

An update to species distribution records of geckos (Reptilia: Squamata: Gekkonidae) on the Andaman and Nicobar Islands, Bay of Bengal

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The Andaman and Nicobar Islands are rifted arc-raft continental islands (Ali, 2018). Andaman and Nicobar Islands together form the largest archipelago in the Bay of Bengal and a high proportion of terrestrial herpetofauna on these islands are endemic (Das, 1999). Although often lumped together, the Andamans and Nicobars are distinct from each other in their floral and faunal species communities and are geographically separated by the 10° Channel. Several studies have shed light on distribution, density and taxonomic aspects of terrestrial herpetofauna on these islands (e.g., Das, 1999; Chandramouli, 2016; Harikrishnan and Vasudevan, 2018), assessed genetic diversity across island populations (Mohan et al., 2018), studied the impacts of introduced species on herpetofauna and biodiversity (e.g., Mohanty et al., 2016a, 2019), and studied sleep behaviour of the endemic agamid lizards (Mohanty et al., 2016b). Herpetofauna surveys in the Andaman and Nicobar Islands in the 21st Century have led to extensive inventories of species on several islands of the archipelagos (Vijayakumar and David, 2006; Harikrishnan et al., 2012a, b, 2018; Chandramouli et al., 2012, 2016; Chandramouli, 2015, 2016, 2017; Harikrishnan and Vasudevan, 2015, 2018). See Harikrishnan et al., 2010 for a review of the herpetofauna research in the Andaman and Nicobar Islands that were published before the year 2010.

Many small islands are yet to be surveyed, furthermore strong oceanic currents and events such as the Tsunami

of 2004, and human-mediated transport can introduce additional species to these islands (Chandramouli, 2015). In this study, I provide an update for the occurrence and distribution of species in the family Gekkonidae (geckos) on the Andaman and Nicobar Islands.

Materials and Methods

Teams consisted of between 2–4 members and we conducted opportunistic visual encounter surveys in accessible forested and human-modified areas, both during daylight hours and post-sunset. These surveys were carried out specifically for geckos between November 2016 and May 2017, this period overlapped with the north-east monsoon and summer seasons in these islands. A total of 16 islands in the Andaman and Nicobar archipelagos (Fig. 1) were covered. When an individual was spotted, we identified, captured, and collected the tail tip as a tissue sample, recorded location information, and in many cases obtained digital photographs for further identification. Tissue samples are deposited and stored at the in-house repository at Kartik Shanker's laboratory, Centre for Ecological Sciences, Indian Institute of Science, Bangalore, India.

Species identification was based on diagnostic characters extracted from the original species descriptions and/or published keys and reconfirmed by experts in the field, recognising that the taxonomic status of several species remains uncertain. The tissue samples collected are being used for genetic barcoding and phylogeographic studies to provide an additional line of evidence for future species identification and verification (work in progress). In this study, I present 11 new species distribution records of geckos on the Andaman and Nicobar Islands (Tables 1, 2; Fig. 1, 2; Supplementary S1). Study map of the Andaman and Nicobar Islands was visualized using GeoMapApp (Ryan et al., 2009) and modified in CorelDraw X7. All major islands in Andaman and Nicobar Islands are

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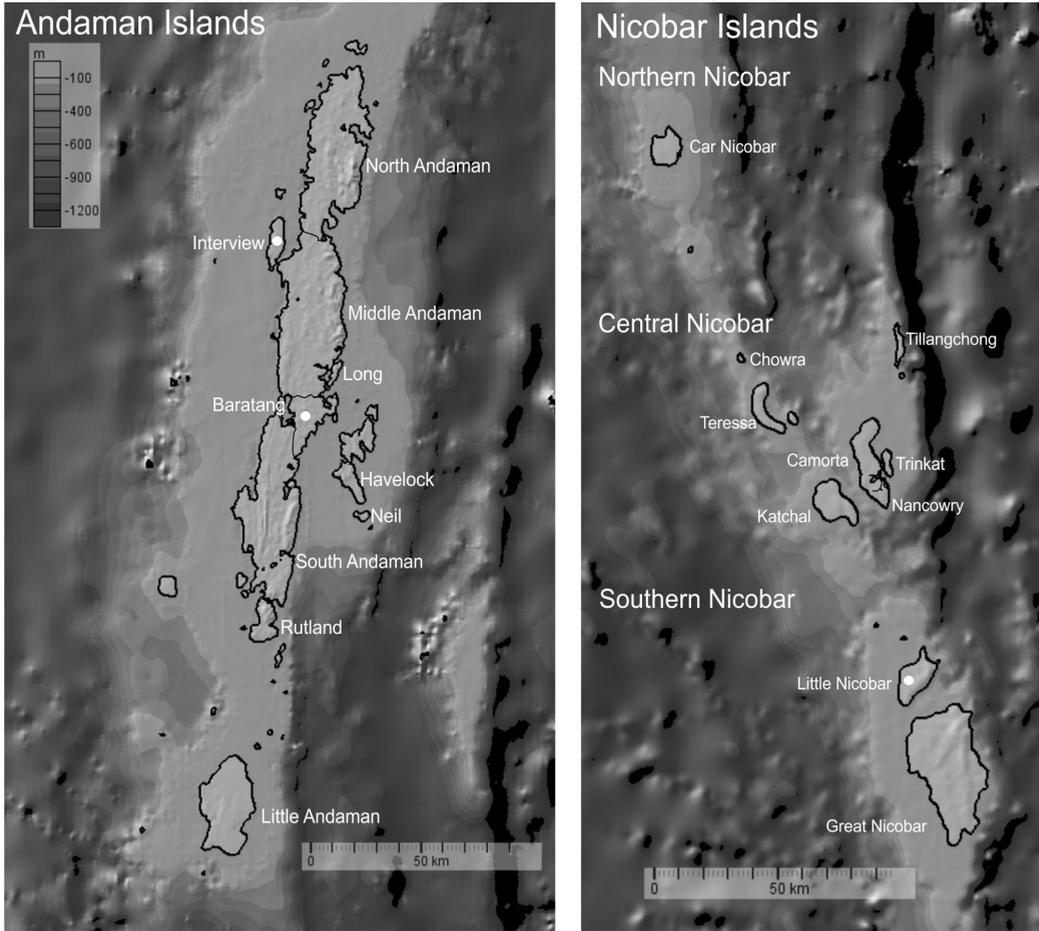


Figure 1. Schematic maps of the Andaman and Nicobar archipelagos. All major islands are labelled. White dots represent islands on which I present new distribution records.

labelled (Fig. 1). However we did not survey Rutland, Chowra, Trinkat, Tillangchong and Nancowry islands in this study and therefore records for these islands are from previous studies only. Recently published records have been integrated along with this study's results to provide the most up-to-date species distribution records of geckoes on all the major islands in the Andaman and Nicobar archipelagos.

Results

Species distributions in the Andaman Islands

In this survey, we recorded all endemic species that were previously recorded by published studies. In addition, on a few islands, we recorded previously unknown or unrecorded occurrences of known

endemic species and human commensal species. For the Andaman Archipelago, I present new records of species distribution from Interview and Baratang Islands (Table 1, Supplementary S1).

Interview Island.—Located west of the Middle Andaman Island (Fig. 1), Interview is one of the few larger islands in this archipelago with no settled human population and therefore remains relatively unexplored. On this island, we detected the Andaman bent-toed gecko (*Cyrtodactylus rubidus* Blyth, 1861), the Andaman giant gecko (*Gekko verreauxi* Tytler, 1865), the flat-tailed house gecko like species *Hemidactylus* aff. *platyurus*, the Andaman day gecko (*Phelsuma andamanensis* Blyth, 1861) and the common house gecko (*Hemidactylus frenatus* Duméril

Table 1. Distributions of geckos on major islands in the Andaman Archipelago. Previously known records are indicated by asterisks (*), new records from this study are denoted by plus signs (+), dots (•) indicate absence or lack of data.

Species	South Andaman	Middle Andaman	North Andaman	Little Andaman	Long	Interview	Baratang	Havelock	Neil	Rutland	Ref ^a
<i>Cnemaspis</i> cf. <i>andersonii</i> (older records refer as <i>Cnemaspis</i> aff. <i>kandianus</i>)	*	•	*	*	•	•	•	*	*	•	1,6,7
<i>Cyrtodactylus rubidus</i>	*	*	*	*	*	+	+	*	*	*	1,2,4,6
<i>Gehyra mutilata</i>	*	•	•	•	*	•	•	*	*	•	1,2,5,7
<i>Gekko verreauxi</i>	*	*	*	*	*	+	+	*	*	*	1,2,4,7
<i>Hemidactylus</i> aff. <i>brookii</i>	*	•	•	•	*	•	•	•	•	•	4,5
<i>Hemidactylus frenatus</i>	*	*	*	*	*	+	+	*	*	*	1,2,4
<i>Hemidactylus leschenaultii</i> Dumeril and Bibron, 1836	*	•	•	•	•	•	•	•	•	•	8
<i>Hemidactylus</i> aff. <i>platyurus</i>	*	*	*	•	*	+	•	•	*	*	1,2,4,6,7
<i>Hemiphyllodactylus typus</i> Bleeker, 1860	*	•	•	•	*	•	•	•	•	•	3,5,7
<i>Lepidodactylus lugubris</i> Dumeril and Bibron, 1836	*	•	•	•	*	•	•	•	•	•	1,2,5
<i>Phelsuma andamanensis</i>	*	*	*	*	*	+	+	*	*	*	1,2,4

^a Numbers refer to the following references: 1—Das, 1999; 2—Harikrishnan et al., 2010; 3—Chandramouli et al., 2012; 4—Harikrishnan et al., 2012a; 5—Chandramouli 2015; 6—Harikrishnan and Vasudevan, 2015; 7—Harikrishnan and Vasudevan, 2018; 8—Gokulakrishnan et al., 2019

Table 2. Distributions of geckos on major islands in the Nicobar Archipelago; ‘*’ indicates previously known distributions, ‘+’ indicates new distribution records from this study and ‘•’ indicates absence or lack of sufficient data; ‘NA’ corresponds to not applicable as *Gekko smithii* is only found in the Southern Nicobar Islands and *Gekko nicobarensis* is endemic to the Northern and Central Nicobar Islands; *Phelsuma andamanensis* is endemic to the Andaman Islands.

Species	Great Nicobar	Little Nicobar	Camorta	Katchal	Tinkat	Teresa	Nancowry	Tillanghong	Chowra	Car-Nicobar	Ref ^a
<i>Cnemaspis nicobaricus</i>	*	+	*	*	•	•	•	•	•	•	1,2,3,5
<i>Cyrtodactylus adleri</i>	*	*	*	*	•	*	*	*	*	*	1,2,3,5
<i>Gehyra</i> cf. <i>mutilata</i>	*	+	*	*	•	*	*	•	*	*	1,2,3
<i>Gekko nicobarensis</i>	NA	NA	*	*	*	*	*	*	*	*	1,2,3,5
<i>Gekko smithii</i>	*	*	NA	NA	NA	NA	NA	NA	NA	NA	1,2,3,5
<i>Hemidactylus frenatus</i>	*	*	*	*	•	*	*	*	*	*	1,2,3
<i>Hemidactylus garnotii</i> Dumeril and Bibron, 1836	•	•	•	•	*	•	•	•	•	•	2
<i>Hemiphyllodactylus typus</i>	*	•	•	•	•	•	•	•	•	•	1,2
<i>Phelsuma andamanensis</i>	NA	NA	NA	NA	NA	NA	NA	NA	NA	*	4

^a Numbers refer to the following references: 1—Das, 1999; 2—Vijaykumar, 2005; 3—Harikrishnan et al., 2010; 4—Chandramouli, 2017; 5—Harikrishnan and Vasudevan, 2018

and Bibron, 1836) at 12.890°N, 92.720°E (Table 1; see Supplementary S1 for more info.).

Baratang Island.—Baratang lies between Middle and South Andaman Islands and is flanked by the Jarawa Tribal reserve in both northern and southern directions. Due to its central position between the

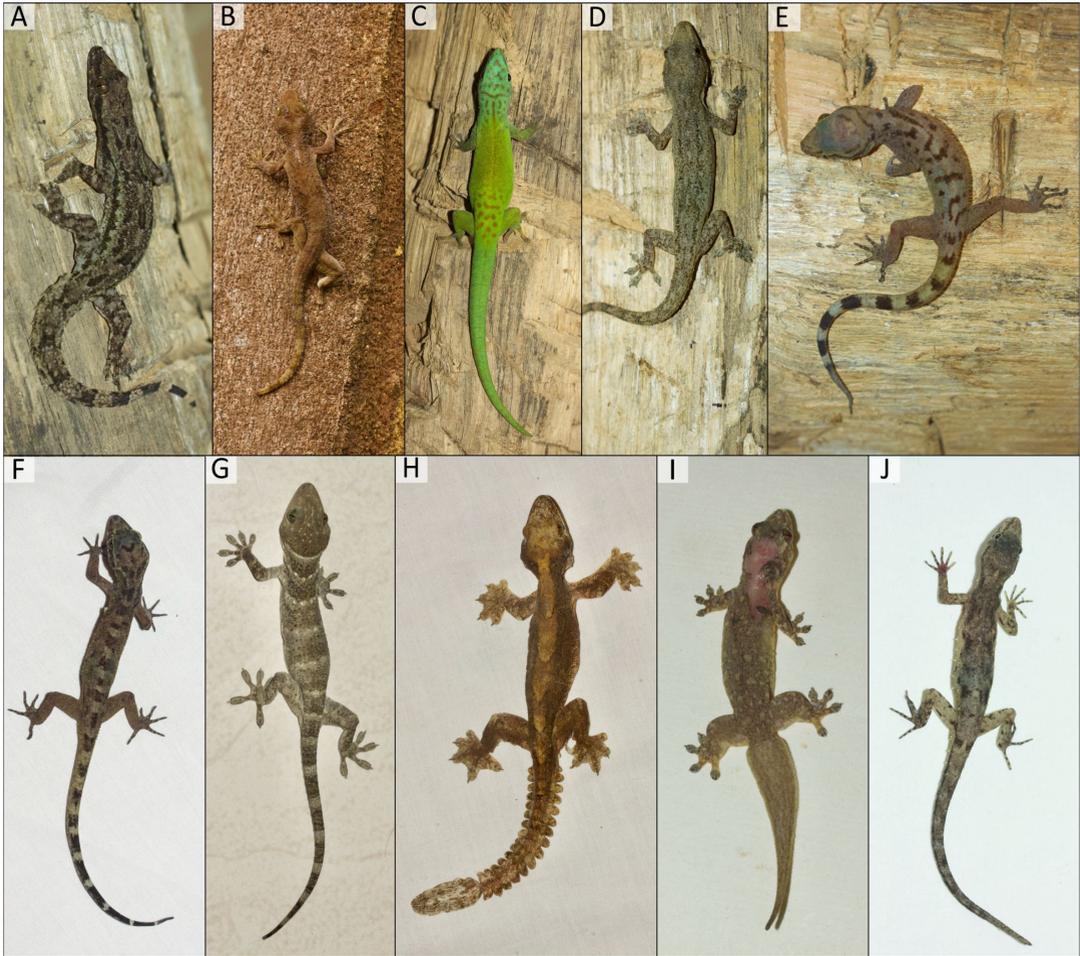


Figure 2. Above: A selection of geckos from the Andaman Islands. A: *Hemidactylus* aff. *platyurus*, B: Andaman giant gecko (*Gekko verreauxi*), C: Andaman day gecko (*Phelsuma andamanensis*), D: Common house gecko (*Hemidactylus frenatus*), E: Andaman bent-toed gecko (*Cyrtodactylus rubidus*), Below: A selection of geckos from the Nicobar Islands. F: Adler's bent-toed gecko (*Cyrtodactylus adleri*), G: Smith's giant gecko (*Gekko smithii*)(sub-adult), H: Nicobar gliding gecko (*Gekko nicobarensis*), I: *Gehyra* cf. *mutilata*, J: *Cnemaspis nicobaricus*. Size not to be scaled.

larger Andaman Islands, this is a small island with modern human settlements. We recorded the Andaman day gecko (*Phelsuma andamanensis*) (tissue ID: CESL 1414), the Andaman giant gecko (*Gekko verreauxi*) (sighted, but not captured) at 12.184°N, 92.790°E; the Andaman bent-toed gecko (*Cyrtodactylus rubidus*) and the common house gecko (*Hemidactylus frenatus*) at 12.163°N, 92.778°E (Table 1; see Supplementary S1 for more info.).

Species distributions in the Nicobar Islands

The Nicobar Islands show differences in their gecko species communities based on their geographical position, central versus the southern Nicobar Islands. We recorded all known endemic species previously recognized on all the islands we sampled, but in addition, we recorded new distribution records of these endemic species on the Little Nicobar (Fig. 1).

Little Nicobar Island.—We recorded two more species in forests close to the village Makachua, in addition to previously recorded species on this island.

Both, *Gehyra* cf. *mutilata* and *Cnemaspis nicobaricus* Chandramouli, 2020 were recorded at the location 7.407°N, 93.710°E (Table 2; see Supplementary S1 for more info). The habitat was a patch of disturbed forest and both the gecko species were found during daylight hours.

Discussion

Biogeographic affinities of the Andaman Islands are Indo-Chinese (Das, 1999), with an exception of the Andaman day gecko (*Phelsuma andamanensis*), which is a Madagascar derivative. In addition to the endemic geckos, human-mediated introductions have led to the presence of cosmopolitan species including species such as the common house gecko (*Hemidactylus frenatus*), and the common four-clawed gecko (*Gehyra* cf. *mutilata*). North Andaman, Middle Andaman, Baratang and South Andaman are together referred to as the Greater Andamans as they are closely positioned with channels less than 1 km separating them (Das, 1999). Islands in the Nicobar Archipelago are geographically more distant compared to the islands in the Andaman Archipelago and have deeper oceanic channels between them. Therefore, it is not surprising that the Andaman Islands are far more homogeneous in their herpetofauna, even though island populations show phylogeographic structure (Mohan et al., 2018).

Interview Island in the Andamans has one base camp today, but modern human colonizers have been visiting this island. Therefore, it was not surprising to find the Common house gecko (*Hemidactylus frenatus*) in and around the base camp (Table 1). The flat-tailed house gecko like gecko, *Hemidactylus* aff. *platyurus* from the Andaman Islands is not identical to the described flat-tailed house gecko (*Hemidactylus platyurus* Schneider, 1797) and is likely an endemic form that needs taxonomic revision (Das, 1999; Harikrishnan et al., 2010; Pers. Obs.).

Baratang Island is flanked by larger islands in the north (Middle Andaman) and south (South Andaman) and is a human-inhabited island. Therefore, we expected to find all the Andaman endemic and human commensal gecko species known from the Greater Andamans. In this study, we detected one human commensal species, the Common house gecko (*Hemidactylus frenatus*), in addition to all the endemic geckos. Extensive surveys in the future could detect more human commensal species on Baratang.

The Nicobar Islands show biogeographical affinities with the Indo-Malayan region (Das, 1999). The Nicobars

are divided into three smaller groups: the northern Nicobars comprising Car Nicobar and surrounding smaller islands; the central Nicobars including Chowra, Camorta, Katchal, Nancowry, Teresa, Trinkat, Tillangchong and smaller islands; and the southern Nicobar group consisting of Great Nicobar and Little Nicobar Islands along with surrounding smaller islands (Rodgers and Panwars, 1988) (Fig. 1). This division is also reflected in terrestrial species communities of these islands. For example, among arboreal nocturnal geckos, the northern and central Nicobars have the Nicobar gliding gecko (*Gekko nicobarensis*) (Das and Vijayakumar, 2009), while the southern Nicobars have the Smith's giant gecko (*Gekko smithii* Gray, 1842) (Table 2). I have not listed the Flat-tailed house gecko (*Hemidactylus platyurus*) for the Nicobar Islands in Table 2 despite the species being listed in two studies (Das, 1999; Tiwari and Biswas, 1973), because this species has not been detected in surveys and published studies in the 21st Century (e.g. Vijayakumar, 2005; Harikrishnan et al., 2010; this study).

The southern Nicobar Islands (Fig. 1) have dense forests covering most parts, the Great Nicobar Island also has elevated hills and valleys; much of this island is protected for the welfare of its native tribe, the Shompen people. Central Nicobar Islands like Teresa have vast grasslands interspersed with forest patches in what seems like valleys. The Adler's bent-toed gecko is endemic to the Nicobar Islands and seems to be widespread across the northern, central and the southern Nicobar Islands. However, this is a potential species complex (Vijayakumar, 2005; unpublished data). Considering deeper sea depths and greater geographic distances, these islands could hold far more diverse populations of species and/or populations that can formally be described as new species. Therefore, several species of herpetofauna in the Nicobar Islands warrant taxonomic revision.

Despite extensive surveys on several islands of the Andaman and Nicobar Archipelagos, new distribution records continue to occur confirming that distributions of herpetofauna on these islands are dynamic and not static. This trend is not surprising considering the number of stochastic climatic events and ever-increasing human movement across these islands. Some of such climatic events include annual monsoons, cyclones, and the Tsunami of 2004. Surveys before the Tsunami of 2004, even though extensive and detailed had failed to record *Gehyra* cf. *mutilata* and *Cnemaspis nicobaricus* in the Little Nicobar Island. This points

out at the possibility of recent colonization events. Previous records show that island endemics do not colonize neighbouring islands as successfully as the commensal species do, despite regular human movement. The occurrence of the Andaman day gecko (*Phelsuma andamanensis*) in the Car Nicobar Island is an exception to this trend, and likely a result of coconut sapling trade between the islands (Chandramouli, 2017). Moreover, our sightings of the *Gehyra* cf. *mutilata* and *Cnemaspis nicobaricus* were outside the premises of human inhabited villages and our sightings of these species were restricted to forested areas, albeit disturbed.

Import and export of food produce and human movement have been increasing in the Andaman and Nicobar Islands and this is likely to result in the introduction of an increasing number of cosmopolitan species. Our study using rapid visual encounter surveys specifically looking for members of Gekkonidae and sampling them for genetic data across the Andaman and Nicobar Islands is the first step towards documenting species diversity and genetic diversity among island populations. Extensive surveys on each of these islands, especially the smaller previously unexplored islands could provide additional species that are not easy to record with rapid surveys of this kind.

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