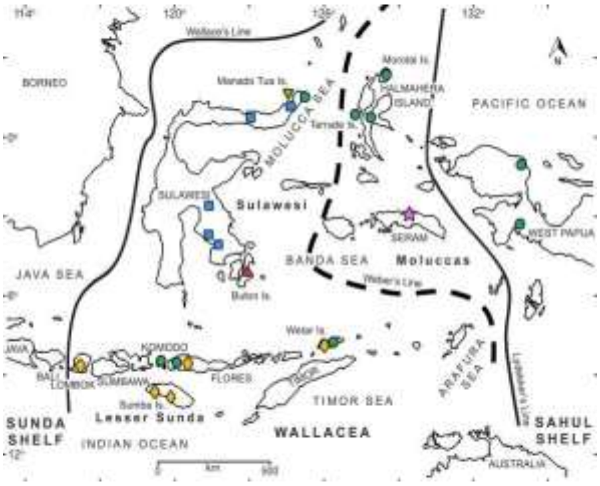

Figure 4. The map of Wallacea and Papua showing the distribution of the genus *Dibamus* in eastern Indonesia: *D. celebensis* (blue squares), *D. novaeguineae* sensu lato (green circles), *D. oetamai* sp. nov. (red upward triangles), *D. manadotuaensis* (olive downward triangles), *D. seramensis* (violet stars), and *D. taylori* (orange diamonds).

Discussion

The *Dibamus* specimens from Buton Island were originally labelled as *D. novaeguineae* due to their close morphological similarity to *D. novaeguineae*. *Dibamus novaeguineae* was described by A.M.C. Duméril & Bibron (1839: 834–835) based on two syntypes sent to Paris from Leyden Museum under the name '*Acontias subcaecus*'. Both syntypes were in the MNHN collections, MNHN-RA 7156 (female) and MNHN-RA 1994.0787 (male; formerly MNHN 7156A). The female syntype had no head, but this was not indicated in the original description nevertheless the authors gave head scalation for only one specimen in their original description (see the English translation in sup. material 1). Therefore, we suspect the head was originally lacking. The species was also the type species of the monotypic genus *Dibamus* A.M.C. Duméril & Bibron, 1839. Greer (1985) designated the male syntype described in its original description, as the lectotype, and the female syntype (now paralectotype) was without a head. In the original description, Duméril & Bibron (1839) synonymized the unpublished nomen '*Acontias subcaecus*' on the label from the Leiden Museum, but Dubois (2022) indicated that the unpublished nomen was an invalid synonym of *D. novaeguineae*. Brygoo (1985) measured the respective total lengths (132 mm and 159 mm) and tail lengths (17 mm and 22 mm) of the syntypes MNHN-RA 1994.0787 and MNHN-RA 7156. The MNHN lectotype was later X-rayed by Eugen Kramer in 1997, but nothing was published. Head skull images of *D. novaeguineae* sensu lato were also provided by Strong *et al*. (2021) for one specimen (UF 33488) collected from Nunang Selatan (Flores, Lesser Sundas); however, the species identity has to be reassessed and probably the specimen is *D. taylori* and not *D. novaeguineae*.

In this study, we recognized *D. novaeguineae* sensu lato as a morphological species complex, according to general morphology and scalation. All Indonesian species can be treated as members of that complex, except *D. dezwaani*, which has a large interparietal similar in size to the frontonasal. In contrast, the species from the *D. novaeguineae* species complex all have a smaller interparietal that is approximately half the size of the frontonasal. Furthermore, the interparietal of all the members of the *D. novaeguineae* complex is similar in size (or sometimes smaller) compared to the surrounding nuchal scales. For most of the known *Dibamus* species, there is no genetic evidence to define their phylogenetic relationships. Due to sexual dimorphism throughout the genus *Dibamus*, some meristic characters (e.g., ventrals, subcaudals) have to be counted separately for each sex. Consequently, larger sample sizes are needed to properly evaluate intraspecific morphological variation. Therefore, studies enhanced with integrative systematic approaches on the genus *Dibamus* will be useful in understanding the morphological variation, biogeography, phylogeny, evolutionary dispersal, and speciation.

In the only phylogenetic study—on the evolutionary dispersal of *Dibamus*—to date, Townsend *et al*. (2011) showed that *D. novaeguineae*, *D. seramensis*, and *D. celebensis* presented closer genetic affinities to one clade (peninsular/island clade in Townsend *et al*. 2011). On the other hand, *D. bourreti* and *D. greeri* (*D. montanus* is probably a misidentification of another Vietnamese species; see Kliukin *et al*. 2023) represent another clade (mainland Southeast Asia clade in Townsend *et al*. 2011). In our morphological assessment, the mainland species complex sensu Townsend *et al*.

(2011) represents a unique morphological character that distinguishes it from the *D. novaeguineae* complex (i.e. peninsular/island clade sensu Townsend *et al*. 2011) by having a large interparietal similar in size to the frontonasal, which is also larger than the surrounding nuchal scales.

Dibamus novaeguineae has long been considered a widely distributed species. reporting specimen locations without detailed morphological examination and thorough comparison to its type material has created taxonomic uncertainty throughout its distribution range. Twenty-one years after its first description, Bleeker (1860) named two related species from Western Sumatra: *Typhlina leucurus* from Agam and *Typhlina ludekingi* from Maninjau Caldera. Smith (1935) considered the former species to be a synonym of *D. novaeguineae*, and the latter species was considered as an "*incertae sedis*" by Greer (1985). Greer (1985) placed *Typhlina ludekingi* as a synonym of *D. novaeguineae*, but without any particular reason, and no specimen was cited. Its type specimen still could not be found and may be lost. Greer (1985) assigned the *Typhlina leucurus* to the genus *Dibamus* and revised it as a valid species. Since Bleeker's species was from Sumatra, subsequent authors report *D. novaeguineae* from Sumatra without proper comparison to the Papuan population. de Rooij (1922) reported *D. novaeguineae* from mainland Sumatra and several islets near Sumatra: Sinabang in Simalur (Simeulue), Babi, Nias, and Nako. de Rooij (1922) illustrated the cloacal area of a female and a male that he attributed to *D. novaeguinea* from Sinabang. However, the population from Nias Island was later described as *D. dezwaani* by Das & Lim (2005). Similarly, the population from Simeuleu Island was described as *D. tebal* by Das & Lim (2009). Boulenger (1890) reported *D. novaeguineae* from Sumatra, and subsequently, Weber (1891) reported the species from Singkarah (Singkarak, West Sumatra) and Kaju tanam (Kayutanam, Padang) from Sumatra. Boettger (1900) and Brongersma (1933) also reported *D. novaeguineae* from Weh Island, at the north point of Sumatra. Furthermore, de Rooij (1917) reported the species from Deli, north Sumatra. Most of the recovered corresponding specimens to *D. novaeguineae* from Sumatra were later identified as new species or *D. leucurus*. Therefore, we consider that *D. novaeguineae* sensu stricto does not occur in Sumatra.

The first report of *Dibamus novaeguineae* on Borneo was made by de Rooij (1915) from Baram River. Subsequently, Lloyd and Inger (1968) reported the species from Nanga Tekalit, Sarawak. Both reports were from the west coast areas of Sarawak, probably these populations correspond to *D. leucurus*, *D. vorisi*, *D. ingeri*, or another unknown species. Boettger (1900) and Smith (1935) reported *Dibamus novaeguineae* from Patani, Peninsular Malaysia, Boulenger (1912) from Bukit Besar, Malaysia, and de Rooij (1922) from Babi Island in Malaysia. However, Denzer & Manthey (1991) mentioned that there is only one report of *D. novaeguineae* from Peninsular Malaysia, Kelantan, first reported by Tweedie (1950). That location of *D. novaeguineae* could certainly be attributed to *D. booliati* which was later described by Das & Yaakob (2003) from the same locality in Kelantan State.

Steindachner (1867) named a related species to *D. novaeguineae* from Nicobar Island as *Rhinophidion nicobaricum*. However, Boulenger (1890) and de Rooij (1915) considered the blind skink population on Nicobar to represent *D. novaeguineae*, and Smith (1935) synonymized it with *D. novaeguineae*. At that time, Smith (1935) only recognized two species in the genus *Dibamus*, *D. novaeguineae* and *D. montanus*. Greer (1985) synonymized it with *D. leucurus*. Tiedemann (1994) placed *R. nicobaricum* back in synonymy with *D. novaeguineae.* Das (1996) revalidated the species, and Das (1999) indicated that the record of *D. novaeguineae* from Nicobar Island was mistaken for one from Lembeh Island (Pulau Lembeh, an island off the coast of Bitung, Sulawesi). Although *D. nicobaricus is* allied to *D. novaeguineae,* comparing the Nicobar population with the Papuan population, revealed that *D. nicobaricus* is a distinct species by having several characteristics such as a single postocular (vs. two in *D. novaeguineae*), 34–38 subcaudals in males (vs. 42–45), and presence of lateral body bands (vs. absent). The taxonomy of the genus *Dibamus* in the Sulu Archipelago has not been assessed yet. The populations found on the islands of the Philippines, e.g. Cebu Island (Brown & Alcala 1986; Supsup *et al*. 2016); Visayan, Mindanao, and Palawan Islands (Supsup *et al*. 2016), Negros Island (Greer 1985; Brown & Alcala 1986), and Papakog(?) Island (Greer 1985) have long been assigned to *D. novaeguineae*. However, Greer (1985) assigned the Philippine populations to *D. novaeguineae* and *D. leucurus*. A head (CAS-SU 26874) and skull of three *D. novaeguineae* specimens (CAS-SU 18762, 26868, and 26898) can be found in Greer (1985). However, all the specimens were from the Philippines, not Papua. Cole & Gans (1997) also indicated the Philippine specimens from Negros Island, which have a diploid number of 36 chromosomes (2*n*=36) were *D. novaeguineae*. As we had no access to the collections from the Philippines, we retained the populations from the Sulu Archipelago as *D. novaeguineae* sensu lato.

Twenty-five years after the first description of *D. novaeguineae*, Peters (1864) named a related species from Ternate (Moluccas), *Typhloscincus martensii*. Subsequently, Peters & Doria (1878) synonymized the genus, *Typhloscincus* with *Dibamus* and synonymized the species with *D. novaeguineae*. We were unable to examine its syntypes ZMB 5026-27 in the Berlin Museum, because the specimens have not been located since 1995 (see Bauer *et al*. 1995; Bauer 2016; Tillack, F. pers. comm. on 4 June 2024). Peters (1864) provided head-scale illustrations of one of the syntypes (female) with an incomprehensive description. However, from that description and illustrations, it is clear that *T. martensii* represents a *Dibamus* species and is also distinct from the new species we describe here. The new species has 17–28 subcaudal scales in females (vs. 36 subcaudals in *T. martensii*); 6 or 7 chin scales bordering the posterior edge of the first infralabials and mental (9 in *T. martensii*); frontal similar size as frontonasal (frontal is at least four times larger than frontonasal). Although such characteristics are clear enough to identify that *T. martensii* is a distinct member of the *D. novaeguineae* species complex, we retain it as a junior subjective synonym of *D. novaeguineae*, until we find a living population from Ternate.

After the discovery of Peters (1864) from Ternate, subsequent authors report *D. novaeguineae* from the Moluccas (Boulenger 1890), including specific islands: Ceram (Seram; de Rooij 1915; de Jong 1926), Ternate (Peters & Doria 1878; Boettger 1900; de Rooij 1915), Halmahera (Peters & Doria 1878; Boettger 1895, 1900; de Rooij 1915), and Morotai (de Jong 1928; Brongersma 1948). These islands probably share a single species; as we have not found any specimens, we leave it for future taxonomic assessments.

Dibamus novaeguineae has been reported from mainland Sulawesi by Boulenger (1890), Weber (1891), Boettger (1900), de Jong (1926); and specifically, from Tomohon, north Sulawesi by Schenkel (1902); Lembeh Island, north Sulawesi by Das (1999); from Luhu (Luwu), south Sulawesi by de Rooij (1915); and Meraka, southeast Sulawesi by Roux (1904). Among these populations, the north Sulawesi population might be represented by *D.* cf. *celebensis*, *D. manadotuaensis,* or another unknown species. The southern population may represent *D. celebensis* sensu stricto and the southeast Sulawesi population might represent the new species we described from Buton. Based on the studied specimens, the distribution pattern of *D. novaeguineae* sensu lato in Sulawesi is somewhat similar to that of the *Oligodon waandersi* complex studied by Amarasinghe *et al*. (2021). Among the *O. waandersi* complex, *O. propinquus* is distributed in the northern, *O. waandersi* in the southern, and *O. tolaki* in the southeastern parts of Sulawesi and Buton Island. However, until we conduct an integrative study, we retain the entire mainland Sulawesi population as *D. celebensis* sensu lato.

Reporting of *Dibamus novaeguineae* from the Lesser Sunda Islands was done by Rooij (1915) from Lombok and Darevsky (1964) from the Komodo Islands. Subsequent authors, Auffenberg (1980), Zug & Kaiser (2014), and Kliukin *et al*. (2024a) followed this without any comparison to *D. novaeguineae* sensu stricto; and also reported it from Flores Island (see Zug & Kaiser 2014). So far, all the specimens we observed from the Lesser Sundas (Appendix) are much closer to *D. taylori* sensu lato than *D. novaeguineae* sensu lato by having a smaller frontal than frontonasal. There is a recent report (Zug & Kaiser 2014) from Komodo and Flores, but until we reassess the Lesser Sunda populations, we consider that *D. novaeguineae* might be distributed throughout the Lesser Sundas. Reports from the eastern parts of the Lesser Sundas, such as Wetar Island (see Dunn 1927), could represent true *D. novaeguineae.* However, this cannot yet be confirmed due to the lack of any corresponding specimens and low sampling effort to date on these islands.

After the description of *Dibamus novaeguineae* from Papua New Guinea, Boulenger (1887, 1890), Boettger (1900), de Rooij (1915), de Jong (1926), Forcart (1953) reported the species from Waigiou (Waigeo) and the western part of West Papua. On the current distribution map (see Fig. 4) *D. novaeguineae* sensu lato is retained on the Moluccas and Lesser Sundas until further investigation with a larger sample size. The lack of specimens, genetic data, and poor understanding of the phylogenetic affinities highlights our incomplete knowledge of the genus *Dibamus*. The reptile fauna of Wallacea is one of the least known in Southeast Asia and many species are restricted to localized areas, such as individual islands, and exhibit substantial geographic variation across the region (see Amarasinghe *et al*. 2015, 2021; Riyanto *et al*. 2022). Given the biogeographical complexity and insular nature of many islands in this region, the resolution of further species from this species complex can be expected.

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Supplemental data

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Appendix. Other Specimens Examined

Dibamus alfredi: Thailand: FMNH 178336 (holotype), 178337–8, NHMUK 1903.4. 13.64.

D. bourreti: Vietnam: MNHN-RA 1935.0417 (holotype).

D. celebensis: Indonesia: Sulawesi: RMNH 3638 (lectotype, designated by Greer 1985), 3637 (paralectotype), MZB. 6369, 11052, NMBA 4057, 4879–80, NHMUK 96.12.9.43, ZMA 10153.

D. leucurus: Sumatra: NHMUK 63.12.4.29 (holotype), 63.12.11.168, MCZ 109854, RMNH 5555, ZMA 11736, 15497, 15501; Borneo: FMNH 138679, 138681.

D. manadotuaensis: Indonesia: Sulawesi: MZB 6822–3, 14728.

D. montanus: Vietnam: NHMUK 1946.8.3.3 (lectotype, designated by Greer 1985), 1946.8.3.2 (paralectotype).

D. novaeguinea: Indonesia: Papua New Guinea: MNHN-RA 1994.0787 (lectotype, formerly MNHN-RA 7156A, designated by Greer 1985), 7156 (paralectotype); West Papua: MZB 7545, 13091.

D. seramensis: Indonesia: Seram: MCZ 7623 (holotype), MZB 2284a–b.

D. smithii: Vietnam: NHMUK 1946.8.21.27 (holotype), 1946.8.21.25–26 (paratypes), 1946.8.21.28–29 (paratypes).

D. taylori: Indonesia: Sumba: NMBA 14777 (holotype), 14776, 14778–80, ZMA 15499; Flores: MCZ 25360; Lombok: NHMUK 97.6.21.31, 1973.3454; Nusa Penida: 5255–8; Wetar: MCZ 27065–27067, MZB 5254.