

Research article

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**A new species of *Dravidogecko* (Squamata: Gekkonidae)
from the under-surveyed Periyar Plateau of the
Southern Western Ghats in Peninsular India**

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Abstract. We describe a new species of *Dravidogecko* from the poorly-inventoried Periyar Plateau of Southern Western Ghats, Peninsular India. The new species *Dravidogecko beddomei* sp. nov. is characterized by: precloacal-femoral pores 46–52; scales across belly 31–33; supralabials 9–11; infralabials 8–9; lamellae on digit IV of pes 10–11. Additionally, the new species is divergent (>13%) from its related congeners. Like its congeners, the new species is currently known only from its type locality and its vicinity – the Devar Malai, Kakki Reservoir – and Sivagiri Hills in the Periyar Plateau of Southern Western Ghats. This discovery further increases the list of new reptiles described from this under-studied massif in the Southern Western Ghats.

Keywords. Allopatry, endemism, gecko, Periyar Plateau, wet zone.

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Introduction

Dravidogecko Smith, 1933 is the only gekkonid genus endemic to the Western Ghats of India (Smith 1933, 1935). Since its first description as *Hoplodactylus anamallensis* by Günther (1875) the status of this taxon as a distinctive genus has been rather contentious and unsettled (Bauer & Russell 1995). Of late, Bansal & Karanth (2013) studied the molecular phylogenetic position of *Dravidogecko* for the first time and remarked on its very ancient, pre-collision origin that happened in the drifting, insular, Indian peninsula. They also reported this genus from the north of the Palghat Gap and reported genetic

sub-structuring. Bansal & Karanth (2013) stated theirs to be the first record of the genus *Dravidogecko* from the north of the Palghat Gap. An historical record by Beddome in Griggs' (1888) from the western Nilgiris was overlooked. Recently, prompted by the natural discontinuities and breaks in the Western Ghats, Chaitanya *et al.* (2019) worked out the phylogenetic systematics of this genus and described six new species, all allopatric and isolated on specific massifs.

Chaitanya *et al.* (2019) restricted the concept of *Dravidogecko anamallensis* (Günther, 1875) to populations inhabiting the Anamalai hills proper and recognised the other populations as new species based on subtle scalations differences and phylogenetic distinction. Populations inhabiting either side of the Anamalai hills, the High Range to the south and the Palni hills to the east were recognized as new species *D. janakiae* Chaitanya, Giri, Deepak, Datta-Roy, Murthy & Karanth, 2019 and *D. tholpalli* Chaitanya, Giri, Deepak, Datta-Roy, Murthy & Karanth, 2019 respectively. Further south across the Nedumkandam the Meghamalai population was described as *D. meghamalaiensis* Chaitanya, Giri, Deepak, Datta-Roy, Murthy & Karanth, 2019. In the far south, further across the Sencottah Gap in the Agasthyamalai hills, in the northwestern (Ponmudi) and southeastern (Manjolai) parts of the massif, two new species *D. smithi* Chaitanya, Giri, Deepak, Datta-Roy, Murthy & Karanth, 2019 and *D. douglasadamsi* Chaitanya, Giri, Deepak, Datta-Roy, Murthy & Karanth, 2019 were described. Lastly, a new species *D. septentrionalis* Chaitanya, Giri, Deepak, Datta-Roy, Murthy & Karanth, 2019 was described from the far northern range of the genus in Waynad. Between the Sencottah Gap and Meghamalai lies the Periyar Plateau, one of the most under-surveyed regions in the entire Western Ghats. In this paper, the Periyar population that remained unstudied till now is described as yet another new species.

Material and methods

The present study is based on the specimens of the new taxon collected, one from the Suttivezhi Vayal in Devar Malai, Tenkasi district, Tamil Nadu and three more from the adjacent Kakki Dam, Pathanamthitta district, Kerala, India (Fig. 1). The specimens were euthanized following which, tissue sample from liver/tail were dissected out and stored in absolute ethanol for genetic studies by the collectors of the specimens. Subsequently the euthanized specimens were fixed in 4% formalin solution for a week and thereafter stored in 70% ethanol. Comparative morphometric and morphological data on *Dravidogecko* congeners were sourced from their original descriptions (Chaitanya *et al.* 2019), and additional comparative materials examined for this study are listed in Appendix 1. The photographs were taken using Cannon 60D digital camera. Geo-coordinates (in decimal degrees up to 3 digits) and elevation (in meters above mean sea level) were recorded using a GPS and later cross-checked from Google Earth. Live uncollected lizards sighted in Sivagiri massif were referred as material belonging of this new species.

Morphometric and morphological data

We followed the morphological terminologies given in Chaitanya *et al.* (2019). The following measurements were scored from the preserved specimens on the left side using Mitutoyo™ dial caliper to the nearest 0.1 mm. – Snout-vent length: measured from tip of snout to vent; tail length: measured from vent to tip of tail; maximum tail width: measured at widest point of tail; maximum length of head: measured from retro-articular process of jaw to the snout-tip; maximum width of head: measured at the widest point of the head; maximum depth of head: measured from occiput to underside of jaws; horizontal diameter of orbit: distance measured from anterior-most border to posterior-most bony border of the orbit; orbit to nostril distance: measured between anterior-most border of orbit and nostril; orbit to snout distance: measured between anterior-most border of orbit and tip of snout; orbit to ear distance, measured from anterior edge of ear opening to posterior-most border of orbit; maximum length of ear opening; internarial distance: measured between left and right nares; interorbital distance: minimum interorbital distance between most anterior supraciliaries; mental scale length: maximum length of the

mental scale; mental scale width: maximum width of the mental scale; primary postmental shield length: maximum length of primary postmental shield; secondary postmental shield length: maximum length of secondary postmental shield; axilla to groin distance: measured from posterior edge of forelimb insertion to anterior edge of hindlimb insertion; humoral length: measured from anterior forelimb insertion to elbow; radius-ulnar length: measured from base of palm to elbow; maximum body width: measured at widest point of the body; thigh length: measured from anterior hindlimb insertion to knee; crus length, measured from base of heel to knee. The following scale counts and external morphological observations were made using ZEISS Stemi 305 stereo microscope – supralabials: counted to the angle of jaw on both left and right side; infralabials: counted to the angle of jaw on both left and right side; ventral scale rows: the number of ventral scales across mid-abdomen, demarcated by last row of granular scales on flanks; subdigital lamellae count: total lamellae on the basal portion of digit I to digit V of manus and pes; toe lengths: measured total lengths of digit I to digit V of manus and pes; precloacal-femoral pores count (in male individuals): total number of contiguous series of precloacal-femoral pores. For live uncollected lizards, fewer measurements were scored, but the major diagnostic characters were photo-documented to permit unambiguous species identification. The type material of the new species was housed at the Bombay Natural History Society, Mumbai, India (BNHS).

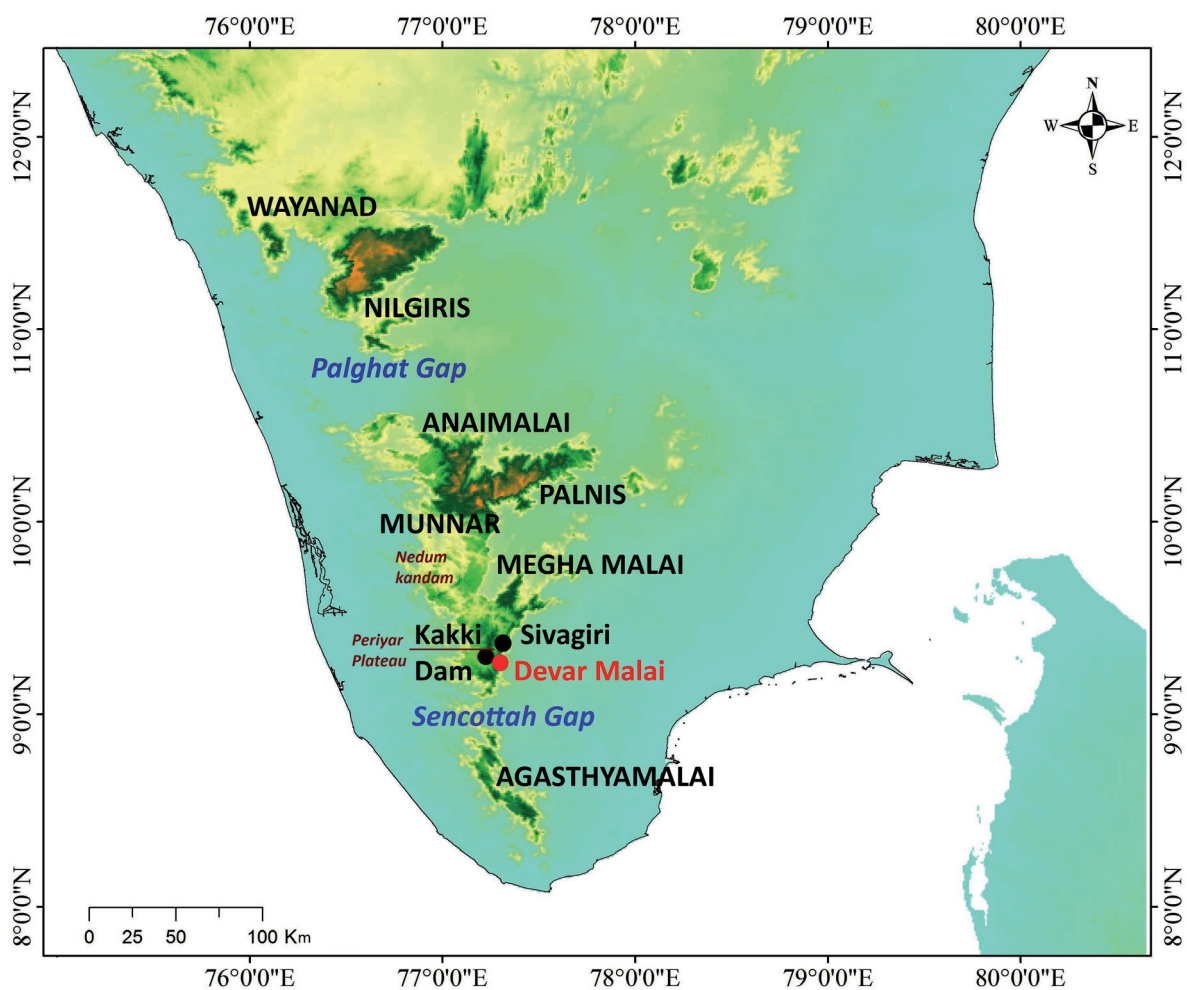


Fig. 1. Map of Southern Western Ghats, India, showing the type locality (Devar Malai / Suttivezhi Vayal / Vairavankulam Hills), paratypes' locality (Kakki Dam) and referred materials' locality (Sivagiri) – the distribution range of *Dravidogecko beddomei* sp. nov.

Molecular methods

Total genomic DNA from the ethanol-preserved tissue sample of the holotype specimen was isolated using phenol-chloroform-isoamyl alcohol method (Sambrook & Russell 2001), then dissolved in 50 µl of 0.1% TE buffer (pH 7.6–8.0, 10 mM TrisHCL, 0.1 mM EDTA) and stored at 4°C. The DNA was confirmed using a 1% Agarose gel and electrophoresed at 70V. The DNA was then purified and the mitochondrially embedded nicotinamide adenine dinucleotide dehydrogenase subunit 2 (ND2) region was amplified through Polymerase Chain Reaction (PCR). ND2 gene was used here due to the availability of sequences for the majority of described *Hemidactylus* Goldfuss, 1820 and *Dravidogecko* from the subcontinent. The PCR was carried out in 25 µl reaction volume containing 2.5 µl of 2.5 mM dNTP, 2.5 µl of 2.5 mM MgCl₂, 0.25 µL each of forward and reverse primer (L4437: 5'-AAGCAGTTGGGCCCATACC-3': (Macey & Schulte 1999), H4980: 5'-ATTTTTCGTAGTTGGGTTT-3': (Macey *et al.* 1997), 0.66 µl of 2 units of Taq DNA polymerase, 1 µl of extracted DNA of the sample, and the remaining volume was made up using Milli Q water. The PCR conditions were as follows: initial denaturation at 94°C for 2 minutes, denaturation at 94°C for 35 seconds, annealing at 52°C for 45 seconds, and extension at 72°C for 3 minutes. The final extension was at 72°C for 10 minutes for 35 cycles. The amplified PCR products were checked using on a 2% Agarose Gel and viewed under the AlphaDigiDoc RT2 system. The PCR samples were purified using QIAquick® PCR Purification Kit. The cleaned purified PCR products were then sequenced (both forward and reverse) using a 3130xl Genetic Analyzer. The sequences were checked for stop codons, quality checked for potential errors from the chromatograms, contigs were assembled and edited, and tested for homologous sequences using BLAST.

Sequence data for the ND2 gene of the members of the genus *Dravidogecko* (Chaitanya *et al.* 2019) along with other members of *Hemidactylus* as an outgroup were downloaded from GenBank. *Hemidactylus* was used as an outgroup since the phylogenetic relationships between *Dravidogecko* and *Hemidactylus* have been previously established (Bansal & Karanth 2013; Chaitanya *et al.* 2019). Gene sequences were aligned using the MAFFT ver. 7 (online version) adjusted to reading open frames, the uncorrected pairwise sequence distance percentage for comparison with other members of the genus *Dravidogecko* was calculated in MEGA X ver. 11 (Kumar *et al.* 2018) for an alignment dataset of 1041 bp length. The aligned gene dataset was subjected to perform best partitioning scheme and models for Maximum Likelihood (ML) phylogenetic analyses were selected in MEGA X (Kumar *et al.* 2018). The dataset was partitioned by codon position and the GTR + G + I model was used. ML tree for the gene was constructed in MEGA X (Kumar *et al.* 2018) with support assessed through 1000 thorough bootstrap replicates (see Fig. 2). The ND2 gene data for the new species described herein were submitted to GenBank with accession number (Table 1).

Results

Phylogenetic relationships

The molecular phylogenetic analysis with a dataset comprised of seven species of *Dravidogecko* and 10 species of *Hemidactylus* recovered an ML phylogeny with a familiar topology similar to (Chaitanya *et al.* 2019). *Dravidogecko beddomei* sp. nov. was sister to the *D. meghamalaiensis*, *D. smithi* and *D. douglasadamsi* clade. The support for the split between the clades containing *D. septentrionalis* and *D. anamallensis* is was strong (<95), the split between *Dravidogecko beddomei* and its sister clade is morderate (<69). *Dravidogecko beddomei* is 16.2–16.4% divergent from its closest congeners *D. meghamalaiensis*, 15.2–15.3% divergent from *D. smithi* and 19.5% divergent from *D. douglasadamsi*. Genetic distances are given in Table 2, comparing all the currently described species of *Dravidogecko*.

Table 1 (continued on next page). Species included in the phylogeny along with their respective ND2 GenBank accession numbers.

Species	Voucher	Accession no. (ND2 gene)	Location	Source
<i>Dravidogecko beddomei</i> sp. nov.	BNHS 2648	OQ473579	Suttivezhi Vayal / Vairavan kulam hills in Devar Malai, Tenkasi, Tamil Nadu, India	Present study
<i>Dravidogecko anamallensis</i> (1)	ZSIK 2969	MN520264	Valparai, Tamil Nadu, India	Chaitanya <i>et al.</i> 2020
<i>Dravidogecko anamallensis</i> (2)	ZSIK 2970	MN520265	Valparai, Tamil Nadu, India	Chaitanya <i>et al.</i> 2019
<i>Dravidogecko tholpalli</i> (1)	BNHS 2352	MN520261	Kodaikanal, Dindigul district, Tamil Nadu, India	Chaitanya <i>et al.</i> 2019
<i>Dravidogecko tholpalli</i> (2)	ZSIK 2986	MN520271	Kodaikanal, Dindigul district, Tamil Nadu, India	Chaitanya <i>et al.</i> 2019
<i>Dravidogecko smithi</i> (1)	ZSIK 2981	MN520262	Ponmudi, Thiruvananthapuram district, Kerala, India	Chaitanya <i>et al.</i> 2019
<i>Dravidogecko smithi</i> (2)	BNHS 2350	MN520263	Ponmudi, Thiruvananthapuram district, Kerala, India	Chaitanya <i>et al.</i> 2019
<i>Dravidogecko meghamalaiensis</i> (1)	BNHS 2347	MN520266	Meghamalai, Theni district, Tamil Nadu, India	Chaitanya <i>et al.</i> 2019
<i>Dravidogecko meghamalaiensis</i> (2)	ZSIK 2977	MN520272	Meghamalai, Theni district, Tamil Nadu, India	Chaitanya <i>et al.</i> 2019
<i>Dravidogecko septentrionalis</i> (1)	BNHS 2342	MN520267	Lakkidi village, Wayanad district, Kerala, India	Chaitanya <i>et al.</i> 2019
<i>Dravidogecko septentrionalis</i> (2)	BNHS 2343	MN520273	Lakkidi village, Wayanad district, Kerala, India	Chaitanya <i>et al.</i> 2019
<i>Dravidogecko janakiae</i> (1)	BNHS 2357	MN520268	Munnar, Idukki district, Kerala, India	Chaitanya <i>et al.</i> 2019
<i>Dravidogecko janakiae</i> (2)	ZSIK 2988	MN520269	Munnar, Idukki district, Kerala, India	Chaitanya <i>et al.</i> 2019
<i>Dravidogecko douglasadamsi</i>	BNHS 2349	MN520270	Manjolai estate, Tirunelveli district, Tamil Nadu, India	Chaitanya <i>et al.</i> 2019
<i>Hemidactylus treutleri</i>	CES 14116	MN482237	Gummadapuram, Atmakur, Andhra Pradesh, India	Lajmi <i>et al.</i> 2020
<i>Hemidactylus treutleri</i>	CES 14216	MH454770	Gaganpahad, Hyderabad, Telangana, India	Lajmi <i>et al.</i> 2019
<i>Hemidactylus varadgirii</i>	VG 349	MK569849	Amboli, Kolhapur, Maharashtra, India	Agarwal <i>et al.</i> 2019
<i>Hemidactylus murrayi</i>	LLG 6755	EU268366	Empangon Air Hitam, Pulau Pinang, Malaysia	Bauer <i>et al.</i> 2008
<i>Hemidactylus flaviviridis</i>	KUZ R72238	AB937992	Chiba, Japan	Kurita <i>et al.</i> 2014
<i>Hemidactylus sahali</i>	NCBS-AU709	MG742362	Saswad, Pune, Maharashtra, India	Mirza <i>et al.</i> 2018
<i>Hemidactylus whitakeri</i>	NCBS-AU713	MH666066	Kodalagurki village, Bangalore rural District, Karnataka, India	Mirza <i>et al.</i> 2018
<i>Hemidactylus scabriceps</i>	CES 12008	MH454769	Tirunelveli, Tamil Nadu, India	Lajmi <i>et al.</i> 2019

Table 1 (continued).

Species	Voucher	Accession no. (ND2 gene)	Location	Source
<i>Hemidactylus siva</i>	NHM.OU.REP.H	MK569845	Hampi, Bellary, Karnataka, India	Agarwal <i>et al.</i> 2019
<i>Hemidactylus persicus</i>	CAS 227612	EU268377	4.5 km N of Tanuf, Wadi Tanuf, Wilayat Nazwa, Oman	Bauer <i>et al.</i> 2008
<i>Hemidactylus prashadi</i>	CES 11033	MN482228	–	Lajmi & Karanth 2020
<i>Hemidactylus paaragowli</i>	CESL 273	MN496393	Kanayar, Kollam District, Kerala, India	Srikanthan <i>et al.</i> 2018b
<i>Hemidactylus maculatus</i>	CES 14024	MN482227	–	Lajmi & Karanth 2020
<i>Hemidactylus leschenaultii</i>	CES 14072	MN482225	–	Lajmi & Karanth 2020
<i>Hemidactylus kolliensis</i>	NCBS-BH737	MT943049	Perambalur, Pachamalai, Tamil Nadu, India	Khandekar <i>et al.</i> 2020
<i>Hemidactylus kangerensis</i>	BNHS 2486	MK569824	Kanger Valley National Park, Bastar, Chhattisgarh, India	Agarwal <i>et al.</i> 2019
<i>Hemidactylus hemchandrai</i>	CES 16279	MH454764	Ravanwadi, Maharashtra, India	Lajmi <i>et al.</i> 2019
<i>Hemidactylus vanam</i>	CES 15247	MN482239	–	Lajmi & Karanth 2020
<i>Hemidactylus graniticolus</i>	CES 15265	MN482224	Gingee, Villupuram, Tamil Nadu, India.	Lajmi & Karanth 2020
<i>Hemidactylus gujaratensis</i>	CES 17067	MG760344	Girnar Hills, Gujarat, India	Lajmi <i>et al.</i> 2018
<i>Hemidactylus acanthopholis</i>	CES 17066	MG711531	Kallidaikurichi, Tirunelveli, Tamil Nadu, India	Chaitanya <i>et al.</i> 2018
<i>Hemidactylus yajurvedi</i>	CES 12006	MH454772	Kanker District, Chattisgarh, India	Lajmi <i>et al.</i> 2019
<i>Hemidactylus sushilduttai</i>	CES 11079/ NCBS-AU157	MN482236	Simhachalam, Visakhapatnam, Andhra Pradesh, India	Lajmi & Karanth 2020; Khandekar <i>et al.</i> 2021
<i>Hemidactylus tamhiniensis</i>	CES 14023	MN482222	Tamhini Ghat, Pune, Maharashtra, India	Lajmi & Karanth 2020; Khandekar <i>et al.</i> 2021

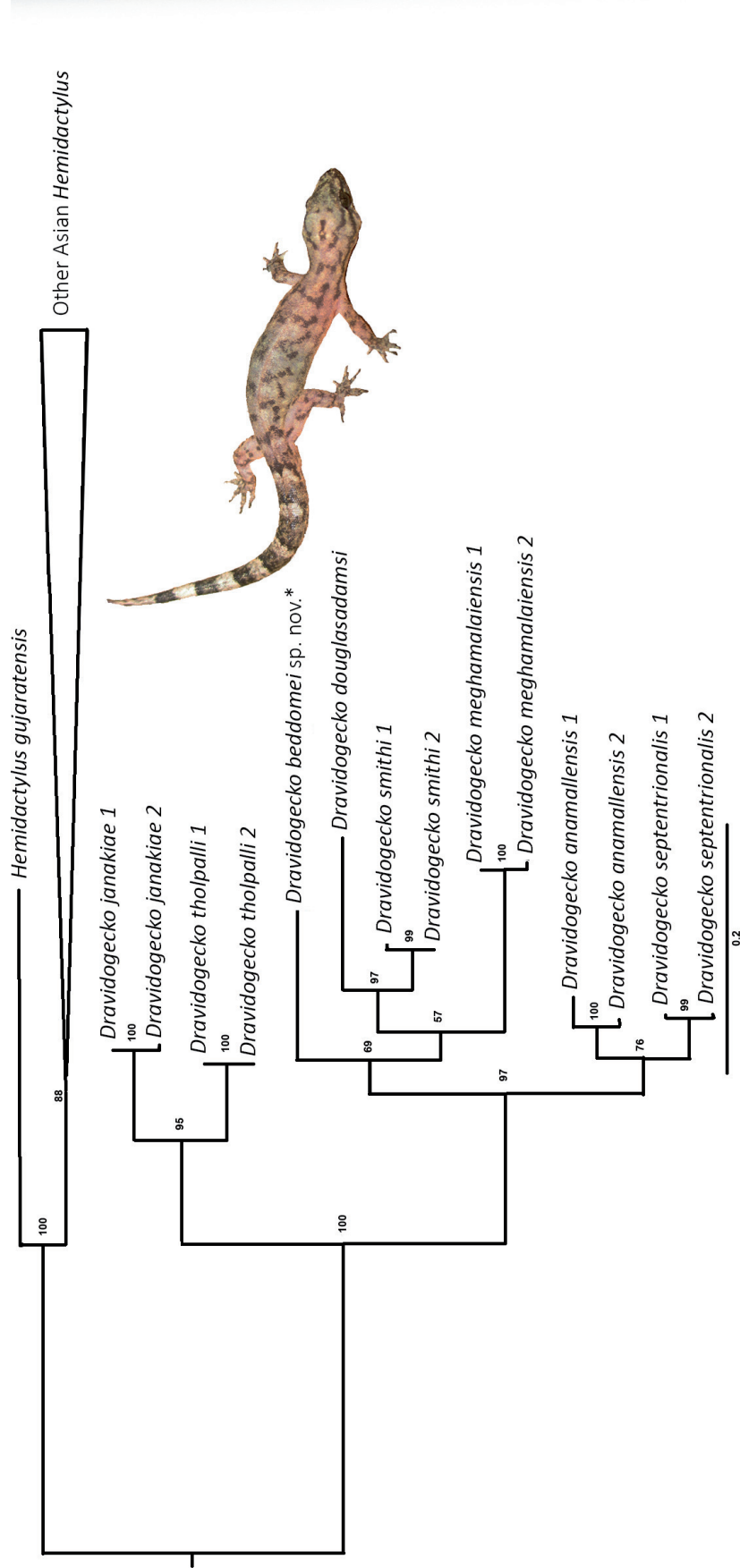


Fig. 2. Maximum-likelihood phylogram of the species of *Dravidogecko* Smith, 1933 based on ND2 (up to 1041 bp) mitochondrial gene sequences. Numbers adjacent to nodes indicate weak likelihood bootstrap support values respectively (> 69%).

Taxonomy

Class Reptilia Laurenti, 1768
Order Squamata Oppel, 1811
Family Gekkonidae Gray, 1825
Subfamily Gekkoninae Gray, 1825
Genus *Dravidogecko* Smith, 1933

Dravidogecko beddomei sp. nov.

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Figs 1, 3–6

Summarized description and diagnosis

A species of *Dravidogecko* endemic to the Periyar Plateau, characterized by the following combination of characters: snout-vent length up to 50.8 mm; two pairs of well-developed postmentals, inner pair longer than mental and outer postmentals, anteriorly in strong contact with mental; bordered by 1st infralabial scale, mental, outer postmentals and two or three gular scales; ventral scale rows, 31–33; precloacal-femoral pores 46–52 ($n = 3$); subdigital lamellae beneath of digit I: six, and digit IV: eight or nine (manus); subdigital lamellae beneath of digit I: five or six and digit IV: 10 or 11 (pes); supralabials 9–11 and infralabials eight or nine on each side.

Differential diagnosis

Dravidogecko beddomei sp. nov. can be distinguished from all other (allopatric) congeners based on the following characters: number of precloacal-femoral pores 46–52 (vs 52–56 in *D. septentrionalis*, 40–43 in *D. douglasadamsi*, 38–40 in *D. tholpalli*, 35–36 in *D. janakiae*, 36–38 in *D. meghamalaiensis*); ventral scales rows across belly 31–33 (vs 29–31 in *D. smithi*, 25–31 in *D. tholpalli*, 24–30 in *D. janakiae*, 25–28 in *D. anamallensis*); lamellae on digit IV of pes 10–11 (vs 12 in *D. anamallensis*); mental scale is shorter in length than postmental shield, mental scale length / primary postmental shield length 0.8–0.9 (vs 1.0–1.3 in *D. meghamalaiensis*; 1.0–1.1 in *D. douglasadamsi*; 1.1–1.2 in *D. smithi*; and 1.0–1.6 in *D. janakiae*).

Genetic divergence (p-distance)

Dravidogecko beddomei sp. nov. is 13.0–22.5% divergent from all other (allopatric) congeners, and 16.2–16.4% divergent from its closest congeners *D. meghamalaiensis*, 15.2–15.3% divergent from *D. smithi* and 19.5% divergent from *D. douglasadamsi* (Table 2).

Etymology

The specific epithet is a patronym coined in genitive singular case, honouring Col. Richard Henry Beddome (1830–1911), the pioneering herpetologist who first surveyed this part of the Western Ghats, the Devar Malai Hills (see Ganesh 2010).

Material examined

Holotype

INDIA • adult ♂; “Suttivezhi Vayal or Vairavankulam hills in the northern edge of Devar Malai, Tenkasi district, Tamil Nadu, India”; 9°10'32.88" N, 77°16'17.4" E; alt. 970 m a.s.l.; Dec. 2011; S. Pal and M. Prabhu leg.; BNHS 2648 (Fig. 3A–I).

Paratypes ($n = 3$)

INDIA • 1 adult ♂; “Kakki Dam, Periyar Forest, Pathanamthitta district, Kerala, India”; 9°19'31.08" N, 77°8'40.56" E; alt. 1030 m a.s.l.; Dec. 2011; S. Pal and M. Prabhu leg.; BNHS 2645 (Fig. 4A–B) •

Table 2. Pairwise uncorrected ND2 sequence divergence between *Dravidogecko beddomei* sp. nov. and its congeners.

Species name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. <i>Hemidactylus aaronbaueri</i>															
2. <i>Hemidactylus acanthophilis</i>	32.9														
3. <i>Dravidogecko douglasadamsi</i>	40.7	46.9													
4. <i>Dravidogecko janakiae</i> 1	40.3	43.9	26.3												
5. <i>Dravidogecko janakiae</i> 2	40.3	44.2	25.9	0.2											
6. <i>Dravidogecko meghamalaiensis</i> 1	39.2	43.7	18.5	24.9	24.6										
7. <i>Dravidogecko meghamalaiensis</i> 2	39.7	44.8	18.9	25.4	25.1	0.4									
8. <i>Dravidogecko septentrionalis</i> 1	39.5	43.0	17.2	19.2	18.9	14.9	15.4								
9. <i>Dravidogecko septentrionalis</i> 2	38.2	42.0	17.2	19.5	19.1	14.9	14.4	0.3							
10. <i>Dravidogecko smithi</i> 1	37.0	43.2	12.2	21.7	21.4	14.4	14.5	12.1	11.7						
11. <i>Dravidogecko smithi</i> 2	37.2	43.2	12.2	21.7	21.4	14.1	14.2	12.3	11.9	0.2					
12. <i>Dravidogecko tholpalli</i> 1	41.4	43.6	25.9	10.8	11.1	24.9	25.4	20.6	20.4	21.4	21.4				
13. <i>Dravidogecko tholpalli</i> 2	40.7	42.6	25.6	11.1	11.4	25.1	24.3	20.8	19.5	20.8	20.8	0.3			
14. <i>Dravidogecko anamallensis</i> 1	39.6	41.2	17.3	18.8	18.4	14.7	14.6	5.2	5.4	11.8	12.1	20.7	19.6		
15. <i>Dravidogecko anamallensis</i> 2	38.6	41.5	19.5	19.6	19.3	15.5	15.0	6.5	6.1	12.2	12.6	20.2	19.2	2.4	
16. <i>Dravidogecko beddomei</i> sp. nov.	40.4	45.0	19.5	22.5	22.1	16.4	16.2	15.0	13.7	15.2	15.3	21.7	20.4	13.0	13.9

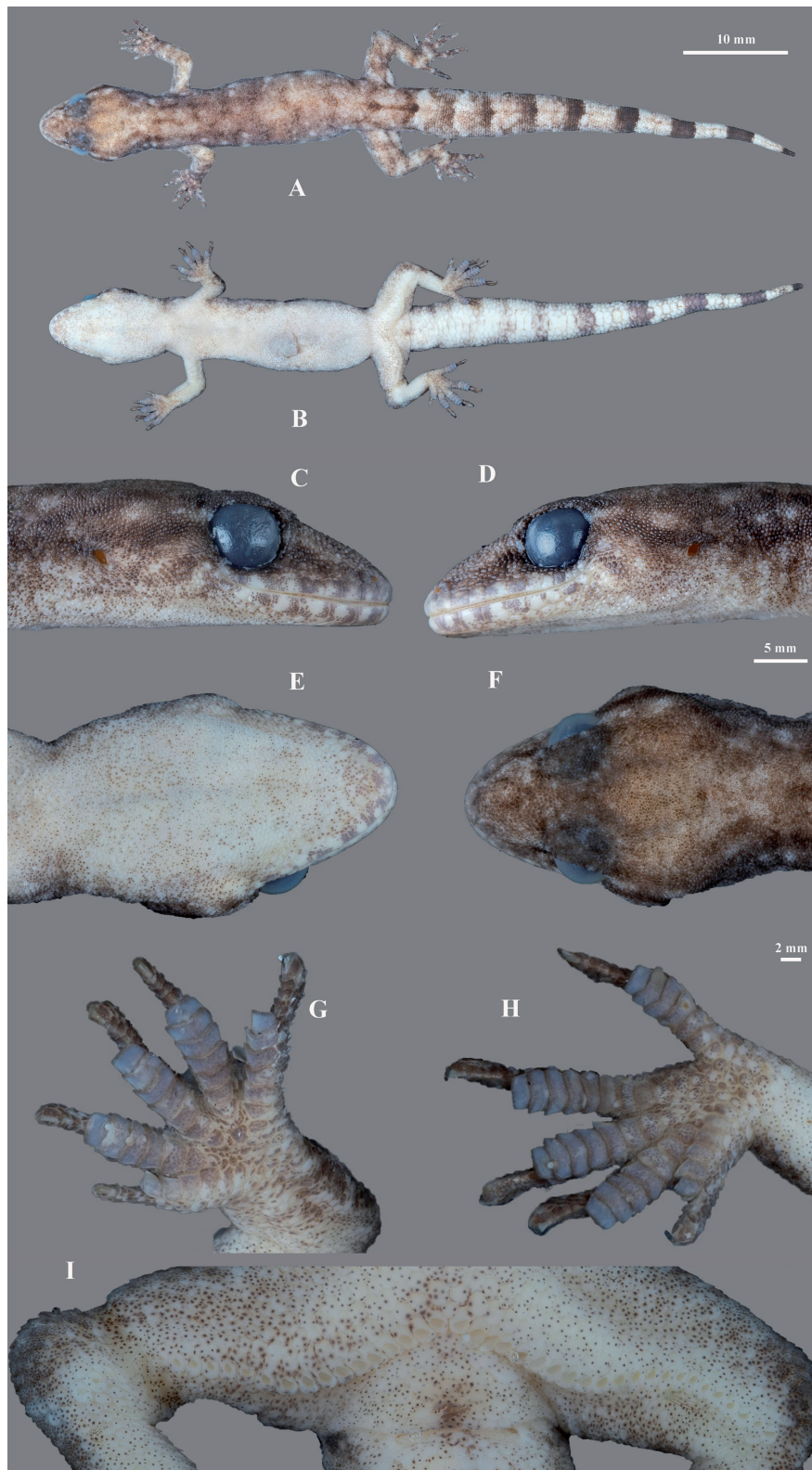


Fig. 3. *Dravidogecko beddomei* sp. nov., holotype, ♂ (BNHS 2648). **A.** Dorsal view of entire specimen. **B.** Ventral view of entire specimen. **C.** Right side of the head. **D.** Left side of the head. **E.** Ventral view of the head. **F.** Dorsal view of the head. **G.** Lamellae on digits of left manus. **H.** Lamellae on digits of left pes. **I.** Precloacal-femoral pores.

1 adult ♂; same collection data as for preceding; BNHS 2646 (Fig. 4C–D) • 1 adult ♀; same collection data as for preceding; BNHS 2647 (Fig. 4E–F).

Other referred specimens (n = 2)

India, 2 adults ♀, sighted in Sivagiri hills (9°20′59.27″ N, 77°19′55.89″ E; 1100 m a.s.l.), north of Suttivezhi Vayal (type locality) and east of Kakki Dam (paratype locality); April 2008, uncollected (Figs 5–6).

Description of holotype

Holotype is in generally good condition (Fig. 3), well fixed, moderately flat beneath, without ventrolateral folds on both sides of trunk. An adult male; snout-vent length 45.7 mm.

HEAD. Head short in length (28.0% of snout-vent length); relatively broad in width (77.3% of maximum head length); slightly depressed (44.5% of maximum head length), distinct from neck. Loreal region inflated, interorbital region concave, forehead not concave, canthus rostralis indistinct; snout relatively long (55.6% of maximum head width), slightly longer than horizontal diameter of the eye orbit (54.6% of eye orbit to snout tip distance). Scales on snout, forehead, and canthus rostralis rounded and granular; scales on snout larger than those on occipital region and interorbital region; scales on occipital region and interorbital small, rounded, mostly granular. Eyes rounded, small (23.4% of maximum head length); pupil vertically elliptical with crenulated margins; supraciliaries small, gradually decreasing in size posteriorly. Ear opening deep, roughly oval (16.7% of eye orbit to nostril distance); lacking enlarged lobules. Supralabial scale count, 11/10 (left/right), 9th supralabial on left side and 8th supralabial on right side are in mid-orbital position, 10th and 11th supralabial on left side and 10th supralabial on right side to the angle of jaw, supralabials are roughly rectangular in shape with slightly convex above. Rostral rectangular with wide convex, fairly visible when viewed dorsally, without a distinct rostral groove.

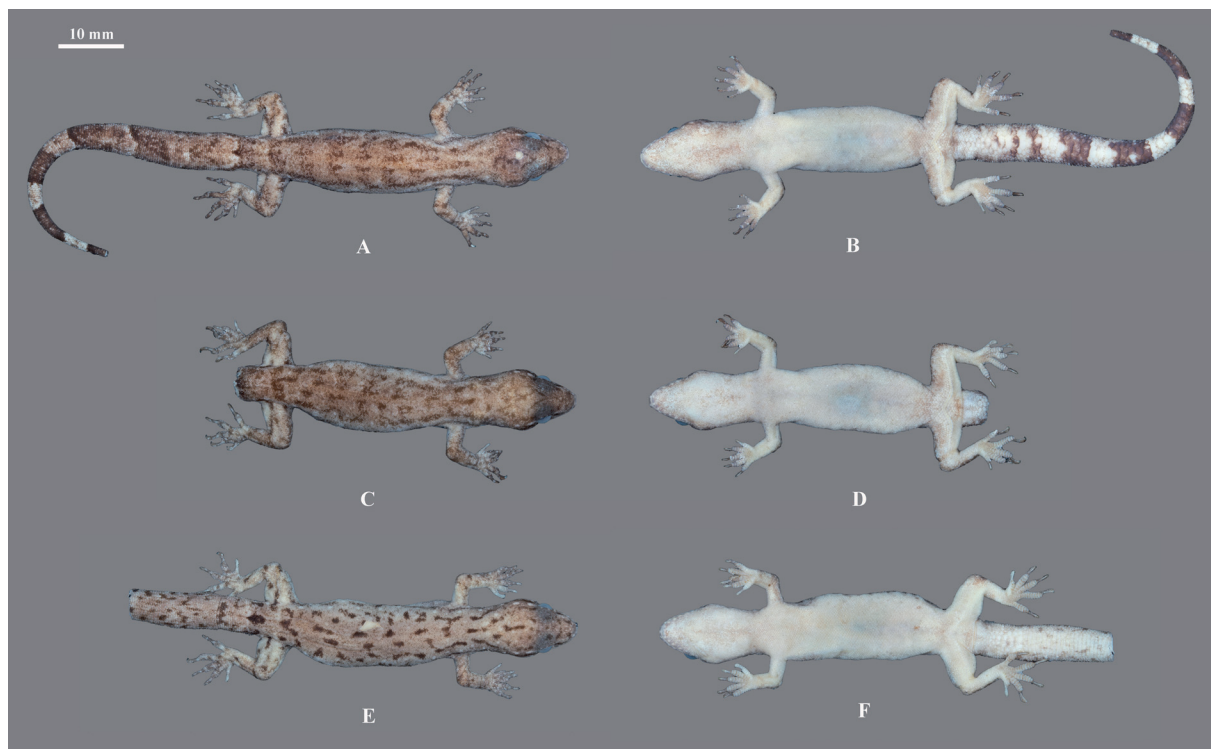


Fig. 4. *Dravidogecko beddomei* sp. nov., paratypes. **A–B.** Male (BNHS 2645), dorsal and ventral view. **C–D.** Male (BNHS 2646), dorsal and ventral view. **E–F.** Female (BNHS 2647), dorsal and ventral view.

Nostril oval shaped, oriented laterally, touches 1st supralabial on either sides, single supranasal; two large internasals, separated by single small scale, all in broad contact with rostral; two postnasals on either side, smaller than the internasals, the lower in contact with 1st supralabial; anteriorly rostral contacting with nasal; nostrils about the size of the lower postnasal, roughly circular; nasal surrounded by internasal, rostral, 1st supralabial and two postnasals on either side; 1 or 2 rows of scales separate orbit from supralabials at mid-orbital position. Infralabial scale count, 9/9 (left/right); 1st–4th infralabials slightly larger in size, rectangular in shape; 5th–9th infralabials decreases in size posteriorly; the lower edges of 3rd–9th infralabials are bordered with two rows of enlarged elongated scales. Mental scale triangular; two pairs of well-developed postmentals; primary postmental pair comparatively larger in size to secondary postmental pair, contacting each other, and 1st infralabial on both sides; secondary pair, not contacting each other, touches 1st and 2nd infralabials; both primary and secondary pair bordered by smooth, granular, rounded scales.

BODY. Moderately elongated, axilla to groin distance (43.3% of snout-vent length), dorsally compressed, without ventrolateral folds. Dorsal pholidosis composed of small, flat, granular and rounded scales that are juxtaposed in arrangement, homogeneous in shape. Ventral scales sub-imbricate, smooth, granular,



Fig. 5. Live uncollected adult females of *Dravidogecko beddomei* sp. nov. sighted in Sivagiri Hills.

homogeneous in shape and size, larger than dorsal granular scales, ventral scales across belly 32; gular region covered in small granular scales about equal in size to dorsal granules, gradually increasing in size posteriorly, anterior gular scales visibly larger and flatter; scales on femoral region larger than those on sacrum and chest with some precloacal scales being largest; scales on dorsal aspect of upper arm larger than granules on dorsum, flat, smooth, and sub-imbricate; dorsal aspect of forearm with smaller, sub-imbricate scales intermixed with a few rounded granules around the elbow; scales on dorsal aspect of hand and digits larger than those on forearm, flat, imbricate; scales on dorsal part of thigh and shank heterogeneous in size, flat, weakly pointed and sub-imbricate; largest on anterior aspect of thigh. Scales on dorsal aspect of foot larger than those on shank, flat, rounded and imbricate; non-lamellar scales in the palmar and plantar regions flat and smooth; ones on palm juxtaposed while those on sole sub-imbricate and weakly pointed. Pre-anal groove absent; pre-anal depression absent; an incessant series of 49 precloacal-femoral pores that are indistinct towards the knee.

LIMBS. Fore and hind limbs relatively short, slender, ventral surfaces of limbs covered with uniform, flattened, sub-imbricate scales; forearm short (humeral length is 13.8% of snout-vent length; radius ulnar length is 13.4% of snout-vent length); tibia short (thigh length 16.8% of snout-vent length; crus length is 16.6% snout-vent length); digits moderately short, flattened, with relatively long terminal phalanges, strongly clawed; all digits of manus and digits II–V of pes indistinctly webbed; terminal phalanx of all digits curved, angular from distal portion of expanded lamellar pad, more than half as long as associated toepad; scapulae beneath each digit are undivided, in a straight transverse series; lamellae count of left manus – digit I (6), digit II (7), digit III (8), digit IV (9), and digit V (7); lamellae count of left pes – digit I (6), digit II (7), digit III (8), digit IV (10), and digit V (7); toe lengths of left manus – digit IV (2.8) > digit III (2.5) > digit V (2.2) > digit II (2.1) > digit I (1.6); toe lengths of left pes – digit IV (3.4) > digit III (3.2) > digit II (2.7) > digit V (2.3) > digit I (1.6).

TAIL. Original, complete; oval in cross section; long (tail length/snout-vent length: 1.1) with fairly pointed tail tip in dorsal aspect, flat beneath, tapering posteriorly, tail dorsum covered with smooth, flat, somewhat rounded, sub-imbricate scales, larger than those on dorsum, becoming slightly enlarged laterally; subcaudal scales larger, with an undivided median series of enlarged scales.

Variation

Type series of *Dravidogecko beddomei* sp. nov. is comprised of three adult males (BNHS 2648: holotype; BNHS 2645, BNHS 2646: paratypes), and one adult female (BNHS 2647). In general, agreeing well with the holotype, the intraspecific meristic, morphometric and basic pholidosis variations in paratypes (Fig. 4), are summarized in Table 3.

Coloration in preservation

After preservation in alcohol for 11 years, overall dorsum uniformly brown, mottled with dark chocolate brown discontinuous longitudinal streaks from the snout to the base of tail. Similar mottling faintly visible on dorsal aspect of limbs. Neck pale brown, with discontinuous longitudinal streaks same as dorsum; single continuous, roughly rectangular, pale brown streak bordered with the dark chocolate brown streaks originates from the narial region, following the contour of the cranium posteriorly and prolonging almost the neck region. Frontal and interorbital region with scattering of smaller dark blotches which are faintly visible. A distinct dark blotch bordering the supraciliary region on either side. Labials slightly paler than the head dorsum with scattering of dark brown splotches. Tail same as like dorsum with brown colour with alternating pale-dark brown longitudinal bands, the first of which is roughly saddle-shaped. Ventral surface of tail is cream colored, with scattered faintly visible mid-brown blotches in the hemipenial region followed by alternating pale-dark bands.

Table 3 (continued on next page). Mensural (mm) and meristic data of *Dravidogecko beddomei* sp. nov. Abbreviations: * = damaged; L = left; R = right; H = holotype; P = paratype.

Characters (Mensural & Meristic)	BNHS 2648 (H)	BNHS 2645 (P)	BNHS 2646 (P)	BNHS 2647 (P)
Sex	Male	Male	Male	Female
Snout-vent length	45.7	49.1	49.4	50.8
Tail length	50.9	61.4	*	21.6*
Tail width	5.1	6.8	*	5.7
Mid body width	9.3	10.8	10.9	9.6
Maximum length of head	12.8	13.1	13.3	12.1
Maximum width of head	9.9	9.3	9.4	9.5
Maximum depth of head	5.7	5.2	5.5	5.5
Maximum length of ear opening	0.6	0.7	0.6	0.7
Eye orbit to ear opening distance	4.9	4.3	4.9	4.1
Horizontal diameter of the eye orbit	3.0	2.7	3.1	3.2
Eye orbit to nostril distance	3.6	3.5	3.5	3.6
Eye orbit to snout tip distance	5.5	4.8	5.2	5.1
Interorbital distance	4.2	5.1	5.3	5.5
Internarial distance	3.1	3.0	3.5	3.2
Humoral length	6.3	6.2	6.4	6.3
Radius ulnar length	6.1	6.1	6.3	5.9
Thigh length	7.7	8.5	7.7	7.1
Crus length	7.6	6.9	7.4	7.6
Axilla to groin distance	19.8	23.7	24.1	25.6
Mental scale length	1.3	1.2	1.4	1.4
Mental scale width	2.4	2.3	2.4	2.5
Primary postmental shield length	1.5	1.5	1.6	1.5
Secondary postmental shield length	1.1	1.1	1.1	1.2
Toe lengths (manus)				
Digit I	1.6	1.7	1.7	1.7
Digit II	2.1	1.9	2.2	2.2
Digit III	2.5	2.3	2.7	2.8
Digit IV	2.8	2.5	2.9	2.7

Table 3 (continued).

Characters (Mensural & Meristic)	BNHS 2648 (H)	BNHS 2645 (P)	BNHS 2646 (P)	BNHS 2647 (P)
Digit V	2.2	2.1	1.8	2.3
Toe lengths (pes)				
Digit I	1.6	1.4	1.7	1.8
Digit II	2.7	2.5	2.5	3
Digit III	3.2	2.8	2.8	3.2
Digit IV	3.4	4.7	3.7	4
Digit V	2.3	2.7	2.4	2.7
Supralabial scale count (L/R)	11/10	9/10	10/9	10/9
Imfralabial scale count (L/R)	9/9	9/9	9/8	8/8
Ventral scale count	32	31	31	33
Subdigital lamellae count of manus (Digit I–V)	6-7-8-9-7	6-7-8-9-7	6-7-8-9-7	6-7-8-8-6
Subdigital lamellae count of pes (Digit I–V)	6-7-8-10-7	6-8-9-11-8	5-8-9-10-7	6-8-9-11-7
Precloacal-femoral pores	46	52	47	–

Coloration in life (based on live uncollected specimens)

Dorsum creamy brown with dark brown mottling and longitudinal streaks throughout; dorsal markings distinct in life. Head dorsum brown or ground colour, with three distinctly paler patches bordered with chocolate brown streaks, anterior and posterior to the eye and just above the ear opening, extending till neck. Labials with the dark brown blotches with alternating off-white blotches. Snout mottled with brown spots. A brown discontinuous streak originating at ear opening, delimited with two dark streaks that continue beyond forelimb insertion. Limbs creamy brown, irregularly scattered with dark blotches. Tail original, with distinctly banded pale and dark portions. Iris marbled, golden, suffused with dark-brown venation; pupil vertical, black with crenulated margins.

Suggested common name

Beddome's Dravidogecko.

Ecology and distribution

Dravidogecko beddomei sp. nov. is a poorly known species that is currently known only from in and around the type localities – Devar Malai, Kakki Dam and Sivagiri Hills. The first two sites are situated ca 20 airline km apart across the Ranni Rivulets of Periyar river, Suttivezhi Vayal (holotype locality) being to the east and Kakki Dam (paratype locality) being to the west of it. The live sightings of the referred material originate from Sivagiri Hills, situated in Tenkasi district, Tamil Nadu, just 20 airline km north of the holotype locality. It is to be noted that all these localities are well within a geographically proximate and ecologically homogenous area and are also comparable in their elevations: 970 m, 1030 m and 1100 m a.s.l. It is likely that *D. beddomei* also occurs in other nearby areas of Periyar Plateau (in

Kerala and Tamil Nadu States). Like other congeners, *D. beddomei* is nocturnal and rupicolous. The geographically closest species to *D. beddomei* is *D. meghamalaiensis* that is distributed ca 50 airline km northeast off this range in the geographically disparate and detached Meghamalai Mountains (Chaitanya *et al.* 2019). The new species *D. beddomei* occurs within a Protected Area – the Periyar Tiger Reserve. But yet the presence of a seasonal pilgrim spot (Sabarimalai) and a Damming site (Kakki) should be causes for its conservation concern.

Discussion

The discovery of this new species of *Dravidogecko* despite a recent comprehensive study on phylogenetic systematics of this genus bolsters the view that unsampled massifs in southern India often harbours undescribed species of gekkonids. The discovery of *Dravidogecko beddomei* sp. nov. is broadly similar to the recent discoveries of new geckos of the genera *Hemidactylus* Goldfuss, 1820 (Srikanthan *et al.* 2018), *Hemiphyllodactylus* Bleeker, 1860 (Agarwal *et al.* 2020) and *Cnemaspis* Strauch, 1887 (Cyriac *et al.* 2018; Sayyed *et al.* 2019; Pal *et al.* 2021) from the Southern Western Ghats. Thus, unsampled hills harbouring an undescribed congener having rather small and well-circumscribed distribution range, often assembled as point-endemic, allopatric species also mirrors the pattern seen in amphibians (e.g., Biju *et al.* 2014; Garg *et al.* 2017).

As for the localities from where the new species *Dravidogecko beddomei* sp. nov. was found, these ranges rank as some of the most under-studied in the entire Western Ghats. Recently, new taxa of reptiles were described from many places in these massifs. A new pit viper *Craspedocephalus travancoricus* Mallik, Srikanthan, Ganesh, Vijayakumar, Campbell, Malhotra & Shanker, 2021 was described including a paratype from from Devar Malai (Mallik *et al.* 2021). A new agamid genus *Agasthyagama* Srikanthan, Adhikari, Ganesh, Deuti, Das, Kulkarni, Gowande, & Shanker, 2021 was erected for the species *A. beddomii* (Boulenger, 1885), whose type locality is Sivagiri Hills (Boulenger 1885 read with Srikanthan *et al.* 2021). A new rock gecko *Hemidactylus paaragowli* Srikanthan, Swamy, Mohan & Pal, 2018 was described from Kanayar, Achenkovil and Ambanad hills (Srikanthan *et al.* 2018). Two new day geckos *Cnemaspis jackiei* Pal, Mirza, Dsouza & Shanker, 2021 and *C. nigriventris* Pal, Mirza, Dsouza & Shanker, 2021 were described from Vairavankulam and Achenkovil respectively (Pal *et al.* 2021). *Dravidogecko beddomei* is one such recent addition of a new reptile from here.



Fig. 6. Landscape (left) and habitat (right) of *Dravidogecko beddomei* sp. nov. at the Sivagiri Hill.

The description of this new species *Dravidogecko beddomei* sp. nov. fills a major void in the distribution of this genus in massifs between Meghamalai and Ponmudi hills (Chaitanya *et al.* 2019). Given their rather small and narrow ranges, it is probable that other undescribed species of *Dravidogecko* occur in nearby taller peaks surrounding the range of *D. beddomei*. As with the prevailing (incomplete) diversity of geckos of the genera *Cnemaspis*, *Cyrtodactylus*, *Hemidactylus* and *Hemiphyllodactylus* (Cyriac *et al.* 2018; Srikanthan *et al.* 2018; Sayyed *et al.* 2019; Agarwal *et al.* 2020; Pal *et al.* 2021), a sufficiently dense geographic plus taxon sampling and molecular phylogenetic studies will further aid in unraveling the true diversity of this ancient, mico-endemic gecko genus *Dravidogecko*.

Compared to the endemic genera in other lizard families, viz. *Kaestlea* Eremchenko & Das, 2004, *Ristella* Gray, 1839 (Scincidae), *Salea* Gray, 1845, *Agasthyagama*, *Microauris* Pal, Vijayakumar, Shanker, Jayarajan & Deepak, 2018, *Monilesaurus* Pal, Vijayakumar, Shanker, Jayarajan & Deepak, 2018 (Agamidae) (Aengals *et al.* 2018; Srikanthan *et al.* 2021) the depauperate gekkonid endemism at the genus-rank becomes apparent in the Western Ghats. When we compare the scenario with the related fauna of Sri Lanka (Bossuyt *et al.* 2004), the paucity of endemic gekkonid genera becomes much more obvious. There is no ecological equivalent to *Dravidogecko* in the island, despite its richer endemic lizard genera of both scincids and agamids (Somaweera & Somaweera 2009). As posited by Bansal & Karanth (2013), this cross-taxonomic comparison adds weight to the sheer antiquity (Eocene, 60 Ma) of this genus *Dravidogecko*. It is likely that time since isolation plays a major role in shaping this ensemble of allopatric, point endemic species of *Dravidogecko*, across adjacent massifs of the Western Ghats – a hypothesis that remains to be tested (also see Bansal & Karanth 2013; Chaitanya *et al.* 2019).

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Appendix 1. List of comparative material examined (n = 21; 6 species).

Dravidogecko anamallensis (Günther, 1875): BMNH 1946.8.23.61 (holotype) from the Anamallay Mountains, Coll. R.H. Beddome.

Dravidogecko douglasadamsi Chaitanya, Giri, Deepak, Datta-Roy, Murthy & Karanth, 2019: CESL 384, CESL 385, CESL 393 from Kodayar (8.5242° N, 77.3593° E; 1340 m a.s.l.) Coll. S. Pal on 17-Aug-11; CESL 479, CESL 480, CESL 481 from Sengaltheri (8.5341° N, 77.4503° E; 980 m a.s.l.), Coll. S. Pal on 21-Aug-11; both Kalakkad-Mundanthurai hills, Tirunelveli district, Tamil Nadu.

Dravidogecko janakiae Chaitanya, Giri, Deepak, Datta-Roy, Murthy & Karanth, 2019: CESL 368 from Gundumalai (10.1785° N, 77.1052° E; 1400 m a.s.l.) in Munnar Hills, Coll. S. Pal on 24-Jul-11; CESL 372 from Rajamalai (10.1447° N, 77.0491° E; 1770 m a.s.l.), Munnar Hills, Coll. S. Pal on 28-Jul-11.

Dravidogecko meghamalaiensis Chaitanya, Giri, Deepak, Datta-Roy, Murthy & Karanth, 2019: CSPT/L-41 from Varushanad-Rajapalayam ranges, in former Madurai district [now Theni district], Tamil Nadu, in 1980.

Dravidogecko septentrionalis Chaitanya, Giri, Deepak, Datta-Roy, Murthy & Karanth, 2019: CESL 050, CESL 051, CESL 056 from Vaithiri (11.5314° N, 76.0527° E; 930 m a.s.l.), Waynad Hills, Kerala.

Dravidogecko tholpalli Chaitanya, Giri, Deepak, Datta-Roy, Murthy & Karanth, 2019: CESL 332, CESL 333, CESL 334, CESL 335 from Kodaikanal town (10.2365° N, 77.4907° E; 2035 m a.s.l.); CESL 338 from Kookal, Palnis (10.2954° N, 77.3645° E; 1790 m a.s.l.); MAD no number from Palnis, collector and date unknown.

Dravidogecko smithi Chaitanya, Giri, Deepak, Datta-Roy, Murthy & Karanth, 2019: photo-voucher of an adult male topotype sighted in Upper Sanatorium Ponmudi hills (8.7658° N, 77.1129° E; 1100 m a.s.l.), Kerala in March 2016, by S.R.Ganesh.

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