

# A review of the Gekkonid genus *Cyrtodactylus* Gray, 1827 (Sauria: Gekkonidae) in the Andaman and Nicobar archipelago with the description of two new species from the Nicobar Islands

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## ABSTRACT

A comprehensive review of members of the gekkonid genus *Cyrtodactylus* Gray, 1827 from the Andaman and Nicobar Islands was undertaken to assess the true diversity of the genus in this region. Samples collected across different islands within the archipelago show significant and consistent morphological variation associated with the region of origin. Detailed redescriptions are presented for the two known species *Cyrtodactylus rubidus* and *C. adleri*. Two new species *C. nicobaricus* sp. nov. and *C. camortensis* sp. nov. are described from the northern and central group of islands of the Nicobar archipelago based on morphological distinction and geographic separation from the above two named species from this archipelago. Information on geographic distribution, natural history and conservation status for all of these species are presented.

**Key words:** cryptic species, geographic distribution, insular endemic, allopatry, Gekkonid

## INTRODUCTION

The Gekkonid genus *Cyrtodactylus* Gray, 1827 represents the most species rich genus among old world geckos and is currently known to comprise over 300 species (Uetz and Hosek, 2020). The distribution of this genus spans from the Indian subcontinent in the west to Australia in the East, across tropical Asia and Australasia. Recent studies have demonstrated a very high degree of underestimation of species richness within this genus (E.g. Grismer *et al.*, 2018a; Quah *et al.*, 2019). Among these, knowledge on *Cyrtodactylus* species from the Andaman and Nicobar archipelago, situated in the Bay of Bengal, south of the Burmese peninsula (the Ayerwady Delta) and east of the Indian subcontinent has been relatively poor. In one of the foremost herpetological investigations conducted in the Andaman archipelago, Blyth (1861) described a new gekkonid genus *Puellula* with the species *Puellula rubida* from "Port Blair" in his publication titled "Report of the curator". Stoliczka (1870) transferred this species to the genus *Cyrtodactylus* Gray, 1827 where it rightly belongs and is currently placed. Later, Biswas and Sanyal (1980) and Biswas (1984) reported the occurrence of *Cyrtodactylus rubidus* from Car Nicobar and Great Nicobar Islands in the Nicobar archipelago. Das (1997) based on examination of some of the Nicobarese specimens reported by Biswas and Sanyal (1984) and also on his own collections from Great Nicobar, described *Cyrtodactylus adleri* as a new species. Recent fieldwork in the Andaman and Nicobar archipelago revealed the existence of

some populations of *Cyrtodactylus* spp. from the Central group of the Nicobar Islands and Car Nicobar Island that do not conform to these nominate taxa. In this article, these two populations present outside the morphological and geographic boundaries of the two nominate taxa are described as new species. Additionally, data on aspects pertaining to taxonomy, morphology, natural history and distribution are provided for the two known species, *C. rubidus* and *C. adleri*.

## MATERIALS AND METHODS

Gekkonids of the genus *Cyrtodactylus* encountered in the field were gently restrained, measured, scored for morphological characters, photographed and released at the site of capture. Three dead specimens of *Cyrtodactylus rubidus*, four of *C. adleri*, three specimens of the *Cyrtodactylus* sp. from Car Nicobar and two specimens of the Camorta Island population were collected from in and around human habitations between May and Nov 2017 and preserved in 70% ethanol, and are deposited in the collections of the Department of Ocean Studies and Marine Biology (DOSMB) Pondicherry University, Brookshabad, Port Blair. Type specimens of the new species described here have been deposited in the collections of the Zoological Survey of India, Port Blair. The following measurements in mm were recorded with vernier calipers and characters of pholidosis and colouration were scored. Snout-vent length (SVL), measured from the snout tip to the anterior edge of the cloaca; tail length (TAL), measured from the posterior edge of the

cloaca till the tail tip; trunk length (AG), measured between the axilla and groin; head length (HL), measured from the snout tip till the jaw angle; head width (HW), measured at the broadest point on the head; head depth (HD), measured from the top of the head to the throat, ventrally; horizontal eye diameter (ED), eye-nostril distance (EN), snout length (ES), measured from the anterior eye margin to the snout tip; distance from eye to tympanum (ETY), measured from posterior eye margin to anterior edge of the tympanum; tympanum diameter (TYD), measured at the widest point of the tympanic opening; upper arm length (UAL), measured from the axilla till the elbow; lower arm length (LAL), measured from the elbow to the wrist; palm length (PAL), measured from the wrist till the tip of finger III; thigh length (FEL), measured from the point of insertion of the hindlimb to the trunk till the knee; tibia length (TBL), measured from the knee to heel; foot length (FOL), measured from heel to the tip of toe IV; length of fingers (F1-F5) and toes (T1-T5) measured from the fork till the tip excluding claw. Supralabials and infralabials were counted along the upper and lower lips between rostral and mental till the gape, respectively. Ventrals were counted along a transverse series across the underside at mid-body; intemasals were counted between the nasal scales; subdigital lamellae were counted on the ventral surface of digits on fingers and toes. Geo-coordinates of the localities where the individuals were encountered were recorded with a Garmin GPS MAP 78s and mapped with ARC MAP v. 10.

A principal component analysis was performed based on sixteen morphometric measurements and five meristic characters namely, the number of supralabials, infralabials, number of subdigital lamellae under toe IV, number of dorsal tubercle series and the number of ventrals, between the superficially similar species pair, *C. rubidus* of the Andaman Islands and *C. nicobaricus* sp. nov. from Car Nicobar. Character comparisons across species are restricted to those within the Andaman and Nicobar archipelago. This is justifiable based on the fact that many of the *Cyrtodactylus* species have relatively narrow and finite geographic distribution ranges (Grismer *et al.*, 2018a; Welton *et al.*, 2010) and it is highly unlikely that a species from the Andaman and Nicobar Islands could have a distribution outside the Islands across oceanic barriers. So far, despite several studies over the past decades, the two species known from these islands have never been documented elsewhere.

## SYSTEMATICS

### *Cyrtodactylus rubidus* (Blyth, 1861) (Figures 1&2; Table 2)

*Puellula rubida* Blyth, 1861

*Gecko tigris* Tytler, 1864: 546

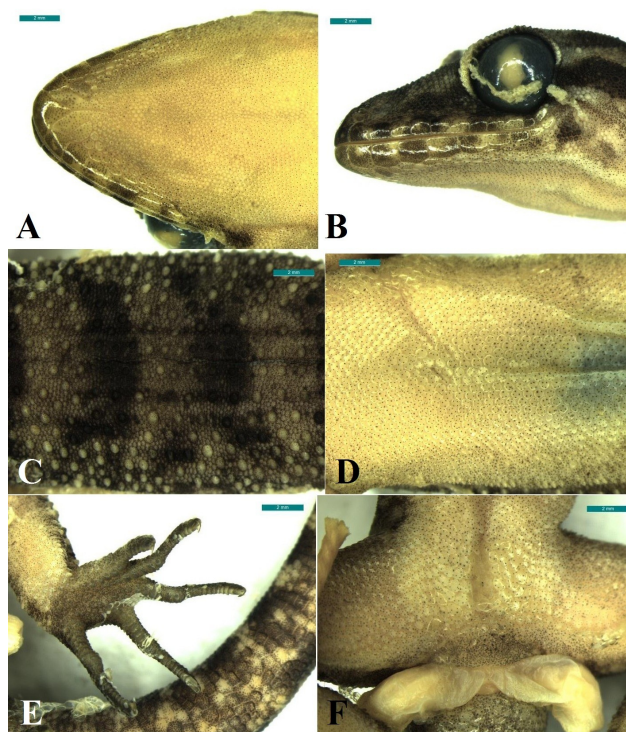
*Crtodactylus rubidus*– Stoliczka, 1870:165

*Gymnodactylus rubidus*– Boulenger, 1885: 45; Smith, 1935: 54

**Syntypes:** ZSI 6208-6210 from 'Andamans' (*fide* Das *et al.*, 1998)



**Figure 1.** *Cyrtodactylus rubidus* from South Andaman (above); Middle Andaman (middle) and Long Island (below).



**Figure 2.** (A) dorsal and (b) ventral views of head, (c) dorsal and (d) ventral views of the trunk, (e) ventral view of the right foot and (f) preloacal region of a topotype (DOSMB05069) of *Cyrtodactylus rubidus*

**Table 1.** Comparison of morphological characters between *Cyrtodactylus* spp. of the A&N Islands

	<i>C. rubidus</i>	<i>C. nicobaricus</i> sp. nov.	<i>C. camortensis</i> sp. nov.	<i>C. adleri</i>
SVL	48.59-56.75	45.77-50.77	53.41-63.75	42.13-62.8
transverse tubercles	13-15	16-18	16-18	18-20
Supralabials	10-11	10	11	10-11
Infralabials	9	8-9	8-9	8-10
Precloacal groove	present	present	absent	absent
Ventrals	juxtaposed	imbricate	juxtaposed	imbricate
Subdigital lamellae	17-19	14-15	19-21	18-20
Nuchal loop pattern	present	present	absent	absent
Dorsal pattern	banded	banded	spotted	spotted

**Material examined:** DOSMB05069, DOSMB05073 – Brookshabad, Port Blair, South Andaman; DOSMB05047 – Little Andaman.

#### Differential diagnosis and comparisons: (Table 1)

*Cyrtodactylus rubidus* is endemic to islands of the Andaman archipelago and is characterized by: moderate adult body size (SVL 48.59–56.75 mm); intensely tuberculate dorsum (13–15 transverse rows at midbody); 10–11 supralabials; nine infralabials; two elongate inner pair of post-mentals in broad contact with each other; two smaller, separated outer pair of postmentals; presence of a precloacal groove and up to six precloacal pores located around the precloacal groove in males; presence of four enlarged internasals; evident ventrolateral dermal folds; 38–40 transverse rows of juxtaposed ventrals (vs. imbricate in *C. adleri* and *C. nicobaricus* sp. nov.); two pairs of rounded post-cloacal spurs in males; 17–19 subdigital lamellae under the IV toe, of which the basal six are expanded; presence of a nuchal loop formed by post ocular streaks extending and joining at the nape and a dorsal colour pattern of 8–9 dark transverse bands on a dark grey to brown background.

#### Description of a toptop (DOSMB05069):

An adult male, measuring 56.07 mm SVL. Head large, longer than broad (HL:HW 1.53) with a rounded snout tip when viewed dorsally; eyes large with a vertically elliptical pupil, (ED:HL 0.25) but shorter than the snout. Habitus depressed, with a long trunk (AG 23.4). Supralabials 11/11; infralabials 9/9; mental triangular; bounded by a large pair of rhomboidal inner pair of postmentals, in contact with each other; outer pair smaller and separated. Dorsum covered by nearly uniform, rounded tubercles (lacking keels) throughout; in 15 transverse rows. Ventral scales circular; juxtaposed. Precloacal groove evident; demarcated by a thin dark line separating the two adjacent white patches of enlarged precloacal scales. Two pairs of rounded, cloacal spurs present on either sides of the hemipenial bulge. Six precloacal pores present around the precloacal groove. Thigh short (FEL:SVL 0.17); scales on ventral surface of the thighs smooth. Tibia slightly longer than the thighs (TBL:SVL 0.18); feet shorter than the thighs. Toes curved and elongated with 19 subdigital lamellae under toe IV; of which, the basal six are slightly dilated and the

rest undilated; relative lengths of toes IV>III>V>II>I; Upper arm shorter than lower arm (UAL:LAL 0.81); palm shorter than lower arm; relative length of fingers IV>III>V>II>I. Dorsal colouration brown with 7-8 dark brown relatively slender transverse bars on the trunk that are narrower than the ground colour. A distinct, U-shaped band (the nuchal loop) from behind the eyes to the nape. Tail with dark transverse bands; underside uniform creamy yellow. Enlarged precloacal scales bright white in colour. Measurements of the examined specimens are in table 2.

**Variation:** Females lack the pale skin patch in the precloacal region and precloacal pores. Two small, rounded cloacal spurs located near the sides of the vent in males. Measurements of the studied specimens are in table 2.

**Distribution:** *C. rubidus* occurs throughout most islands of the Andaman archipelago and was recorded from the following islands: South Andaman, Middle Andaman, Baratang, North Andaman, Little Andaman, Havelock, Neil, Kyd, Rutland, Interview, North Reef, Paget, Tarmugli, Long, North Passage and Guitar. It has also been recorded from far and distant ones such as Narcondam (Raman *et al.*, 2013). Records during the present study are in figure 10.

**Natural History:** Commonly found in forests as well as human habitation. Nocturnal and feeds on insects. Ophidian predators such as *Lycodon hypsirhinoides* were often seen feeding on *C. rubidus*.

#### *Cyrtodactylus nicobaricus* sp. nov. (Figures 3-4; Table 2)

*Cyrtodactylus rubidus* (nec Blyth, 1861) – Biswas & Sanyal, 1984: 477

*Cyrtodactylus adleri* (nec Das, 1997) – Harikrishnan & Vasudevan, 2018

**Holotype:** ZSI/ANRC/T/ 11074), an adult male, collected by S.R. Chandramouli from human habitation in Chuckchucka Village (9.21° N, 92.79° E, 33.4 m asl.) in Car Nicobar Island on 17 June 2017.

**Paratopotypes:** DOSMB05100, an adult female and DOSMB05101, an adult female, collected by S.R. Chandramouli from the type locality on 13 and 15 June 2017 respectively.

Table 2. Measurements and morphological characters of *Cyrtodactylus* spp. of the A&N

Voucher No:	ZSI/ANRC/ T/ 11074		DOSMB05100		DOSMB05101		mean	
	m	f	f	f	f	mean		
Species	<i>Cyrtodactylus nicobariensis</i> sp. nov.							
Sex	<i>Cyrtodactylus rubridus</i>							
SVL (mm)	45.77	46.47	50.77	56.75	48.59	56.07	53.80	
Trunk length	15.21	17.04	19.79	24.88	21.83	23.4	23.37	
Tail	53	35.77	27.35	65	61	72	66.00	
Head length	14.12	14.73	15.11	15.68	13.86	16.41	15.32	
Head width	9.43	8.7	9.23	10.88	9.07	11.1	10.35	
Head depth	5.52	5.66	5.44	6.79	5.98	7.47	6.75	
Eye dia	3.56	2.73	3.74	3.75	3.02	4.16	3.64	
Tympanum dia	0.73	0.65	0.88	0.83	0.86	0.67	0.79	
Eye- nostril	4.65	4.7	5.04	4.91	4.33	4.96	4.73	
Eye - snout	6	5.96	6.13	6.9	5.88	6.75	6.51	
Eye - tympanum	4.44	4.46	4.48	4.58	4.2	5.09	4.62	
Supalabials	10	10	10	10	10	11	-	
Infralabials	8	9	8	9	9	9	-	
Ventrals	38	37	40	38	39	40	-	
Upper arm length	5.36	5.91	6.09	7.74	7.43	6.25	7.14	
Lower arm length	5.9	6.22	7.17	7.66	5.89	7.72	7.09	
Palm length	5.42	5.71	5.38	5.58	5.4	6.38	5.79	
Femur length	8.75	10.25	8.88	11.09	8.63	9.73	9.82	
Tibia length	8	8.42	8.14	10.61	8.85	10.11	9.86	
Foot length	6.96	7.11	7.34	7.8	7.62	8.89	8.10	
T4 lamellae	14	15	14	17	17	19	-	
F1	1.17	1.14	1.6	2.1	1.96	2.05	2.04	
F2	1.62	2.52	2.06	3.35	3.16	3.34	3.28	
F3	2.87	3.38	2.86	4.25	3.46	3.92	3.88	
F4	3.76	3.66	3.21	4.32	4.02	4.31	4.22	
F5	2.48	2.86	2.44	3.56	3.67	3.77	3.67	
T1	1.29	1.72	1.53	2.38	1.76	2.7	2.28	
T2	2.44	3.42	2.41	3.8	3.96	4.31	4.02	
T3	4.18	4.65	3.58	5.3	4.63	5.22	5.05	
T4	4.7	4.7	4.19	5.47	4.78	5.23	5.16	
T5	4.33	4.54	3.88	3.95	4.37	5.04	4.45	
Post-mentals	2+2	2+2	2+2	2+2	2+2	2+2	2+2	

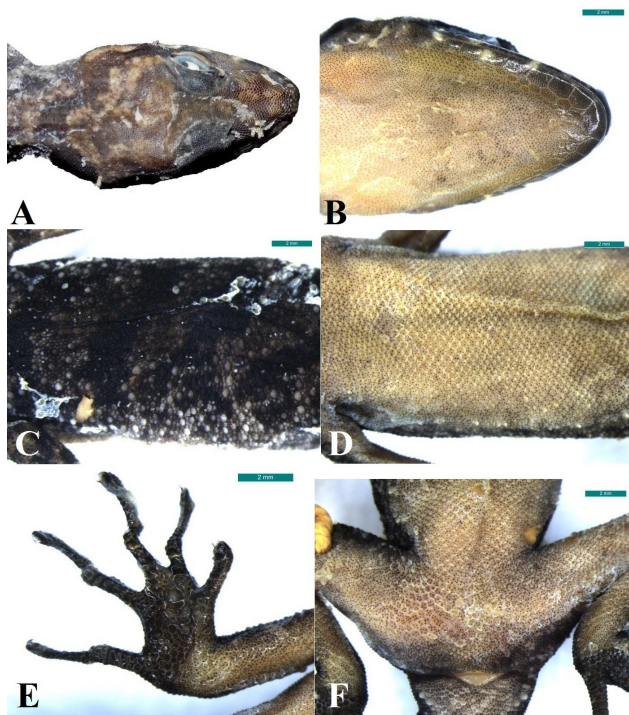
continued

Table 2. Measurements and morphological characters of *Cyrtodactylus* spp. of the A&N (continued)

Voucher No:	DOSMB05016	DOSMB05024	DOSMB05057	ZSI/ANRC/ T/ 11076	mean	ZSI/ANRC/ T/ 11075	DOSMB05083
Species	<i>Cyrtodactylus adleri</i>			<i>Cyrtodactylus camortensis</i> sp. nov.			
Sex	f	m	m	m		m	f
SVL (mm)	42.13	55.93	52.56	62.8	<b>53.35</b>	53.41	63.75
Trunk length	16.95	22.67	19.43	25.62	<b>21.16</b>	23.75	24.74
Tail	40	65	67	46.39	<b>54.59</b>	64	52
Head length	12.5	16	14.61	17.32	<b>15.1</b>	15.74	17.01
Head width	7.25	10.21	9.04	11.02	<b>9.38</b>	10.64	11.28
Head depth	5.04	6.47	5.57	6.91	<b>5.99</b>	6.5	6.9
Eye dia	2.92	3.52	3.75	4.32	<b>3.62</b>	3.67	4.33
Tympanum dia	0.75	0.87	0.7	0.67	<b>0.74</b>	0.88	1.02
Eye- nostril	3.01	4.81	4.97	5.41	<b>4.55</b>	5.52	6.02
Eye - snout	4.62	6.79	6.12	6.88	<b>6.1</b>	6.92	7.66
Eye - tympanum	3.65	4.77	3.68	5.32	<b>4.35</b>	5.27	5.62
Supalabials	11	10	10	11	-	11	11
Infralabials	10	9	8	8	-	8	9
Ventrals	46	48	47	50	-	47	49
Upper arm length	5.4	7.52	7.3	8.45	<b>7.16</b>	7.52	8.58
Lower arm length	4.95	8.23	7.53	9.27	<b>7.49</b>	7.3	8.67
Palm length	5.04	6.67	6.4	5.92	<b>6.0</b>	6.63	6.3
Femur length	7.16	11.17	8.86	11.85	<b>9.76</b>	9.72	10.02
Tibia length	7.61	10.11	9.64	10.07	<b>9.35</b>	9.45	10.47
Foot length	6.54	8.06	8.73	9.53	<b>8.21</b>	9.61	9.04
T4 lamellae	19	18	20	18	-	21	19
F1	1.2	2.32	2.95	2.35	<b>2.2</b>	2.15	2.46
F2	2.13	3.06	3.57	3.73	<b>3.12</b>	4.11	3.13
F3	2.64	3.76	4.82	4.28	<b>3.87</b>	4.32	4.92
F4	3.28	4.28	4.76	4.21	<b>4.13</b>	4.33	4.93
F5	2.95	3.37	3.73	3.82	<b>3.46</b>	3.67	4.01
T1	1.95	2.3	2.06	2.63	<b>2.35</b>	3.19	3
T2	2.52	4.05	3.91	4.82	<b>3.82</b>	4.85	4.37
T3	4.25	4.86	5.15	5.35	<b>4.9</b>	5.66	5.32
T4	4.67	4.85	5.16	5.84	<b>5.13</b>	5.98	5.57
T5	3.94	4.6	5.16	5.38	<b>4.77</b>	5.3	5.66
Post-mentals	2+2	2+2	2+2	2+2		2+2	2+2



**Figure 3.** *Cyrtodactylus nicobaricus* sp. nov. Above: Holotype ZSI ZSI/ANRC/T/ 11074; below: living individuals from Car Nicobar



**Figure 4.** (A) dorsal and (b) ventral views of head, (c) dorsal and (d) ventral views of the trunk, (e) ventral view of the right foot and (f) preloacal region of a paratype (DOSMB05100) of *Cyrtodactylus nicobaricus* sp. nov.

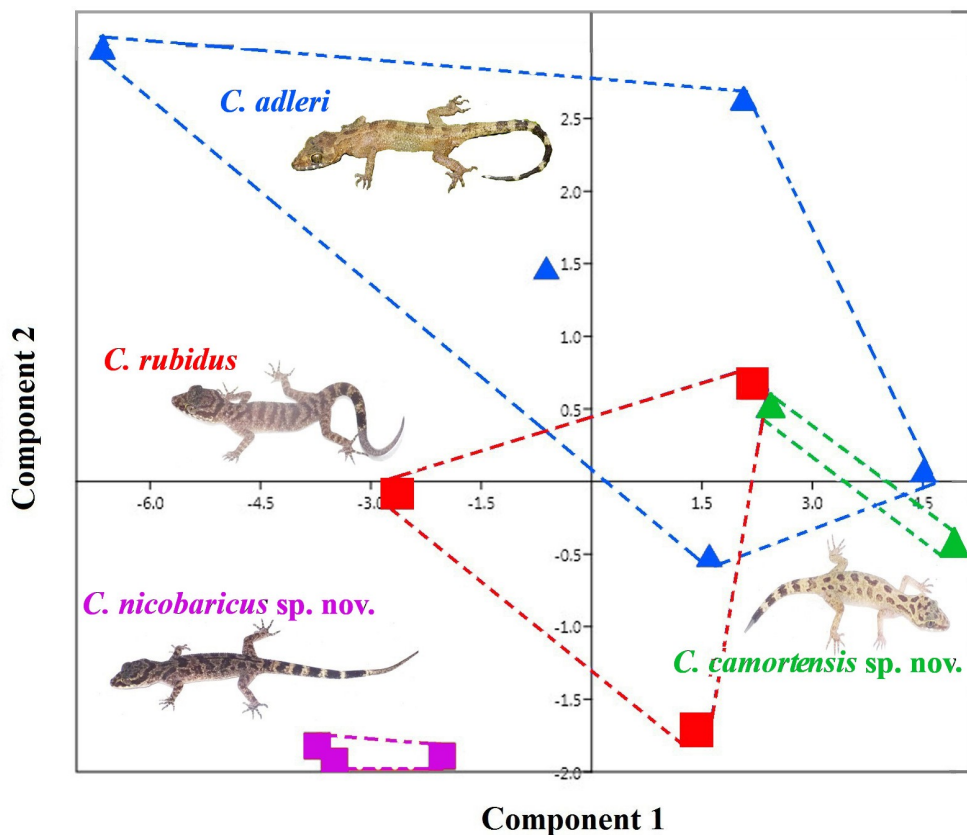
### Differential diagnosis and comparisons: (Table 1, Figure 5)

A *Cyrtodactylus* endemic to Car Nicobar Island of the Nicobar archipelago which is diagnosed and characterized by: presence of 16–18 transverse rows of dorsal tubercles (vs. 13–15 in *C. rubidus*); 10 supralabials, eight-nine infralabials, two elongate inner pair of post-mentals in broad contact with each other; two smaller outer pair of post-mentals separated from each other; presence of a preloacal groove (vs. absent in *C. adleri* and *C. camortensis* sp. nov.) and upto six preloacal pores located around the preloacal groove in males; absence of femoral pores; presence of four enlarged internasals; presence of ventrolateral dermal folds; 37–40 strongly imbricate ventrals (vs. juxtaposed and non-overlapping ventrals in *C. rubidus*); two pairs of rounded cloacal spurs in males; 14–15 subdigital lamellae under the IV toe of which, the basal six are slightly dilated (vs. 17–19 in *C. rubidus*); presence of a dark nuchal loop formed by post ocular streaks extending and joining at the nape (vs. absent in *C. adleri* and *C. camortensis* sp. nov.); dorsal colour pattern of five to six dark transverse bands on a dark brown ground colour (vs. a series of vertebral spots in *C. adleri* and *C. camortensis* sp. nov.) with a series of short longitudinal bands converging posteriorly towards mid-dorsum between forelimbs.

### Description of holotype: ZSI/ANRC/T/ 11074

A medium sized adult male measuring 45.77 mm SVL. Head longer than broad (HL:HW 1.5) with a rounded snout tip. Eyes large with a vertically elliptical pupil, (ED:HL 0.25) but shorter than the snout. Habitus depressed; with a long trunk (AG 15.21). Supralabials 10/10, infralabials 8/8; mental triangular and broad bounded by two pairs of post-mentals. Inner pair in contact with each other, slightly larger than the outer pair. Dorsum covered by smooth, rounded tubercles of intermixed size; in 17 transverse rows. Ventrals imbricate, overlapping with each other, with a blunt, rounded posterior vertex. Venter cream coloured with small black spots scattered all throughout. Preloacal groove and cloacal spurs evident; six preloacal pores located around the preloacal groove situated in the middle of the large, brightly coloured patch of scales. Thigh short (FEL:SVL 0.19); tibia slightly shorter than thighs (TBL:SVL 0.17); foot longer than thigh, with long curved digits lacking dilations. Relative length of toes IV>III>V>II>I; 14 subdigital lamellae under toe IV, of which the basal six are slightly dilated. Upper arm slightly shorter than lower arm (UAL:LAL 0.91); palm shorter than lower arm; relative length of fingers IV>III>V>II>I. Dorsal colouration greyish brown overall, with a series of five thick transverse bars across the body, which are about as broad as the spaces in between them. A dark, U shaped band, the nuchal loop present from behind the eyes to the nape. The first band on the trunk bordered by short longitudinal lines. Original tail complete and has a distinct, alternating light and dark banded pattern.

**Variation:** The female paratypes lack an obvious hemipenial bulge or a preloacal groove. Two small, rounded cloacal spurs located near the sides of the vent in



**Figure 5.** PCA plot showing the relative distribution of *Cyrtodactylus* spp. of the A&N Islands: *Cyrtodactylus rubidus* (red squares) from the Andaman archipelago; *Cyrtodactylus nicobaricus* sp. nov. (purple squares) from Car Nicobar; *Cyrtodactylus camortensis* sp. nov. (green triangles) from central Nicobar Islands and *Cyrtodactylus adleri* (blue triangles) from southern Nicobar Islands.

male. Male slightly smaller than the two females. Measurements of the paratypes are in table 2.

**Distribution:** *Cyrtodactylus nicobaricus* sp. nov. is endemic to Car Nicobar and possibly Batti Malv, the northern group of the Nicobar Islands. Recorded only from Car Nicobar during this study and its presence or absence on the smaller, adjacent Batti Malv Island is not known.

**Natural History:** A common species found in forests as well as human habitation. Often observed on leaf-litter in the forest floor and branches of small shrubs up to about 1m above the ground. Nocturnal and feeds on insects.

**Etymology:** A toponym, named after the type locality of this species, Car Nicobar Island, which is colloquially called just as 'Nicobar'.

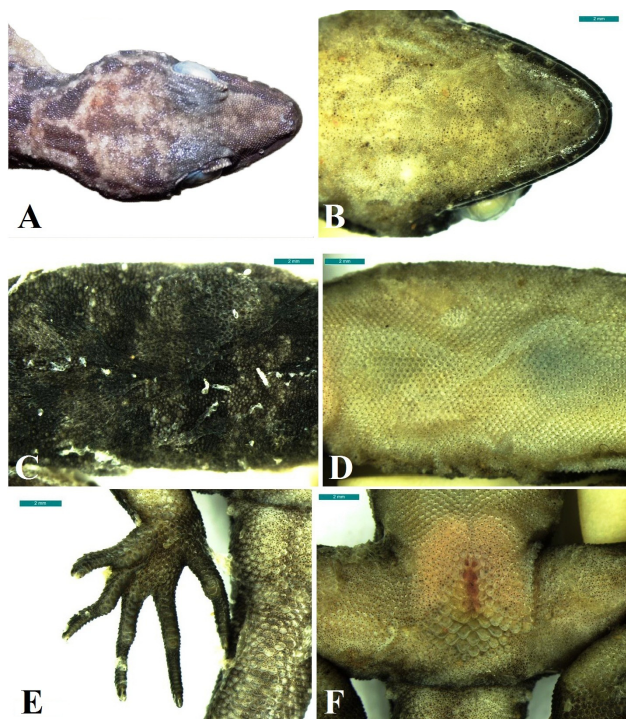
***Cyrtodactylus camortensis* sp. nov. (Figures 6-7; Table 2)**  
*Cyrtodactylus adleri* (nec Das, 1997) – Harikrishnan & Vasudevan, 2018

**Holotype:** ZSI/ANRC/T/ 11075, an adult male, collected by S.R. Chandramouli on 27 July 2017 from human habitations near Changua Village (8.018N, 93.494 E, 140 m asl.), Camorta, Central group of the Nicobar Islands.

**Paratopotype:** DOSMB05083, an adult female, collected by S.R. Chandramouli from the same locality on 28 July 2017.



**Figure 6.** *Cyrtodactylus camortensis* sp. nov. Above: Holotype ZSI/ANRC/T/ 11075 in preservation; middle and below: *Cyrtodactylus camortensis* in life from Camorta



**Figure 7.** (A) dorsal and (B) ventral views of head, (C) dorsal and (D) ventral views of the trunk, (E) ventral view of the right foot and (F) precloacal region of the holotype *Cyrtodactylus camortensis* sp. nov.

#### Differential diagnosis and comparisons: (Table 1)

A *Cyrtodactylus* endemic to the central group of the Nicobar Islands, characterized by: presence of 16-18 transverse rows of dorsal tubercles (vs. 13–15 in *C. rubidus*); 11 supralabials, eight to nine infralabials, two elongate inner pair of post-mentals in broad contact with each other; two smaller outer pair of post-mentals separated from each other, absence of a precloacal groove (vs. present in *C. rubidus* and *C. nicobaricus* sp. nov.) and upto seven precloacal pores in males; absence of femoral pores; presence of four enlarged internasals; 47–49 juxtaposed ventrals (vs. strongly imbricate ventrals in *C. adleri* and *C. nicobaricus* sp. nov.); two pairs of rounded cloacal spurs in males; 19–21 subdigital lamellae under the IV toe, of which the basal seven are slightly dilated (vs. 17–19 in *C. rubidus*; 14–15 in *C. nicobaricus* sp. nov.; 19–20 *C. adleri*); absence of a dark nuchal loop formed by post ocular streaks extending and joining at the nape (vs. present in *C. rubidus* and *C. nicobaricus* sp. nov.); dorsal colour pattern of dark vertebral spots, bounded by lateral streaks (vs. 5–6 dark transverse bands on a dark brown ground colour in *C. rubidus* and *C. nicobaricus* sp. nov.).

#### Description of holotype (ZSI/ANRC/T/ 11075):

A fairly large adult male measuring 55.93 mm SVL. Head fairly large (HL:SVL 0.29); longer than broad (HL:HW 1.48) with a rounded snout tip. Eyes large (ED:HL 0.23) with a vertically elliptical pupil. Habitus depressed; with a long trunk (AG 23.75). Supralabials 11/11, infralabials 8/8; mental wedge-shaped and fairly long, bounded by two pairs of pentagonal post-mentals. Inner pair in contact with each other, slightly larger than

the separated outer pair. Dorsal tubercles smooth, in 16 transverse rows, slightly enlarged and relatively much smaller than in the other species. Ventrals circular in shape, non-overlapping and juxtaposed, in 49 rows across the belly. Venter pale white with each ventral scale bearing small black spots. Precloacal groove absent, but a pinkish patch with distinctly enlarged precloacal scales occur, within which seven precloacal pores are present. Femoral pores absent. Thigh short (FEL:SVL 0.18); tibia as long as the thigh (FEL:TBL 1.0); foot slightly shorter than thigh. Hemipenial bulge and rounded cloacal spurs distinct. Toe IV with 21 lamellae, of which the basal seven are slightly dilated. Relative length of toes IV>V>III>II>I. Upper arm slightly longer than lower arm (UAL: LAL – 1.03); palm shorter than lower arm; relative lengths of fingers: IV>III>II>V>I. Left hand lacking palm, presumably due to injury. Dorsal coloration grayish brown with a series of 7 dark spots with confluent short lateral bands. A short, broken V shaped marking on the nape. Tail with dark annuli; venter pale white in colour.

**Variation:** The female paratype shows a striking contrast in colouration by being bright yellowish with large dark brown circular dorsal blotches. However, this variation is not sex specific, as an adult male of such colouration was also recorded from Katchall. Measurements of the paratypes are in table 2.

**Distribution:** *Cyrtodactylus camortensis* is endemic to the central group of islands within the Nicobar archipelago and was recorded from Camorta, Katchall, and Nancowry Islands. However, it could potentially occur in the other Islands of this group such as Chowra, Teressa, Bompoka and Tillanchong.

**Natural History:** An uncommon species found in forests as well as human habitation. Seen frequently on the ground, roads and culverts alongside. Nocturnal and feeds on insects.

**Etymology:** A toponym, named after Camorta Island, the type locality of this species.

#### *Cyrtodactylus adleri* Das, 1997 (Figures 8-9; Table 2)

**Type material:** ZSI 25057 (holotype) from '1 km E Galathea River mouth, Great Nicobar'; ZSI 25059–25061; ZSI 23398, ZSI 25117 (paratypes), all from Great Nicobar.

**Material examined:** DOSMB05016 and DOSMB05024 – Great Nicobar, DOSMB05057, ZSI/ANRC/T/ 11076 – Little Nicobar

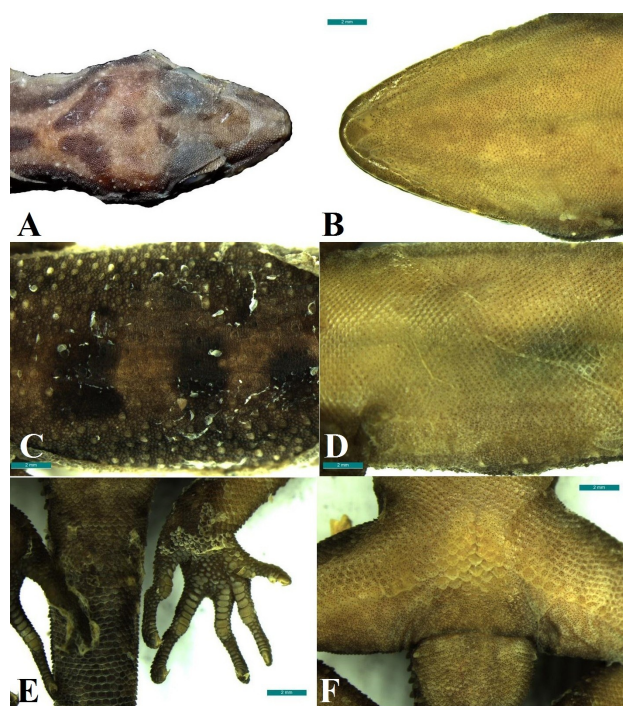
#### Differential diagnosis and comparisons: (Table 1)

*Cyrtodactylus adleri* is endemic to the southern group of islands in the Nicobar archipelago and is characterized by: moderate adult body size (SVL 42.13–62.8 mm); intensely tuberculate dorsum (18–20 transverse rows at midbody); 10–11 supralabials; 8-10 infralabials; two elongate inner pair of post-mentals in broad contact with each other; two smaller, separated outer pair of post-mentals; absence of a precloacal groove (vs. present in *C. rubidus* and *C. nicobaricus* sp. nov.) and upto six





**Figure 8.** *Cyrtodactylus adleri* from Great Nicobar (above); Little Nicobar (below).



**Figure 9.** (A) dorsal and (b) ventral views of head, (c) dorsal and (d) ventral views of the trunk, (e) ventral view of the left foot and (f) preloacal region of *Cyrtodactylus adleri* DOSMB05024.

preloacal pores in males; presence of 4 enlarged inter-nasals; 46–50 transverse rows of imbricate ventrals (vs. juxtaposed in *C. rubidus* and *C. camortensis* sp. nov.); 20–23 transverse rows of keeled triheadral dorsal tubercles; two pairs of rounded cloacal spurs in males; 18–20 subdigital lamellae under the IV toe; absence of a nuchal loop formed by post ocular streaks extending and joining at the nape and a dorsal colour pattern of dark vertebral spots, bounded by lateral streaks (vs. 5–6 dark transverse bands on a dark brown ground colour in *C. rubidus* and *C. nicobaricus* sp. nov.).

**Description of a topotype (DOSMB05024):**

An adult male, measuring 55.93 mm SVL. Head large, (HL:SVL 0.28); longer than broad (HL:HW 1.57) with a rounded snout tip. Eyes large (ED:HL 0.2); with a vertically elliptical pupil. Habitus depressed with a long trunk (AG 22.67). Supralabials 10/10; infralabials 9/9; mental short, as broad as long. Post-mentals in two pairs, inner pair larger and in contact with each other, outer pair small and separated. Dorsal tubercles large and triheadral with a longitudinal keel; in 18 transverse rows at mid-body. Ventrals imbricate, in 48 transverse rows, rhomboidal in shape and imbricate, overlapping with each other. Preloacal groove absent, but a pale patch of distinctly enlarged preloacal scales present, within which six preloacal pores occur. Two small, rounded colacal spurs present. Femoral pores absent. Thigh short (FEL:SVL 0.2); slightly longer than the tibia (TBL:SVL 0.18); foot shorter than thigh. Toes curved and bear 18 subdigital lamellae under toe IV, of which the basal eight are slightly dilated. Relative length of toes V>IV>III>II>I. Upper arm slightly shorter than lower arm (UAL:LAL 0.91); palm a little shorter, with curved fingers bearing undilated subdigital lamellae. Relative length of fingers IV>V>III>II>I. Dorsum grey brown with dark brown spots along the vertebra. A ‘V’ shaped mark on the nape bordered by two dark longitudinal streaks till the axilla. Tail annulated with dark bands.

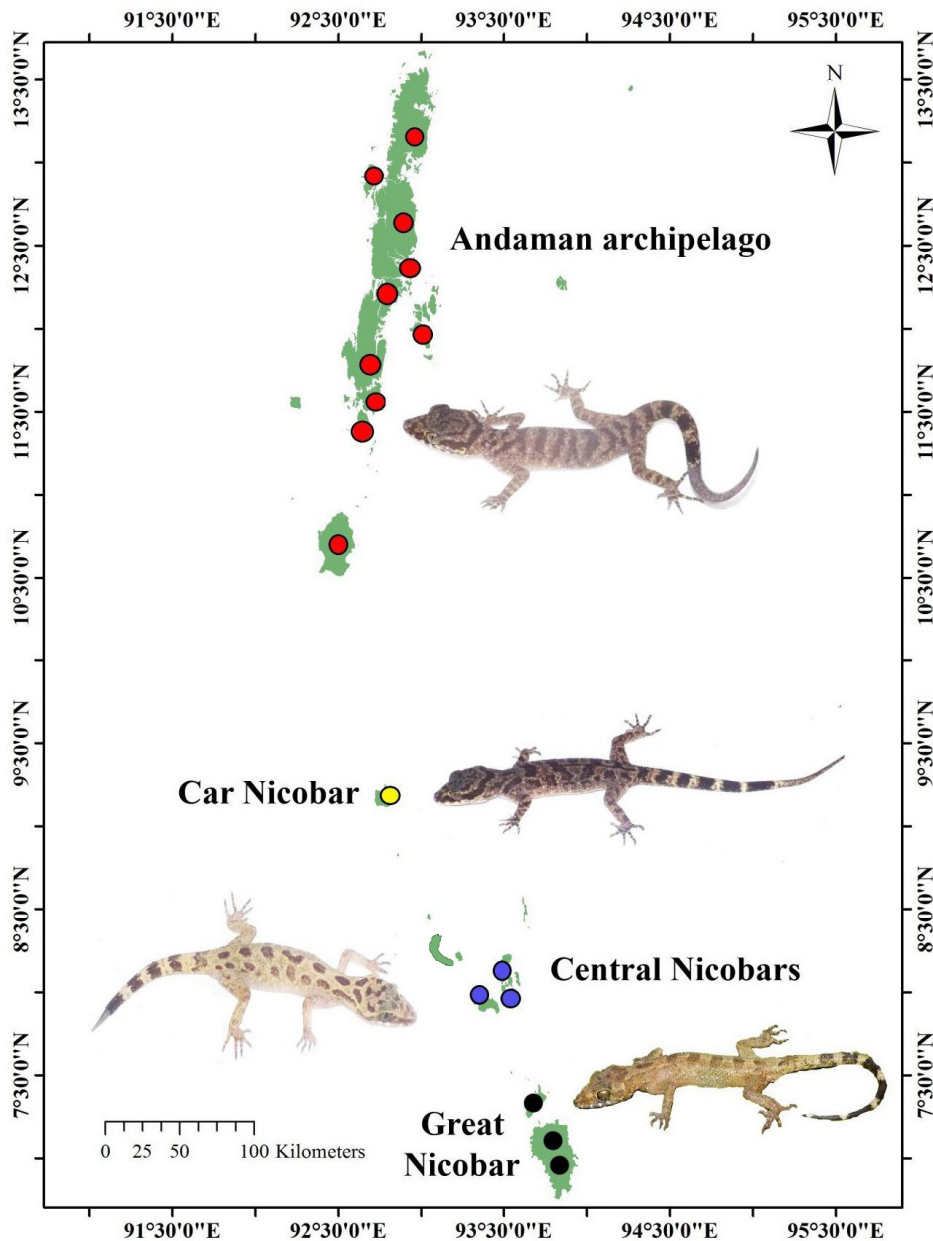
**Variation:** Males larger than females, which lack preloacal pores. Gravid females had two eggs discernible inside the belly. Measurements of the examined specimens are in table 2.

**Distribution:** Recorded from Great Nicobar and Little Nicobar Islands during this study and could potentially occur on small, adjacent islands such as Pilo Milo, Kondul and Menchal.

**Natural History:** A common species found in forests as well as human habitation. Nocturnal and feeds on insects. Observed frequently in the forests, mostly on stems of shrubs.

**DISCUSSION**

The present study reveals an underestimated diversity of *Cyrtodactylus* geckos within the Andaman and Nicobar archipelago until now, which is in line with the vast number of new species discoveries made throughout most



**Figure 10.** Map of the Andaman & Nicobar archipelago showing the distribution of: *Cyrtodactylus rubidus* (red: Andaman Islands); *C. nicobaricus* sp. nov. (yellow: Car Nicobar); *C. camortensis* sp. nov. (central Nicobars: blue) and *C. adleri* (black: Little & Great Nicobar).

parts of the range of this genus (e.g. Pauwels *et al.* 2016; Oliver *et al.*, 2019; Quah *et al.*, 2019; Grismer *et al.*, 2015; Zeigler *et al.*, 2013; Grismer *et al.*, 2008; Grismer *et al.*, 2018b, Nazarov1 *et al.*, 2018; Grismer *et al.*, 2019). Since Blyth (1861) described *C. rubidus* from the Andaman Islands, there had been a vast gap of 136 years in-between until the description of the second species, *C. adleri* by Das (1997). The present discovery of two new species from other parts of these islands after a gap of 22 years, despite several surveys for herpetofauna conducted here in the past (e.g. Das, 1999; Vijayakumar, 2005; Harikrshnan and Vasudevan, 2018) is significant. Though Vijayakumar (2005) reported unidentified populations of *Cyrtodactylus* spp. on islands of the northern and central group of the Nicobar Islands, no attempt has been made towards attaining a systematic resolution until

now. On the other hand, Harikrishnan and Vasudevan (2018) referred the northern and central Nicobar populations to *C. adleri* without any justification. The present study has revealed that *C. adleri* is in fact, restricted to the southern group of the Nicobar Islands and the species occurring to the north of its range represent hitherto undescribed populations as evidenced by their differing morphology and allopatric distribution, as detailed above. This has a direct impact on the implications drawn by Harikrishnan and Vasudevan (2018) who presumed 'positive co-occurrence' of other lizard species such as *Bronchocela rubrigularis*, *Dasia nicobarensis* and *Gekko nicobarensis* with *C. adleri* while dealing with its niche. Because of their misconception of *C. adleri*, such erroneous conclusions have been drawn. Likewise, Agarwal *et al.* (2014:147) in their study on biogeography of

naked-toed geckos, referred a sample of *Cyrtodactylus* from Nancowry Island to *C. adleri*, which is now referable to *C. camortensis* sp. nov.

Among these, *C. rubidus*, the earliest known species from the Andaman archipelago shows the widest distribution within these islands occurring throughout most parts of the Andaman archipelago. The newly described *Cyrtodactylus nicobaricus* sp. nov. probably has the most narrow geographic distribution range within the archipelago, being restricted only to Car Nicobar, situated at the northern region of the Nicobar archipelago (Figure 10). The other species, *C. camortensis* sp. nov. and *C. adleri*, although restricted to a few small islands, have a relatively wider distribution range in comparison to *C. nicobaricus* sp. nov. Though spatially compact and proximate, lots of intrinsic biogeographic variations within the Nicobar archipelago have been well established (Das, 1999; pers. obs). The distribution pattern of *Cyrtodactylus* geckos in the Nicobar archipelago roughly reflects the distribution pattern of agamids of the genus *Bronchocela* in this region, with *B. cf. cristatella* being restricted to Car Nicobar, *B. rubrigularis* to the islands of the central group and *B. danieli* in Great Nicobar Island, situated to the south. Among these, conservation status has been assessed only for *C. adleri* as Least Concern (Böhm and Dewhurst, 2010). Going by the IUCN criteria B1 and B2, the two new species described here would fall under the category of endangered species (extent of occurrence < 5000 km<sup>2</sup> and area of occupancy < 500 km<sup>2</sup>). The Andamanese species *C. rubidus* would fall under the least concerned category as it occurs on most of the islands throughout the Andaman archipelago. Although fairly common within their respective distribution ranges, these geckos face competition for space and resources from other nocturnal, insectivorous species with similar body sizes but relatively wider geographic ranges such as *Hemidactylus* spp. and *Gehyra mutilata*. These species often tend to get introduced easily to new areas by transportation through human agency (e.g. Chandramouli, 2015; Gokulakrishnan *et al.*, 2019) and therefore, pose a threat to the native *Cyrtodactylus* geckos.

#### Key to *Cyrtodactylus* species of the Andaman and Nicobar Islands:

##### A) Preclacal groove present

1. ventrals juxtaposed, 17-19 subdigital lamellae under toe IV..... *C. rubidus*
2. ventrals imbricate, 14-15 subdigital lamellae under toe IV..... *C. nicobaricus* sp. nov.

##### B) Preclacal groove absent

1. ventrals juxtaposed, 19-21 subdigital lamellae under toe IV, 16-18 transverse rows of small, rounded tubercles on mid-dorsum..... *C. camortensis* sp. nov.
2. ventrals imbricate, 18-20 subdigital lamellae under toe IV, 18-20 transverse rows of large, keeled tubercles on mid-dorsum..... *C. adleri*

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