

## Burmese *Hemidactylus* (Reptilia, Squamata, Gekkonidae): Taxonomic Notes on Tropical Asian *Hemidactylus*

George R. Zug<sup>1</sup>, Jens V. Vindum<sup>2</sup>, and Michelle S. Koo<sup>3</sup>

<sup>1</sup> Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, DC, 20560 USA.; Email: zugg@si.edu; <sup>2</sup> Department of Herpetology, California Academy of Sciences, San Francisco, CA, 94103 USA; Email: jvindum@calacademy.org;

<sup>3</sup> Museum of Vertebrate Zoology, University of California, Berkeley, CA. 94720 USA

**Five species of the gecko genus *Hemidactylus* are commonly reported from Myanmar (Burma). A sixth gecko, *Cosymbotus platyurus*, has been shown recently to be within the tropical Asian clade of *Hemidactylus* species and is included in that genus here. Not all tropical Asian species were included in that molecular study; thus we provide a preliminary assessment of the taxonomic status of all species in the putative tropical Asian clade, with an emphasis on the species occurring within political confines of Myanmar.**

One or more species of *Hemidactylus* geckos occur at most localities inventoried by our Myanmar Herpetological Survey program (1997–2003). With a few exceptions, these geckos are readily assigned to the five species recognized as occurring in Myanmar (Smith 1935): *H. bowringii*, *H. brookii*, *H. frenatus*, *H. garnotii*, *H. karenorum*. None of these species is uniquely Burmese, although *H. karenorum* has the smallest distribution of the five, occurring in Assam and Myanmar (Smith 1935). The other taxa are more broadly distributed and two (*H. frenatus*, *H. garnotii*) have become global via accidental human transport. A sixth species is added to the Burmese *Hemidactylus* fauna by molecular analysis of Carranza and Arnold (2006) identifying *Cosymbotus platyurus* as a member of the tropical Asian clade.

Among our biodiversity inventories, we occasionally find *Hemidactylus* geckos that do not match comfortably the general characteristics that we use to recognize and differentiate the six “typical” Burmese species. These atypical geckos are not, however, the focus of this report. Rather, we provide a preliminary assessment of taxonomic matters affecting the known species of Burmese *Hemidactylus* arising from the molecular phylogenetic study of Carranza and Arnold (2006; abbreviated henceforth as C&A-06). Before proceeding with that assessment, we offer a brief review of the currently recognized species of Burmese *Hemidactylus*.

### MATERIALS AND METHODS

The morphological data of this report derive solely from Burmese specimens vouchering the regional inventories of the Myanmar Herpetological Survey. The specimens examined are identified in the following section. They represent only a subset of vouchers available and purposefully derive from lowland to mid-elevation sites (< 500 m asl) of the Central Dry Zone southward to and including the Ayeyarwaddy and Sittaung deltas. We recognize that these geographically mixed samples may cloud regional differentiation, but our goal is to provide only preliminary descriptions of

the morphology of Burmese *Hemidactylus*. A limited sample size of 20 to 30 individuals for each species is also compatible with this goal. The maps (Figs. 1–6), however, detail the distribution of all Burmese *Hemidactylus* species in the CAS and USNM collections; the specific identity of these specimens relies heavily on their identification (principally by Htun Win, J. Vindum, or G. Zug) at time of cataloging.

The morphological data include the following characters: MEASUREMENTS: **CrusL**, Crus length; **ForeaL**, Forearm length; **HeadL**, Head length; **JawW**, Jaw width; **SnEye**, Snout-eye length; **SnForel**, Snout-forelimb length; **SVL**, Snout-vent length; **SnW**, Snout width; **TrunkL**, Trunk length. SCALATION: **Chin**, Chin (postmental) scales; **4FingLm**, Fourth finger lamellae (scansors); **4FingDv**, Fourth finger lamellae divided; **4ToeLm**, Fourth toe lamellae; **4ToeDv**, Fourth toe lamellae paired; **Inflab**, Infralabials; **NaInf**, Naris-infralabial contact; **SnS**, Snout scales; **Subcaud**, Subcaudal scales; **Suplab**, Supralabials; **PoreTot**, Total pores. These traits are defined in Caleb and Zug (2007). Statistical analysis performed in SYSAT 11.

The synonymies derive from Wermuth (1965), Zug (1990), Bauer (1994), and Kluge (2002). Kluge's list, as the most recent of the synonymies, established the current recognition of available and valid scientific name for these geckos. Only primary synonyms are given. Type localities are given as in the original description, and all type localities were verified against the original descriptions.

**SPECIMENS EXAMINED.**— *Hemidactylus bowringii*: Magway Divis., Shwe-Settaw CAS 213598–599, 213603, 213619, 213779, 213782–783, 213835, 213838, 213840, 213845, 213860–861, 213876–878, 213882, 231067; Magway Divis., Shin-Ma-Taung CAS 215841, 215843–844, 215846, 215848; Sagaing Divis., miscellaneous localities - Yinpaungtaing CAS 215392, Khim Aye CAS 215434, 215437, Alaungdaw Kathapa N.P. CAS 215444, 215519, 215646, 215759, 215777, Chatthin W.S. – USNM 520552–056, 537425–426, Pale – CAS 215434, 215437, Sweekawngan village – CAS 232243–244.

*Hemidactylus brookii*: Mandalay Divis., Mt. Popa CAS 213976, 214040–042, 215829, 231277, 231341–342, 231357, USNM 564914–927; Mandalay Divis., Yin Mar Bin CAS 215297; Sagaing Divis., Alaungdaw Kathapa NP CAS 206650 ,

*Hemidactylus frenatus*: Magway Divis., Shwe-Settaw WS USNM 564861–862; Sagaing Divis., Alaungdaw Kathapa NP USNM 564889–891, Kabaing USNM564895–896, Chatthin WS USNM 520560–565, 524047–051; Sagaing Divis., Yin Bar Min CAS 215306; Yangon Divis., Yangon USNM 520558–559.

*Hemidactylus garnotii*: Bago Divis., Dawe USNM 564931–932; Mandalay Divis., Pyin-Oo-Lwin USNM 564933–938, 564940, Mt. Popa USNM 564945; Mon State, Kyaikhtiyoo WS USNM 564941; Rakhine State., Gaw USNM 564944; Sagaing Divis., Alaungdaw Kathapa N.P. USNM 564942–943, Chatthin W.S. USNM 537427.

*Hemidactylus karenorum*: Magway Divis., Shwe-Settaw CAS 213597, 213816–817, 213833, 213836, 213846, 231136, USNM 564946–947; Mandalay Divis., Mt. Popa CAS 210670–671, 214048, 214057–058, 214078–079, 214142, 231308, 231313, 231340, USNM 564949–951.

*Hemidactylus platyurus*: Chin State, Nat-Ma-Taung CAS 222332; Sagaing Divis., Alaungdaw Kathapa NP CAS 204982–983, 210135, 210152–153, 210284, 210286, 210296–297, 210308, 215559, 215585, 215600, 215679, 210308, 215559, 215585, 215600, 215679, 215734, USNM 564952–954, Htamanthi WS CAS 232192.

## SYNOPSIS OF BURMESE *HEMIDACTYLUS*

### *Hemidactylus bowringii* (Gray)

Bowring's or Asian smooth gecko

*Doryura Bowringii* Gray 1845:156. Type locality, syntypes without locality data; restricted to "Hong-kong or neighbourhood" by Smith (1935:99).

*Leiurus berdmorei* Blythe 1853:646. Type locality, "Mergui" [= Myeik Beik, Tanintharyi Divis., Myanmar].

**DESCRIPTION.**— Adults 34–51 mm SVL; adult SVL not sexually dimorphic: females average

41.8±4.36 mm SVL (35.6–50.7 mm); male average 39.7±3.95 mm SVL (34.5–49.0 mm). Moderately built, somewhat flattened lizards. Proportions (female – mean, min.-max.; male – same): SnForel/SVL 38, 34–41%; 38, 35–40%; TrunkL/SVL 47, 42–51%; 44, 34–51%; Foreal/SVL 12, 10–14%; 12, 11–14%; CrusL/SVL 14, 12–16%; 14, 12–15%. Tail length (unregenerated) slightly longer than SVL and equal in females and males. Tail flattened, broader than high (oblong in cross-section), and tapering gradually to thin tip.

Head moderately large and broad, distinct from neck, flattened and conical to obovate in dorsal outline. HeadL/SVL 25, 22–27%; 26, 24–29%; JawW/HeadL 64, 57–72%; 62, 51–69%; SnEye/HeadL 40, 35–43%; 40, 35–45%; SnW/HeadL 7, 4–9%; 6, 4–9%. All digits of fore- and hindfeet with digital pads. Digital pads oblong in shape with distal end only slightly wider than proximal end; slender terminal portion (ultimate and penultimate phalanges) of digit arising from within and free of digital pad of all digits. Claws on all digits; slight or no webbing at base of digits.

Head, body, and tail scalation of small, equal-sized, juxtaposed tubercles dorsally and laterally; ventrally slightly overlapping scales, >5× dorsal tubercles, from base of neck to pelvic area; transition from ventral scales to tubercles ventrolaterally; no ventrolateral skin fold on trunk. Head dorsally and laterally with scales on snout and lips, elsewhere small tubercles. Rostral scale large, rectangular with middorsal cleft; nares bordered by rostral, first supralabial, and 3 nasal scales, supranasal largest. Supralabials 7–12, infralabials 6–10. Broad triangular mental scale ventrally, bordered posteriorly by 2 large anterior chin scales, usually touching one another midventrally; posterior chin scales about half size of anterior ones and rarely touching medially.

Limbs scaled above and below, except for tubercles on posterior surface of thigh. Subdigital lamellae on pad: 6–9 on 4<sup>th</sup> finger, distal lamella undivided, subsequent 3–7 divided; 7–11 on 4<sup>th</sup> toe, distal lamella undivided, subsequent 3–7 divided. Bilateral series of 18–27 (total) precloacal-femoral pores in males, left and right sides separated at midpelvic by 1–4 nonpore-bearing scales. Tail midventrally with rectangular, slightly overlapping, smooth-surfaced plates from vent to at least mid-length; large smooth scales ventrolaterally quickly grading into tubercles. Tail distinctly segmented, each segment 8–10 scales long; pair of small erect scales ventrolaterally at posterior edge of each segment.

*Hemidactylus* geckos can lighten or darken their skin tones. Adults in dark phase, dorsal ground color from head to base of tail medium brown to tan with diffuse, small dark-brown smudges dorsally and dorsolaterally and occasionally with faint white spots to nearly uniform; laterally often series of white spots highlighted by dark-brown smudge in front of each spot. Some individuals with dark-brown postorbital stripe from eye, above ear-opening, to axilla. Dorsal and lateral pattern of white spots bordered by dark marks sharply defined in some population, e.g., Shwe-Settaw. In light phase, dorsum nearly uniform beige or with very faded markings on light background. Ventrally immaculate cream to light yellow from chin through belly; pelvic area and underside of tail light orangish beige.

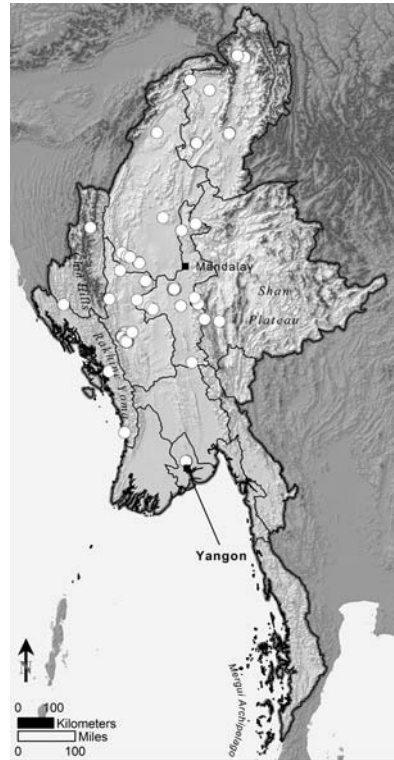


FIGURE 1. Distribution of *Hemidactylus bowringii* in Myanmar based on voucher specimens of the CAS/NWCD/SI Myanmar Herpetological Survey.

**DISTRIBUTION.**— Bowring's gecko occurs broadly in Burma (Fig. 1) from the Shan Plateau and adjacent China (Yunnan [CAS specimens] and Sichuan [Zhao 2003]) southward to the Myanmar coast from the western Rakhine to southern Tanintharyi. To the west, its distribution includes northern India — Godavari Valley, Sikkim, Darjeeling — and Bangladesh (Smith 1935), North [=West] Bengal (Tikader and Sharma 1992), and the terai of Nepal (Kästle 2002). This gecko has been reported only thrice from Indochina: three juveniles from Laos (Bourett 1939), one individual from Saigon, Vietnam (Bobrov 1992), and apparently one or a few from northern Vietnam (Darevsky et al. 1984). *H. bowringii* does occur abundantly in some localities in southern China from Hainan westward to Taiwan (Zhao and Adler 1993) and the Ryukyu Islands (Ota 1989).

Because of this gecko's near absence in Indochina, we question the naturalness of its Oriental distribution. Is it an invasive or does the disjunct distribution denote the presence of eastern and western species? Resolving this matter is beyond the scope of this study; however for the moment, we favor the invasive-species explanation. Published evidence (e.g., Karsten et al. 1986; Ota 1989; Lazell 2002) notes its occurrence predominantly or exclusively as a human commensal. Only Lazell (2002) reported it as occurring abundantly in woodlands (disturbed); however, he stated (*in litt*, 9&10 Aug. 2006) that it did not occur in woodlands when *Hemiphyllodactylus chapaensis* was present, and furthermore, *H. bowringii* was abundant and widespread in and around human edifices.

**NATURAL HISTORY.**— Burmese *Hemidactylus bowringii* is a forest-floor resident. During the day, it occurs beneath leaf litter, logs, and bark. At night, it forages on and beneath the leaf litter. Gravid females from central Myanmar samples were taken in May, July, August, and October.

### *Hemidactylus brookii* (Gray)

Asian spiny gecko

*Hemidactylus Brookii* Gray 1845:153. Type locality, "Borneo." "Australia.;" restricted to "Borneo" by Smith (1935:89).

*Gecko Tytleri* Tytler 1865:547. Type locality, "Moulmein" [= Mawlamyaing, Mon State, Myanmar].

*Hemidactylus kushmorensis* Murray 1884:109. Type locality, "Bhaner, Upper Sind frontier" [presumably = Bhanar, Sindh, Pakistan].

*Hemidactylus Gleadowi* Murray 1884:360, Type locality, "Rantha forest in Sind, (Jerruck division)" [= Jerruck region, Pakistan].

*Hemidactylus gleadowii* Boulenger 1885:129. Amended spelling.

*Hemidactylus Murrayi* Gleadow 1887:49. Type locality, "Pimpri and Garvi, in the "Dangs", [Gujarat State, India].

*Hemidactylus Tenkatei* Lidth de Jeude 1895:121. Type locality, "Rotti" [= Pulau Roti (Lesser Sundas), Indonesia].

*Hemidactylus subtriedroides* Annandale 1905:29. Type locality, "Tsagain, Upper Burma" [= Sagaing, Sagaing Divis., Myanmar].

*Hemidactylus brookii parvimaclatus* Deraniyagala 1953:45. Type locality, "Colombo" [Sri Lanka].

**DESCRIPTION.**— Adults 45–65 mm SVL; adults sexually dimorphic: females average 53.7±6.28 mm SVL (45.06–61.7 mm); male average 59.6±4.31 mm SVL (50.2–65.0 mm). Moderately robust, slightly flattened lizards. Proportions (female – mean, min.-max.; male – same): SnForel/SVL 38, 35–41%; 37, 33–40%; TrunkL/SVL 41, 36–48%; 42, 39–46%; Foreal/SVL 12, 11–14%; 12, 10–13%; CrusL/SVL 14, 12–15%; 13, 12–14%. Tail length (unregenerated) slightly longer than SVL and equal in females and males. Tail broader than high (oblong in cross-section), distinctly spiny, and tapering gradually to thin tip.

Head moderately large and broad, distinct from neck, flattened and conical to obovate in dorsal outline. HeadL/SVL 25, 22–27%; 26, 24–29%; JawW/HeadL 64, 57–72%; 62, 51–69%; SnEye/HeadL 40, 35–43%; 40, 35–45%; SnW/HeadL 7, 4–9%; 6, 4–9%. All digits of fore- and hindfeet



with digital pads. Digital pads obovate with distal end slightly wider than proximal base; slender terminal portion (ultimate and penultimate phalanges) of digit arising from within and free of digital pad of all digits. Claws on all digits; slight or no webbing at base of digits.

Head, body, and tail scalation of small, equal-sized, juxtaposed tubercles dorsally and laterally between multiple (14–16) longitudinal rows of enlarged, slightly keeled, conical tubercles; tubercles of parasagittal 2–3 rows slightly smaller and flattened; ventrally, slightly overlapping scales,  $> 5\times$  dorsal tubercles, from base of neck to pelvic area; transition from ventral scales to tubercles ventrolaterally; no ventrolateral skin fold on trunk. Head dorsally and laterally with scales on snout and lips, elsewhere small tubercles. Rostral scale large, rectangular with middorsal cleft; nares bordered by rostral, first supralabial, and 3 nasal scales, supranasal largest. Supralabials 8–11, infra-labials 8–10. Broad triangular mental scale ventrally, bordered posteriorly by 2 large anterior chin scales, broadly touching one another medially; posterior chin scales about two-thirds size of anterior ones and not in contact medially.

Limbs scaled above and below, some large tubercles on anterior and dorsal surface of forearm, more numerous enlarged tubercles on dorsal surface of thigh and crus. Subdigital lamellae on pad: 6–8 on 4<sup>th</sup> finger, distal lamella undivided, subsequent 5–7 divided; 7–8 on 4<sup>th</sup> toe, distal lamella undivided, subsequent 5–7 divided. Bilateral series of 11–16 (total) precloacal-femoral pores in males, left and right sides separated at midpelvic by 4–7 nonpore scales. Tail midventrally with rectangular, slightly overlapping, smooth-surfaced plates from vent to at least mid-length; large smooth scales ventrolaterally quickly grading into tubercles. Tail distinctly segmented, each segment 8–10 dorsal scales long; pair of small erect scales ventrolaterally at posterior edge of each segment; dorsally tail distinctly segmented, with middle of each segment bearing roseate of 6 large, keeled conical tubercles.

Adults in dark phase, two-toned brown from head to base of tail, top of head and middorsum onto tail lighter brown than dorsolaterally and sides; sides medium dark-brown to tan; shape and width of lighter middorsal area narrow to broad with broadly scalloped edge; typically in smaller adults and juveniles small dark spots/dashes scattered in both light and dark area; in some individuals, laterally enlarged tubercles lighter than surrounding granular tubercles creating a spotting effect. Many individuals with orbital stripe from snout through eye to ear; broad whitish stripe on snout border above and below by dark border, beyond eye only white stripe and ventral dark border. Ventrally immaculate white to cream from chin to underside of tail. In light phase, two toned dorsum faded but still evident as is faded orbital stripe behind eye. Ventrally immaculate white to cream to light yellow from chin through belly; pelvic area and underside of tail light orangish beige.

**DISTRIBUTION.**—Asian *Hemidactylus brookii* occurs widely, but not abundantly, in low elevation areas of north-central Myanmar southward to southern Thaninthary (Fig. 2). Kästle (2002) recognized the taxon *H. brookii subtreidroides* and depicted the latter's occurrence in northern Myanmar and adjacent Arunachal Pradesh. Our survey of

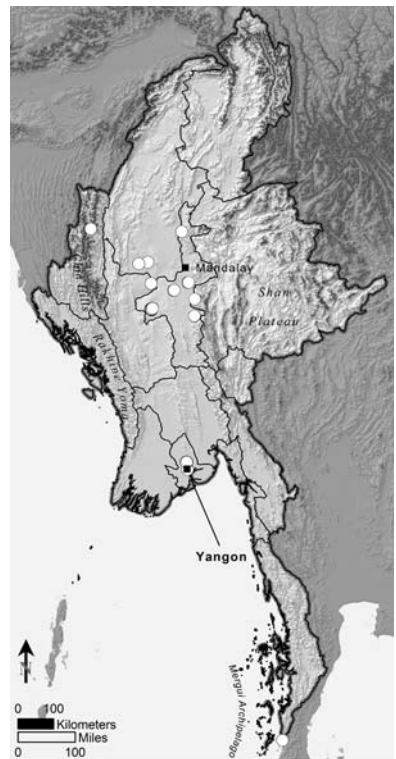


FIGURE 2. Distribution of *Hemidactylus brookii* in Myanmar based on voucher specimens of the CAS/NWCD/SI Myanmar Herpetological Survey.

sites in northern Sagaing Division has not found *H. brookii* in the northernmost reaches of Myanmar.

The usual description of a nearly pan-tropical distribution for *H. brookii* is applicable only to the paraphyletic concept of this “species.” C&A-06’s Asian *brookii* still has a broad distribution, but one that naturally lies entirely east of the Indus R. valley. It is a common house gecko in peninsular India and Sri Lanka according to Smith (1935) and others (Sri Lanka, Deraniyagala 1953; India, Daniel 1983). Tikader and Sharma (1992) mapped its occurrence throughout India. Das (2002), however, reported only a northern India occurrence, and Khan (2002) listed it as a common gecko of the plains of Pakistan and absent from the northern mountains. Kästle (2002) showed a broad terai occurrence and a few records from mid-montane elevations in Nepal. Bauer and Günther (1992) reported a single specimen from the Bhutan-Indian border. Pawar and Birand (2001) found it as human commensal in only two (Nameri National Park, western Arunachal Pradesh, and Balphakaram NP, central Meghalaya) of eight nature reserves surveyed in Northeast India.

As for *H. bowringii*, *H. brookii* is largely absent from Indochina and is excluded from recent reptile field guides (e.g., Cox et al. 1998, Manthey and Grossman 1997) to this area. De Rooij (1915) reports *H. brookii* from Singapore, Sarawak and several Lesser Sunda islands. More recent surveys (Dunn 1927; Darevsky 1964; Auffenberg 1980; Lian 1993) report *H. frenatus*, *H. garnotii*, and/or *H. platyurus* from the latter areas but not *H. brookii*. Denzer and Manthey (1991) noted that the Singapore record was doubtful. Das and Sukumaran (2006) recently documented a single breeding population of *H. brookii* in Borneo.

Southern and eastern China records are limited to Hong Kong and Macau (Karsten et al. 1986) and Zhejiang (Zhao and Adler 1993). Karsten and co-authors stated that it is an introduced species. The Zhejiang record requires investigation, but owing to its presence near Shanghai, it seems likely a record of an introduced population. A similar explanation of introduction is proposed also for the Philippine populations of *H. brookii*; even though it occurs broadly in the Philippines. Brown and Alcalá (1978:30) stated: “limited or nearly so to habitats associated with man.”

**NATURAL HISTORY.**— *Hemidactylus brookii* is largely a commensal species in Myanmar, occurring on assorted constructs or on vegetation in the immediate vicinity of manmade structures. Gravid females occur in central Myanmar samples from February and March.

### ***Hemidactylus frenatus* Duméril and Bibron**

Indo-Pacific house gecko

*Hemidactylus javanicus* Fitzinger 1826:46. Nomen nudum.

*Hemi-dactylus frenatus* Kuhl and Van Hasselt in Schlegel 1827:290. Nomen nudum.

*Hemidactylus frenatus* Duméril and Bibron 1836:366. Type locality, “l’Afrique australe, et . . . tout l’archipel des grandes Indes”; restricted to “Java” by Loveridge (1947:127).

*Hemidactylus Bojeri* Fitzinger 1843:106. Type locality, “Africa. Madagascar. Mauritius.”

*Hemidactylus (Pnoëpus) javanicus* (Cuv.) Fitzinger 1843:106. Type locality, “Asia. India. Bengala. Ceylon. Java. Timor. Amboina. Ins. Mariannae.”; restricted to “Java” by Loveridge (1947:127).

*Hemidactylus vittatus* Gray 1845:155. Type locality, “Borneo.”

*Hemidactylus punctatus* Jerdon 1853:467. Type locality, “Tellicherry” [= Thalassery, Kerala State, India].

*Hemidactylus inornatus* Hallowell 1861:469. Type locality, “Loo-Choo” [= Ryukyu Ids.].

*Hemidactylus pumilus* Hallowell 1861:502. Type locality, “Hong Kong.”

*Gecko chaus* Tytler 1865:547. Type locality, “Moulmein and Rangoon”; restricted to “Rangoon, Burma” by Loveridge (1947:128).

*Gecko caracal* Tytler 1865:547. Type locality, “Rangoon” [= Yangon, Yangon Divis., Myanmar].

*Hemidactylus longiceps* Cope 1869:320. Type locality, “Manilla” [= Manila, Luzon Isl., Philippines].

*Hemidactylus hexaspis* Cope 1869:320. Type locality, “Madagascar.”

*Peripia papuensis* Macleay 1878b:97. Type locality, “Katow” [= Katau, Western Dist., Papua New Guinea].

*Hemidactylus tristis* Sauvage 1879:49. Type locality, “le nord de la Nouvelle-Guinée.”

*Hemidactylus nigriventris* Lidth de Jeude 1905:188. Type locality, “Sintang [Kalimantan Barat, Indonesia]”.

*Hemidactylus fragilis* Calabresi 1915:236. Type locality, “Bur Meldac” [Somalia].

*Hemidactylus vandermeer-mohri* Brongersma 1928:1. Type locality, “Pulu Berhala” [= Palau Berhala – there are two].

*Hemidactylus okinawensis* Okada 1936:271. Type locality, “Okinawa-jima” [Ryukyu Ids.].

*Hemidactylus auritus* Poeppig in Obst 1977:182. Nomen nudum.

**DESCRIPTION.**— Adults 42–59 mm SVL; adult SVL sexually dimorphic: females average  $45.7 \pm 1.98$  mm SVL (42.5–49.1 mm); male average  $51.1 \pm 3.12$  mm SVL (47.8–58.6 mm). Moderately built, somewhat flattened lizards. Proportions (female – mean, min.-max.; male – same): SnForeL/SVL 36, 33–39%; 38, 35–40%; TrunkL/SVL 46, 39–53%; 43, 40–48%; ForeaL/SVL 12, 10–13%; 12, 10–13%; CrusL/SVL 13, 12–15%; 13, 12–14%. Tail length (unregenerated) slightly longer than SVL and proportionally equal in females and males. Tail round to oblong (broader than high) in cross-section, and tapering gradually to thin tip.

Head moderately large, distinct from neck, flattened and elongate conical (blunt triangular) in dorsal outline, yielding a pointed-snout appearance. HeadL/SVL 25, 24–28%; 25, 25–26%; JawW/HeadL 65, 61–67%; 67, 61–72%; SnEye/HeadL 43, 41–45%; 44, 41–47%; SnW/HeadL 12, 12–16%; 13, 12–14%. All digits of fore- and hindfeet with digital pads. Digital pads oblong in shape with distal end only slightly wider than proximal end; slender terminal portion (ultimate and penultimate phalanges) of digit arising from within and free of digital pad of all digits. Claws on all digits; slight or no webbing at base of digits.

Head, body, and tail scalation of small, equal-sized, juxtaposed tubercles dorsally and laterally with several longitudinal rows (about 6) of widely spaced enlarged tubercles (flatten cones, usually unkeeled); ventrally, slightly overlapping scales, 4–5× dorsal tubercles, from base of neck to pelvic area; transition from ventral scales to tubercles ventrolaterally; no ventrolateral skin fold on trunk. Head dorsally and laterally with scales on snout and lips, elsewhere small tubercles. Rostral scale large, rectangular with middorsal groove; nares bordered by rostral, first supralabial, and 3 nasal scales, supranasal largest. Supralabials 9–12, infralabials 7–10. Triangular mental scale ventrally, bordered posteriorly by 2 large anterior chin scales, in contact with one another midventrally; posterior chin scales from subequal to about half size of anterior ones and not touching medially.

Limbs scaled above and below, except for tubercles on posterior surface of fore- and hindlimbs. Subdigital lamellae on pad: 7–9 on 4<sup>th</sup> finger, distal lamella undivided, subsequent 5–7 divided; 8–11 on 4<sup>th</sup> toe, distal lamella undivided, subsequent 5–8 divided. Bilateral series of 23–34 (total, usually  $\geq 29$ ) precloacal-femoral pores in males, left and right sides separated at midpelvic by 0–2 nonpore scales. Tail midventrally with rectangular, slightly overlapping, smooth-surfaced plates from 8–12 scale rows behind vent to at least mid-length; 2–3 rows of large smooth scales ventrolaterally grading into tubercles. Tail distinctly segmented, each segment 10–12 scales long; each segment with 6 (usually) enlarged flattened cone-shaped scales projecting above surface; projecting scales inset about 2 small tubercle rows from rear edge of segment and ventrolateral pair largest in each spiral.

Adults in dark phase, dorsal ground color from head to base of tail dusky brown dorsally, lighter brown stripe from snout through eye above ear to trunk fading thereafter, and dark brown stripe from snout on upper lip through shoulder and distinct to hindlimbs. Preceding bold pattern uncommonly seen; often only marking is faded lateral stripe from snout to shoulder. In light phase, dorsum uniform whitish gray without markings. Ventrally whitish to light beige in all color phases from chin onto underside of tail.

**DISTRIBUTION.**— *Hemidactylus frenatus* occurs broadly throughout Myanmar (Fig. 3) from north-central Sagaing Division and central Kachin State southward to the coast of Tanintharyi, Mon, Yangon, Ayeyarawady, and Rakhine. It is a common house gecko from India eastward through tropical Asia and Indoaustralia to the central Pacific. Sharma (2002: map 29) excluded *H. frenatus* from India north of 24°N.

**NATURAL HISTORY.**— Our surveys reveal that *Hemidactylus frenatus* is always associated with man-made structures. Gravid females occur in central Myanmar samples from May and July.

### *Hemidactylus garnotii* Duméril and Bibron

Fox gecko

*Hemidactylus peruvianus* Wiegmann 1835:240. Type locality, “Peru, bei Tacna”; probably in error, see taxonomic comments in Bauer (1994).

*Hemidactylus Garnotii* Duméril and Bibron 1836:368. Type locality, “l’île de Taïti” [= Tahiti, French Polynesia].

*Doryura vulpecula* Girard 1857:197. Type locality, “Sandwich Islands” [= Hawaiian Islands].

*Hemidactylus Ludekingii* Bleeker 1859a:27. Type locality, “Agam, Padangsche bovenlande” [= Agam, Sumatra].

*D.[oryura] gaudama* Theobald 1868:30. Type locality, “Tonghu (valle Sittangensi).” [= Taungoo (Sittaung R. valley), Bago Divis., Myanmar].

*H.[emidactylus] Mortoni* Theobald 1868:32. Type locality, “Teikgyie” [= Taikkyi, Yangon Divis., Myanmar].

*Hemidactylus (Doryura) mandellianus* Stoliczka 1872:101. Type locality, “Pankabari [Sikkim, India], just above the Sikkim Terai, and . . . the Rungnu and Tistá valleys”.

*Hemidactylus blanfordii* Boulenger 1885:141. Type locality, “Himalayas.” “Darjeeling [West Bengal State, India].”

**DESCRIPTION.**— Adults 49–66 mm SVL, average 56.5±5.13 mm; female only species. Moderately built, somewhat flattened lizards. Proportions (mean, min.-max.): SnForel/SVL 39, 37–43%; TrunkL/SVL 43, 39–46%; Foreal/SVL 11, 10–13%; CrusL/SVL 13, 11–14%. Tail length (unregenerated) distinctly longer than SVL, about 1.2×. Tail flattened, broader than high (oblong in cross-section), and tapering gradually to thin tip.

Head moderately large and broad, distinct from neck, flattened and elongate triangular and snout truncate in dorsal outline. HeadL/SVL 25, 24–26%; JawW/HeadL 63, 60–72%; SnEye/HeadL 46, 40–47%; SnW/HeadL 12, 10–14%. All digits of fore- and hindfeet with digital pads. Digital pads oblong in shape with distal end only slightly wider than proximal end; slender terminal portion (ultimate and penultimate phalanges) of digit arising from within and free of digital pad of all digits. Claws on all digits; slight or no webbing at base of digits.

Head, body, and tail scalation of small, equal-sized, juxtaposed tubercles dorsally and laterally; slightly overlapping scales, >5× dorsal tubercles, ventrally from base of neck to pelvic area; transition from ventral scales to tubercles ventrolaterally; no ventrolateral skin fold on trunk. Head dorsally and laterally with scales on snout and lips, elsewhere small tubercles. Rostral scale large, rectangular with middorsal cleft; nares bordered by rostral, first supralabial, and 3 nasal scales,

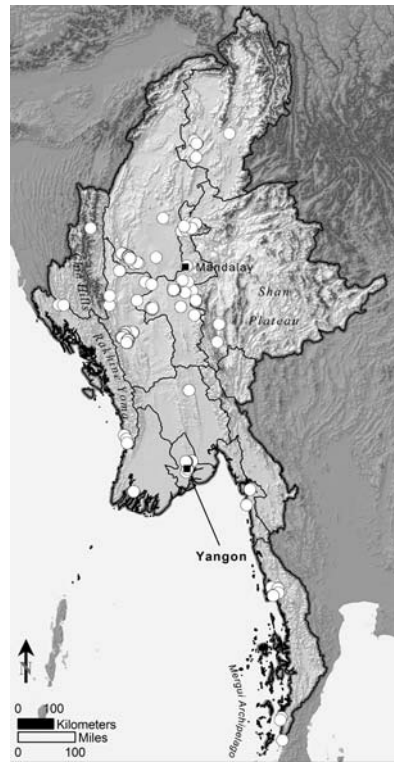


FIGURE 3. Distribution of *Hemidactylus frenatus* in Myanmar based on voucher specimens of the CAS/NWCD/SI Myanmar Herpetological Survey.



supranasal largest. Supralabials 8–13, infralabials 7–10. Triangular mental scale ventrally, bordered posteriorly by 2 moderately large anterior chin scales, in contact midventrally; posterior chin scales two-thirds or less size of anterior ones, rarely touching medially, and regularly separated from infralabials by row of smaller gular scales.

Limbs with moderate-size tubercles above and smooth scale below. Subdigital lamellae on pad extending to base of digit and slightly on to palm/sole: 8–13 on 4<sup>th</sup> finger, distalmost lamella undivided, subsequent 5–8 divided; 10–15 on 4<sup>th</sup> toe, distalmost lamella undivided, subsequent 5–8 divided. No precloacal-femoral pores. Tail midventrally with rectangular, slightly overlapping, smooth-surfaced plates from vent to at least mid-length; large smooth scales ventrolaterally quickly reducing in size to small elongate conical scales on ventrolateral edges. Tail distinctly segmented, each segment 8–10 scales long; ventrolaterally sawblade-like with four conical “spine” scales in each segment, posteriormost one at edge of each segment double the size of preceding three.

Adults in dark phase, dorsal ground color from head to base of tail grayish or yellowish tan to medium brown with five longitudinal rows (middorsal, dorsolateral, and lateral) of whitish spots from nape/neck to rump; on lighter background spots in diffuse brown longitudinal stripes. Only middorsal spots on tail, 2–3× larger than on trunk and often dark edged anteriorly. Most individuals, light or dark phase, with dark-brown postorbital stripe from eye to above ear-opening; this stripe occasionally in front of eye to snout and/or continuous with white spot-bearing lateral stripe. In light phase, dorsum nearly uniform beige or with faded markings on light background. Ventrally immaculate cream to light yellow from chin onto underside of tail.

**DISTRIBUTION.**— *Hemidactylus garnotii* occurs widely, although nowhere abundantly, throughout Myanmar (Fig. 4), largely a low elevation distribution from southern Sagaing Division and central Kachin State southward to the Martaban coast from Rakhine to Mon States.

Its extralimital distribution is broad although spotty with populations established in the Bahamas and southern Florida (USA), throughout the Pacific, and Islands Asia, East Asia westward to Pakistan, and southward to the Seychelles. Tikader and Sharma (1992: map 8) showed its presence in India restricted to Sikkim eastward into central Assam. The recognition of two karyotypically different species (*H. vietnamensis*, Vietnam; *H. stejnegeri*, Taiwan, Ryukyu Islands and likely all of the Philippine Islands [Ota and Hikida, 1989]) suggests a more careful assessment of individual Asian populations before a broad-brush assignment to *H. garnotii*.

**NATURAL HISTORY.**— The few *H. garnotii* captured were either on buildings or immediately adjacent to human constructs. Gravid females occur in central Myanmar samples taken only in February.

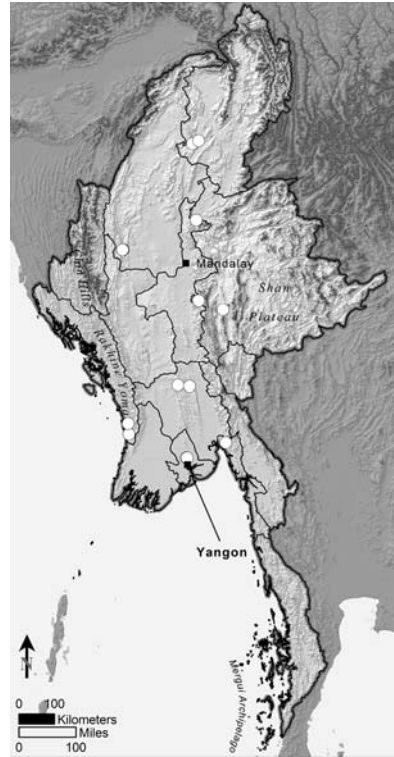


FIGURE 4. Distribution of *Hemidactylus garnotii* in Myanmar based on voucher specimens of the CAS/NWCD/SI Myanmar Herpetological Survey

*Hemidactylus karenorum* (Theobald)

Burmese spotted gecko

*D.[oryura] karenorum* Theobald 1868:30. Type locality, "Karen-choung, prope Toungoo, valle Sittangensi" [= Karenchaung, above Taungoo, Sittang R. valley, Bago Divis., Myanmar].

**DESCRIPTION.**— Adults 38–56 mm SVL; adult SVL not sexually dimorphic: females average  $50.2 \pm 3.56$  mm SVL (45.7–56.1 mm); male average  $47.2 \pm 5.68$  mm SVL (38.3–55.8 mm). Moderately built, somewhat flattened lizards. Proportions (female – mean, min.-max.; male – same): SnForeL/SVL 38, 36–42%; 38, 36–41%; TrunkL/SVL 41, 38–43%; 42, 39–48%; ForeaL/SVL 12, 11–13%; 12, 11–14%; CrusL/SVL 13, 12–14%; 14, 13–15%. Tail length (unregenerated) approximately equal to SVL in both females and males. Tail flattened, broader than high (semicircular to spindle-shape in cross-section), and tapering gradually to thin tip.

Head moderately large and broad, distinct from neck, flattened and conical to obovate in dorsal outline. HeadL/SVL 25, 24–26%; 26, 25–28%; JawW/HeadL 65, 62–70%; 63, 58–71%; SnEye/HeadL 43, 42–45%; 43, 42–46%; SnW/HeadL 13, 12–15%; 13, 11–15%. All digits of fore- and hindfeet with digital pads. Digital pads oblong to obovate in shape with distal end usually wider than proximal end; slender terminal portion (ultimate and penultimate phalanges) of digit arising from within and free of digital pad of all digits. Claws on all digits; slight or no webbing at base of digits.

Dorsal and lateral scalation of head and body of small, equal-sized, juxtaposed tubercles interspersed with numerous smooth-surfaced cone-shaped tubercles (area of each about 3 smaller background tubercles); usually cone-shaped tubercles densely packed on body and without a longitudinal arrangement into rows; dorsally fewer enlarged tubercles on tail and more longitudinally; ventral scales slightly overlapping, about 5× smaller dorsal tubercles; transition from ventral scales to tubercles ventrolaterally; no ventrolateral skin fold on trunk. Head dorsally and laterally with scales on snout and lips, elsewhere small tubercles. Rostral scale large, rectangular with long median cleft, about two-thirds height of rostral; nares bordered by rostral, first supralabial, and 3 nasal scales, supranasal largest. Supralabials 10–12, infralabials 7–11. Broad triangular mental scale ventrally, bordered posteriorly by 2 large anterior chin scales, in contact medially; posterior chin scales equal size of anterior ones and not touching medially.

Limbs uniformly scaled above and below, except for small tubercles on posterior surface of thigh. Subdigital lamellae on pad: 7–9 on 4<sup>th</sup> finger, distal lamella undivided, subsequent 4–7 divided; 8–10 on 4<sup>th</sup> toe, distal lamella undivided, subsequent 5–7 divided. Bilateral series of 26–38 (total and most >34) preloacal-femoral pores in males, left and right sides separated at midpelvic by 1–3 nonpore scales. Tail midventrally with rectangular, slightly overlapping, smooth-surfaced plates from vent to at least mid-length; large smooth scales ventrolaterally quickly grading into lateral fringe scales. Tail distinctly segmented, each segment 8–10 scales long; dorsal scale small, smooth and slightly overlapping; lateral edge of tail fringed with modestly enlarged triangular scales, 3–4 per segment, usually posterior-most one of each segment larger than other, yielding a ragged saw-like fringe.

Adults in dark phase, dorsal ground color from snout onto tail medium brown to grayish khaki; head uniform to diffusely mottled in light and medium brown; dark irregular rectangular spots on dorsum from nape to base of tail; usual spot pattern of dorsum, row of about six spots on midline from nape onto tail, dorsolateral row of spots, and lateral row on trunk often fused into nearly continuous stripe. Most dark phase individuals with dark-brown postorbital stripe from snout through eye and ear to axilla continuous with lateral trunk stripe. In light phase, dorsum nearly uniform beige or with faded markings on light background. Ventrally immaculate cream to light yellow from chin onto tail.

**DISTRIBUTION.**— Our survey data suggest that *Hemidactylus karenorum* may be a Burmese endemic (Fig. 5), although it might reach the eastern mountains in Bangladesh. Our specimen-vouchers limit this species' occurrence to the central and north-central portion of the Ayeyarwady River valley, even absent from the northern portion of the Sittaung River drainage. We have not yet had the opportunity to examine the specimen reported (Smith 1935) from Assam, but the absence of this species from our survey sites in the northern half of the Chindwin River basin suggests a misidentification of the Assam specimen. Tikader and Sharma (1992) listing of *H. karenorum* from Assam appears to be a repeat of Smith's (1935) earlier report. As yet, we are unable to locate the specimen ["Cachar in Assam"] reported by Smith. The BMNH has only four *karenorum* specimens, and they represent two Burmese localities.

**Natural history.**— *Hemidactylus karenorum* is a forest gecko, commonly found in leaf litter along streams or the base of trees.

Gravid females were found in central Myanmar samples taken in February and March.

### *Hemidactylus platyurus* (Schneider)

Asian flat-tailed gecko

*Stellio platyurus* Schneider 1792:30[62]. Type locality, none given.

*Lacerta Schneideriana* Shaw 1802:278. Subsite name for *Stellio platyurus* Schneider.

*G[eko] marginata* Cuvier 1829:55. Type locality, "Bengale." [original description not seen]

*Nycteridium schneideri* Günther 1864:111. Subsite name for *Stellio platyurus* Schneider.

*Nycteridium Himalayanum* Anderson 1871:15. Type locality, "Darjeeling; 3000 feet" [West Bengal State, India].

*Hemidactylus nepalensis* Annandale 1907:151. Type locality, "Kathmandu, Nepal: altitude 4,500 feet."

**DESCRIPTION.**— Adults 47–58 mm SVL; adult SVL and not sexually dimorphic in any traits: females average  $53.2 \pm 2.94$  mm SVL (47.5–50.7 mm); male average  $51.8 \pm 3.63$  mm SVL (49.2–58.1 mm). Moderately built, somewhat flattened lizards. Proportions (female – mean, min.-max.; male – same): SnForel/SVL 36, 34–38%; 36, 33–38%; TrunkL/SVL 46, 40–51%; 45 44–46%; Foreal/SVL 11, 11–12%; 12, 11–12%; CrusL/SVL 12, 11–14%; 13, 11–15%. Tail length (unregenerated) subequal to or slightly longer than to SVL and equal in females and males. Tail strongly flattened, much broader than high, and elongate dagger-like from base to pointed tip, lateral edges serrated with flatten, pointed scales.

Head moderately large and broad, distinct from neck, flattened and broad-triangular to pentagonal in dorsal outline. HeadL/SVL 24, 23–25%; 24, 22–25%; JawW/HeadL 67, 63–74%; 68, 63–73%; SnEye/HeadL 42, 40–46%; 42, 40–47%; SnW/HeadL 15, 14–17%; 14, 14–16%. All digits of fore- and hindfeet with digital pads. Digital pads obovate in shape with distal end slightly wider than proximal end; slender terminal portion (ultimate and penultimate phalanges) of digit arising from within and free of digital pad of all digits. Claws on all digits; modest webbing, about one-third length of digits on fore- and hindfeet.

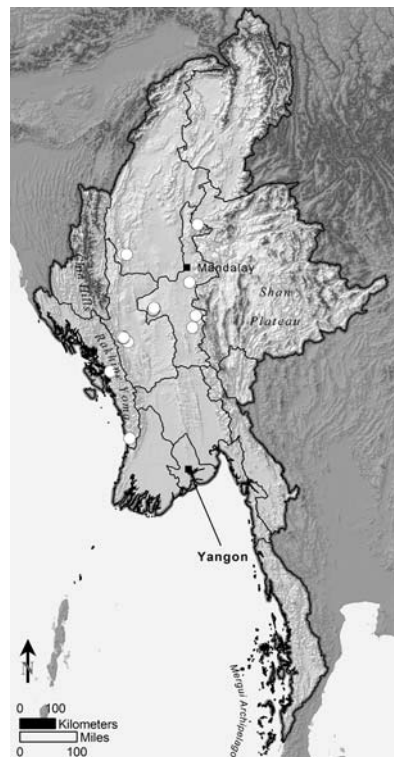


FIGURE 5. Distribution of *Hemidactylus karenorum* in Myanmar based on voucher specimens of the CAS/NWCD/SI Myanmar Herpetological Survey.

Head, body, and tail scalation of small, equal-sized, juxtaposed tubercles dorsally and laterally, including the trunk skin-fold; slightly overlapping smooth scales,  $>5\times$  dorsal tubercles, ventrally from base of neck to pelvic area; transition from ventral scales to tubercles ventrolaterally, 5–6 scale rows from base of skin-fold; distinct ventrolateral skin fold on trunk, posterior edge of thigh and crus, and often on anterior edge of upper arm. Head dorsally and laterally with scales on snout and lips, elsewhere small tubercles. Rostral scale large, rectangular with middorsal cleft; nares bordered by rostral, first supralabial, and 3 equal-sized nasal scales. Supralabials 9–13, infralabials 8–11. Broad triangular mental scale ventrally, bordered posteriorly by 2 large anterior chin scales, usually broadly in contact medially; posterior chin scales half or less the area of anterior ones and broadly separated medially.

Limbs covered above and below with granular scales (about  $2\times$  dorsum scales), except for smooth scales on posteroventral surface of thigh. Subdigital lamellae on pad: 7–9 on 4<sup>th</sup> finger, distal lamella undivided, subsequent 5–7 divided; 6–9 on 4<sup>th</sup> toe, distal lamella undivided, subsequent 5–7 divided. Bilateral series of 36–40 (total) preloacal-femoral pores in males, left and right sides separated at midpelvic by 1–4 nonpore scales. Tail midventrally with rectangular, slightly overlapping, smooth-surfaced plates from vent to near tip; large smooth scales ventrolaterally quickly grading into tubercles. Tail indistinctly segmented, evident only by enlarged lateral-edge spine at posterior edge of each segment, segments 8–9 scales long; ventrolateral edge with series of spine-like scales, last one largest on each segment.

Adults in dark phase, dorsal ground color from head to base of tail medium brown to dusky tan with scattered small, elongate dark-brown spots dorsally, occasionally dorsolateral spots coalesced into dorsolateral stripe from posterior corner of eye (rarely from tip of snout) to shoulder, laterally broad dark-brown stripe from loreal area to inguen. Some individuals with beige stripe between dark-brown stripes from snout through eye to ear-opening. Dorsum of tail variably banded with dark and light brown, dark bands subequal to twice width of light ones.

In light phase, dorsum nearly uniform beige, rarely with diffused mottling on light background. Ventrally immaculate cream to light yellow from chin onto tail.

**COMMENT.**— Our survey has collected a few individuals from southern Tanintharyi, two of which are males — a subadult and an adult. Neither of these individuals displays preloacal-femoral pores or the precursor pits. None of the other traits are strikingly different from the central Myanmar *H. platyurus* sample. This observation and those of M. Smith's (1935) suggest the potential of regional differentiation. The inclusion of images of both *H. craspedotus* and *H. platyurus* in the Cox et al. (1998) *H. platyurus* account potentially exaggerates our interpretation of pattern variation in the latter species.

**DISTRIBUTION.**— Even though *Hemidactylus platyurus* occurs from about 26°N to the southern most tip of Myanmar (~10°N), our survey records (Fig. 6) show a very spotty occurrence and, at least for central and northern Myanmar,

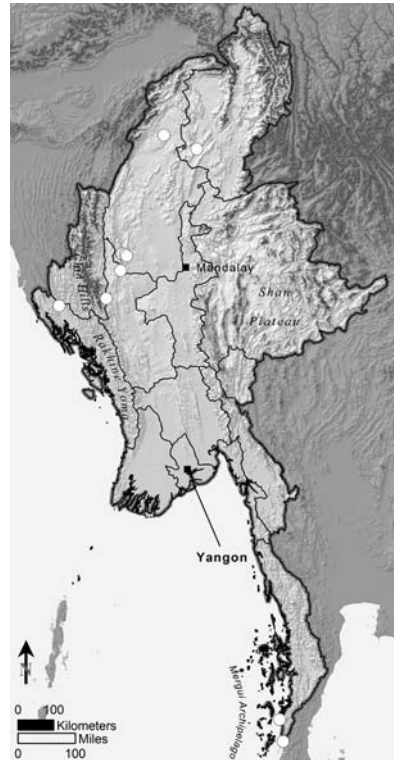


FIGURE 6. Distribution of *Hemidactylus platyurus* in Myanmar based on voucher specimens of the CAS/NWCD/SI Myanmar Herpetological Survey.



no populations in the Ayeyarwady valley or in the foothills and mountains to the east. Tikader and Sharma (1992) also reported a limited distribution (Sikkim, Darjeeling District) in India; furthermore, their statement of its commensal habits suggests a human introduction into the Darjeeling area. Ulber and Ulber (1991) provided a general distribution map of *H. platyurus*, showing a broad distribution from Sri Lanka and eastern India through South Asia to the Philippines and New Guinea. They further noted that this species occurs exclusively in the vicinity of human habitation. Our natural history note below offers a slight contradiction to this exclusivity; however, its high human commensalism likely explains its broad distribution via accidental transport.

**NATURAL HISTORY.**— Most individuals were captured in or on buildings, otherwise two individuals from a sandstone wall of a stream-cut and one from the forest floor.

Gravid females were found in central Myanmar samples taken in June and July, although other adults from these samples were only in early to mid-vitellogenesis.

#### TAXONOMIC NOTES ON TROPICAL ASIAN *HEMIDACTYLUS*

The results of Carranza and Arnold (2006; abbrev. C&A-06) encouraged the current investigation of Burmese *Hemidactylus*. The C&A-06 molecular (mtDNA) phylogeny demonstrated that *Hemidactylus* is monophyletic when *Cosymbotus platyurus* is returned to *Hemidactylus* as proposed by Boulenger (1885). Additionally, their analysis revealed five clades, each of which represents a distinct geographic and evolutionary arena. Their tropical Asian clade ((*platyurus* (*bowringii* (*karenorum*, *garnotii*))) (*flaviviridis* (*brookii*, *frenatus*))) (Fig. 7) contains seven of the approximately 20 species known to occur naturally from the Indus River eastward through tropical Asia. We assume for the following discussion that all Asian *Hemidactylus* are members of the C&A-06's tropical Asian clade. We have not attempted a morphological comparison to locate a synapomorphic trait that supports this assumption. Such a comparison would be useful, and critically, a broader DNA sampling of tropical Asian *Hemidactylus* is essential to test the monophyly of this putative Asian clade.

The monophyly of tropical Asian *Hemidactylus* creates a taxonomic unit that contains about three times as many species (Table 1) as studied by C&A-06. We share C&A-06's unwillingness [implied] to assign formal taxonomic names to this or any of the other identified clades. Formal name assignment of generic or subgeneric names for each of the clades would be easy owing to the surfeit of synonyms for the genus *Hemidactylus*. A partitioning of the genus, however, without a further testing of the monophyly of the five clades is premature and will only obfuscate the affinities of *Hemidactylus* geckos, particularly when less than a quarter of the known species were included in C&A-06's phylogenetic analysis.

Our only exception to a change in generic assignment is reverting to Boulenger's 1885 usage of *Hemidactylus platyurus*. We believe this usage is now necessary in any discussion of Asian *Hemidactylus*. Shifting *platyurus* to *Hemidactylus* restores the combination *H. craspedotus* Mocquard, 1890. This latter taxon became *Mimetozone craspedotus* when de Rooij (1915) assigned the

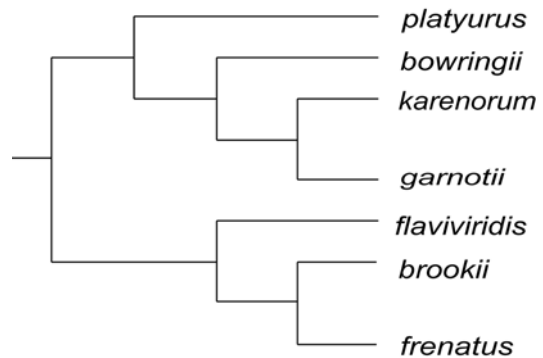


FIGURE 7. Stylized dendrogram displaying the proposed relationships among members of the tropical Asian clade of *Hemidactylus*. The dendrogram derives from the maximum likelihood tree of Carranza and Arnold (2006: fig. 1).

TABLE 1. Putative species of the tropical Asian clade of *Hemidactylus*. Species names are arranged chronological. Only those taxa currently recognized as valid by Kluge (2001) and Bauer (1994) are listed. Type localities are in brackets and generalized; species occurring in Burma in bold.

---

1792	<i>Stellio platyurus</i> Schneider [not stated]
1802	<i>Gecko triedrus</i> Daudin [not stated]
1835 <sup>1</sup>	<i>Hemidactylus flaviviridis</i> Rüppell [Massaua Isl. Eritrea]
1836	<b><i>Hemidactylus frenatus</i></b> Duméril & Bibron <sup>2</sup> [Java]
1836	<b><i>Hemidactylus garnotii</i></b> Duméril & Bibron [Tahiti]
1836	<i>Hemidactylus leschenaultii</i> Duméril & Bibron [Sri Lanka]
1836	<i>Hemidactylus maculatus</i> Duméril & Bibron [Bombay Pres., India]
1842	<i>Hemidactylus depressus</i> Gray [Madagascar]
1845	<b><i>Doryura bowringii</i></b> Gray [Hong Kong]
1845	<b><i>Hemidactylus brookii</i></b> Gray [Borneo]
1854	<i>Hemidactylus subtriedrus</i> <sup>3</sup> Jerdon [Madras Pres., India]
1861	<i>Hemidactylus marmoratus</i> <sup>4</sup> Hallowell [Ryukyu Ids.]
1868	<b><i>Doryura karenorum</i></b> Theobald [Myanmar]
1870	<i>Hemidactylus reticulatus</i> Beddome [eastern Karnataka, India]
1870	<i>Hemidactylus gracilis</i> Blanford [Central Prov., India]
1871	<i>Hemidactylus giganteus</i> Stoliczka [Godavari Valley, India]
1875	<i>Gecko anamallensis</i> Günther [Western Ghats, India]
1890	<i>Hemidactylus craspedotus</i> Mocquard [Borneo]
1906	<i>Tetratolepis scabriceps</i> Annandale [southern Tamil Nadu, India]
1935	<i>Hemidactylus prashadi</i> M.A. Smith [Bombay Pres., India]
1981	<i>Hemidactylus porbandarensis</i> Sharma [Gujarat, India]
1984	<i>Hemidactylus mahendrai</i> Shukla [Uttar Pradesh, India]
1984	<i>Hemidactylus vietnamensis</i> Darevsky & Kupriyanova [northern Vietnam]
1989	<i>Hemidactylus stejnegeri</i> Ota & Hikida [Taiwan]

---

<sup>1</sup> Kluge gives dates as 1840, presumably because the latter sections of this publication appeared over several years.

<sup>2</sup> Kluge credits authorship to Schlegel 1836.

<sup>3</sup> Smith (1935) considered *H. subtriedrus* questionably distinct from *H. triedrus*. Its absence from Das' (2002) pocket guide indicates a similar opinion.

<sup>4</sup> Kluge recognized *H. marmoratus* as a valid taxon, yet Ota (1989) does not include it as a member of the Ryukyu gecko fauna. Smith (1935) synonymized it with *H. leschenaultii*.

type species *Mimetozone floweri* Boulenger, 1897 to the synonymy *H. craspedotus* and retained *Mimetozone* for this gecko with large bilateral body folds and well-webbed digits. She retained the combination *Hemidactylus platyurus*. Subsequently, Smith (1935) synonymized *Mimetozone* Boulenger, *Nycteridium* Günther, 1864, and *Cosymbotus* Fitzinger, 1843 with *Platyurus* Oken, 1836 (see Taylor, 1963, for additional history). Thereafter, these two species regularly shifted between the latter two genera and only with Wermuth's 1965 checklist attained stability in assignment to *Cosymbotus*.

Nowhere in this history of generic reassignments did anyone examine the affinities of *craspedotus* and *platyurus* to one another or to other *Hemidactylus* species. The body folds and digital webbing kept these two taxa closely linked for the last 70 years. C&A-2006's study does not address the relationship of these two species, but it does eliminate the implied relationships of shared generic assignment outside of the genus *Hemidactylus*. It is such implied relationship that argues against the use of formal group names for the various *Hemidactylus* geographic clades.

As previously noted, the C&A-2006 phylogram (Fig. 7) addresses the relationships of only a

third of the members of the putative tropical Asian clade. The phylogram indicates two lineages or clades (*bowringii-garnotii-karenorum-platyurus* and *brookii-flaviviridis-frenatus*). [Hereafter, we use complex for the *bowringii* and *brookii* clades as a phylogenetically neutral label.] Two questions immediately derive from this proposed relationship: 1) Do these two complexes encompass all the tropical Asian *Hemidactylus* or, as additional Asian taxon are examined, will new clades emerge and/or change the composition of current ones? 2) Do the members of each of these clades display a set of morphological traits that permit the visual differentiation of the complexes and assignment of molecularly untested Asian species to one or the other of the complexes? We cannot address the first question as a solution requires a broader molecular sampling of Asian species. This question, however, draws attention to a serious flaw of the C&A-06 study, i.e., inadequate specimen vouchering of their molecular samples. Only about a quarter of the C&A-06 DNA-samples have voucher specimens on which species identification can be re-examined and confirmed. An example of the problems arising from unvouchered samples is the identity of their Thiruvananthapuram-Indian "*Hemidactylus frenatus*." It is likely not a *H. frenatus* as currently conceived throughout the '*frenatus*' broad invasive-distribution. The specimens from recently invaded areas (Colombia and Hawaii) are genetically identical to one another and paired with Burmese specimens (C&A-06: fig. 1; our Fig. 7). The Indian *H. frenatus* is genetically distinct from the Burmese-Invasive lineage, thereby hinting that *Hemidactylus punctatus* Jerdon, 1854 may be a valid taxon, because the C&A-06 sample derived from Thiruvananthapuram, Kerala, about 350 km south of the type locality (Tellicherry) of Jerdon's species. This possibility cannot be examined further without a voucher specimen for the molecular data.

Returning to the second question, a superficial morphological survey of C&A-06's tropical Asian species identified a set of traits (trunk scalation, tail ornamentation, digital lamellae, and precloacal-femoral pores) that generally delimits the two Asian complexes. The *bowringii* complex either lack ornamentation on the tail or the spines are confined to the ventrolateral margin as a single scale-spine or a fringe of unequal sized scale-spines on each side of each caudal segment. Tail ornamentation in the *brookii* complex consists of a circumferential row or rows of scale-spines on each segment. The number of rows, numbers of spines, and relative size of the spines vary between the species, with *H. brookii* having the most spinose tail. Trunk scalation (back and sides) consists of uniformly small juxtaposed (granular) scales in the *bowringii* complex, except for *H. karenorum* with its irregular longitudinal rows of small tubercles. The *brookii* complex members have numerous longitudinal rows of variously developed tubercles on the trunk, except for *H. flaviviridis*, which lacks tubercles. A third to half of the digital lamellae on each digit of *bowringii* complex are divided, in contrast to only the terminal lamellae of the *brookii* complex are undivided. Precloacal-femoral pores occur only in males and are typically continuous across the hindlimb-pelvic junction. Members of the *bowringii* complex regularly possess a total of 26 pores or more, whereas *brookii* members usually have a total of 18 or fewer, except for *H. frenatus* commonly  $\geq 24$  pores. With more pores on each side, *bowringii* members have fewer (0–3) nonpore scales separating the left and right rows of pore-scales, and *brookii* members  $\geq 4$  nonpore scales, except for *H. frenatus* (0–1).

These traits allow a hypothetical assignment of the molecularly untested tropical Asian *Hemidactylus* to the two complexes: *bowringii* complex — *anamallensis*, *craspedotus*, *depressus*, *giganteus*, *leschenaultii*, *stejnegeri*, and *vietnamensis*; *brookii* complex — *maculatus*, *prashadii*, *reticulatus*, and *triedrus*. Several taxa are not assigned: 1) *marmoratus* and *subtriedrus* are not considered valid taxa (see footnotes of Table 1); 2) *gracilis* has 10–12 longitudinal rows of well-developed tubercles on the trunk and a tail oblong in cross-section without ornamentation, sharing a major trait of each complex, but more critically only precloacal pores [a trait shared only with *H. porbandaren-*

sis among tropical Asian *Hemidactylus*, although approached in some *brookii* complex members]; 3) *porbandarensis* [possibly a *brookii* complex member] has 16–17 longitudinal rows of enlarged, keeled tubercles on the trunk dorsum, moderately compressed tail, presumably with transverse rows of six spines at edge of each segment, and a short row of precloacal pores; 4) Annandale's description of *scabriceps* reported dorsal trunk scales imbricate and equal in size to the belly scales [a trait not known elsewhere in tropical Asian *Hemidactylus*]. Shukla's description (1984) of *H. mahendrai* is based on a few juvenile and female specimens. Further, the description lacks a statement differentiating *H. mahendrai* from *H. brookii*, although diagnostic traits are provided for other Indian *Hemidactylus* species. Shukla's description match the traits of female Asian *H. brookii*, thus we tentatively suggest that *mahendrai* is a synonym of the latter species. The uncertainty of assignment for the latter two taxa urges their inclusion in the next molecular phylogenetic analysis.

The preceding taxon assignment derived mainly from the states of trunk scalation, tail ornamentation, and precloacal-femoral pore number. *Hemidactylus leschenaultii* has some enlarged dorsal tubercles, but tail ornamentation and precloacal-femoral pores are strongly *bowringii* complex. *Hemidactylus depressus* similarly has numerous rows of dorsal tubercles and otherwise has *bowringii* complex traits. We note that *H. karenorum* also has numerous tubercles, although smaller than the *brookii* complex condition, smooth and rounded, and not arranged in longitudinal rows. Ignoring the high number of pores in *H. depressus*, *bowringii* complex assignments were unequivocal.

*Hemidactylus stejneri* and *H. vietnamensis* are all-female species and without karyotypic data would have remained unrecognized as distinct genetic lineages from *H. garnotii*. *Hemidactylus vietnamensis* was recognized by Darevsky and colleagues (1984) when they obtained karyotypes from northern Vietnam *H. garnotii*. Contrary to Kluge and Eckardt's karyotypic results ( $3n = 70$ ; Kluge and Eckardt 1969) for Floridian and Hawaiian *H. garnotii*, the karyotype of the Vietnamese "*garnotii*" specimens was  $3n = 60$ . Darevsky et al. (1984: table 2) contrasted seven scalation traits of their Vietnamese specimens ( $n = 17$ ) with a subset ( $n = 28$ ) of Kluge and Eckardt's Hawaiian sample ( $n = 66$ ) and found significant differences in 6 traits. The scalation and karyotypic differences led them to recognize the Vietnamese population as a distinct species. These scalation differences are slight and might result from differences in trait definition and data-collection; however, Ota et al. (1986) examined a set of 7 traits in the Kluge-Eckardt Hawaiian, Darevsky et al. Vietnamese, and 3 Chinese (Yunnan, Hainan, Taiwan) samples. This analysis confirmed the distinctiveness of the Hawaiian and Vietnamese samples from one another. The Hainan and Yunnan samples were not significantly different from one another, but combined they differed modestly from the Hawaiian and Taiwan samples, and strongly differentiated from the Vietnamese one.

Subsequently, Ota and Hikida (1989b) examined the karyotypes of Taiwanese "*garnotii*" and discovered another karyotype ( $3n = 56$ ) and recognized this population as *H. stejneri*. In a series of research articles, Ota and collaborators examined karyotypic evolution and the origin of parthenogenesis in unisexual *Hemidactylus*. Their general conclusion is that there are two parthenogenetic groups: the *H. garnotii-vietnamensis* complex and *H. stejneri*. Both groups arose by hybridization, and presently, evidence identifying the parental species is not available. They also discussed the likelihood of karyotypic evolution without concomitant morphological differentiation within a unisexual species. We lack data and expertise to support or negate their hypothesis of relationships and accept their assessment of two clonal lineages. The C&A06 molecular data show genetic uniformity within Burmese *H. garnotii* and between Burmese and Floridian specimens. Moritz et al. (1993) showed a uniformity of *H. garnotii* karyotype number ( $3n = 63$ ) among Pacific island populations, including Hawaii, and the Florida population. They also noted a low diversity of allozymes and mtDNA among their samples. Combining these results with those of C&A-06



indicates that the Burmese populations is *H. garnotii*. Nevertheless until there is a molecular analysis among the various Asian populations of the parthenogens, we urge caution on assigning the name *garnotii*.

#### ACKNOWLEDGMENTS

The Myanmar Herpetological Survey is a country-wide species inventory designed to uncover the full diversity of the Burmese herpetofauna by surveying broadly but focusing on the forest and wildlife reserves of the Myanmar Forestry Department, Ministry of Forestry. The Survey owes its success to the administrative and logistic support of U Shwe Kyaw, Director General, Forestry Department, and U Khin Maung Zaw, Director, and U Tin Tun, Deputy Director, of the Nature and Wildlife Conservation Division (NWCD, Forestry Dept.), and critically to the NWCD staff (U Htun Win, Daw Thin Thin, U Kyi Soe Lwin, U Awan Khwi Shein, U San Lwin Oo, U Sai Wunna Kyi) who have been the core of our survey team. The Survey is a collaborative effort among the staff of NWCD, the California Academy of Sciences, and the Smithsonian's National Museum of Natural History (SI-NMNH). The latter two institutions have provided a variety of administrative and financial support. We thank all the above individuals and institutions for their past and ongoing support.

Financial support for the Survey and assorted inventory-monitoring programs derived from the National Science Foundation (DEB-9971861: J.B. Slowinski and G.R. Zug) as the primary source, CAS donations, and the SI-NMNH's Biodiversity and Survey Program. The present research received support from NSF (DEB-0451832: A. Leviton, J. Vindum, and G. Zug).

We thank the collections management staff of our respective museum for their assistance with the examination of specimens. Robert F. Fisher and Aaron Bauer reviewed the manuscript; we thank them for their efforts on our behalf. Caleb McMahan provided the morphological data for the *H. bowringii* account. We thank Patricia Zug for data input and assistance with data collection.

#### LITERATURE CITED

N.B. We have not listed citations for authors used solely as part of a scientific name to denote authorship and date of publication.

- ANNANDALE, N. 1906. Notes on the fauna of a desert tract in southern India. Part I.—Batrachians and reptiles, with remarks on the reptiles of the desert region of the North-West Frontier. *Memoirs of the Asiatic Society of Bengal* 1(10):183–202.
- AUFFENBERG, W. 1980. The herpetofauna of Komodo, with notes on adjacent areas. *Bulletin of the Florida State Museum, Biological Sciences* 25:39–156.
- BAUER, A.M. 1994. Familia Gekkonidae (Reptilia, Sauria). Part I Australia and Oceania. *Das Tierreich* 109:1–306.
- BAUER, A.M., AND R. GÜNTHER. 1992. A preliminary report on the reptile fauna of the Kingdom of Bhutan with the description of a new species of scincid lizard (Reptilia: Scincidae). *Asiatic Herpetological Research* 4:23–36.
- BOBROV, V.V. 1992. Notes on lizards (Reptilia, Sauria) from southern Vietnam. *Journal of Bengal Natural History Society* n.s. 11:17–24.
- BOULENGER, G.A. 1885. *Catalogue of the Lizards in the British Museum (Natural History)*, Second edition.. Volume 1. *Gekkonidae, Eublepharidae, Uroplatidae, Pygopodidae, Agamidae*. Taylor and Francis, London, UK. xii + 436, 32 plates.
- BOURRET, R. 1939. XVII. Reptiles et batraciens reçus au Laboratoire des Sciences Naturelles de l'Université au cours de l'année 1938. Descriptions de trois espèces nouvelle. *Bulletin général de l'Instruction publique [Hanoi]* (6):13–34.
- BROWN, W.C., AND A.C. ALCALA. 1978. Philippine lizards of the family Gekkonidae. *Silliman University Natural Science Monograph Series* 1:1–146.

- CARRANZA, S, AND E.N. ARNOLD. 2006. Systematics, biogeography, and evolution of *Hemidactylus* geckos (Reptilia: Gekkonidae) elucidated using mitochondrial DNA sequences. *Molecular Phylogenetics and Evolution* 38:531–545.
- COX, M.J., P.P. VAN DIJK, J. NABHITABHATA, AND K. KHIRAKHUPT. 1998. *A Photographic Guide to Snakes and Other Reptiles of Peninsular Malaysia, Singapore and Thailand*. Ralph Curtis Books, Sanibel Island, Florida, USA. 144 pp.
- DANIEL, J.C. 1983. *The Book of Indian Reptiles*. Bombay Natural History Society, Bombay, India. x + 141 pp., 52 unnumbered plates.
- DAREVSKY, I.S. 1964. Die Reptilien der Inseln Komodo, Padar un Rintja im Kleinen Sunda-Archipel, Indonesien. *Senckbergiana biologica* 45:563–576.
- DAREVSKY, I.S., L.A. KUPRIYANOVA, AND V.V. ROSHCIN 1984. A new all-female triploid species of gecko and kayological data on the bisexual *Hemidactylus frenatus* from Vietnam. *Journal of Herpetology* 18:277–284.
- DAS, I. 2002. *A Photographic Guide to Snakes and Other Reptiles of India*. New Holland Publishers (UK) Ltd., London, UK. 144 pp.
- DAS, I., AND J. SUKUMARAN. 2006/7. A recent record of *Hemidactylus brookii* Gray, 1845 from Borneo. *Gekko* 5: in press.
- DENZER, W., AND U. MANTHEY. 1991. A nominal checklist of the lizards inhabiting peninsular Malaysia and Singapore. *Raffles Bulletin of Zoology* 39:309–322.
- DERANIYAGALA, P.E.P. 1953. *A Colored Atlas of Some Vertebrates from Ceylon. Volume Two. Tetrapod Reptilia*. Ceylon National Museums Publication -Ceylon Government Press, Colombo, Ceylon [Sri Lanka]. xvii + 101 pp., 35 pl.
- DE ROOIJ, N. 1915. *The Reptiles of the Indo-Australian Archipelago. I. Lacertilia, Chelonia, Emydosauria*. E.J. Brill, Ltd., Leiden, Netherlands. xiv + 384 pp.
- DUNN, E.R. 1927. Results of the Douglas Burden Expedition to the island of Komodo. III.—Lizards from the East Indies. *American Museum Novitates* 288:1–13.
- GLEADOW, F. 1887. Description of a new lizard from the Dangs. *Journal of the Bombay Natural History Society* 2:49–51.
- KARSTEN, S.J., M. W-N. LAU, AND A. BOGADEK. 1986. *Hong Kong Amphibians and Reptiles*. Urban Council, Hong Kong. 136 pp.
- KÄSTLE, W. 2002. Family Gekkonidae (geckos). Pages 674–691, 697–722 in H.H. Schleich and W. Kästle, eds., *Amphibians and Reptiles of Nepal. Biology, Systematics, Field Guide*. A.R. G. Gantner Verlag Kommanditgesellschaft, Ruggell, Germany.
- KHAN, M.S. 2002. Key and checklist to the lizards of Pakistan. *Herpetozoa* 15(3/4):99–119.
- KLUGE, A.G. 2001. Gekkotan lizard taxonomy. *Hamadryad* 26:1–209.
- KLUGE, A.G., AND M.J. ECKARDT. 1969. *Hemidactylus garnotii* Duméril and Bibron, a triploid all-female species of gekkonid lizard. *Copeia* 1969:651–664.
- LAZELL, J. 2002. The herpetofauna of Shek Kwu Chau, South China Sea, with descriptions of two new colubrid snakes. *Memoirs of the Hong Kong Natural History Society* 25:1–82.
- LIAN, T.F. 1993. *Checklist of lizards of Sabah*. Sabah Parks Trustees, Kota Kinabalu. 18 pp.
- MANTHEY, ULRICH, AND WOLFGANG GROSSMANN. 1997. *Amphibien & Reptilien Südasiens*. Natur u. Tier Verlag, Münster, Germany. 512 pp.
- MORITZ, C., T.J. CASE, D.T. BOLGER, AND S. DONNELLAN. 1993. Genetic diversity and the history of pacific [sic] island house geckos (*Hemidactylus* and *Lepidodactylus*). *Biological Journal of the Linnean Society* 48:113–133.
- OTA, H. 1989. A review of the geckos (Lacertilia: Reptilia) of the Ryukyu Archipelago and Taiwan. Pages 222–261 in M. Matsui, T. Hikida, and R.C. Goris, eds., *Current Herpetology in East Asia*. Herpetological Society of Japan, Kyoto, Japan.
- OTA, H., I.S. DAREVSKY, L.A. KUPRIYANOVA, T. HIKIDA, K.-Y. LUE, S.-H. CHEN, AND T. HAYASHI. 1993. Geographic variation in the parthenogenetic lizard, *Hemidactylus stejnegeri* Ota & Hikida (Gekkonidae Reptilia), with comments on recently discovered male phenotypes. *Tropical Zoology* 6:125–142.
- OTA, H., T. HIKIDA, AND E. ZHAO. 1986. Notes on members of the *Hemidactylus garnotii-vietnamensis* species

- complex from Hainan and Yunnan of China. *Japanese Journal of Herpetology* 11(3):79–85.
- OTA, H., AND T. HIKIDA. 1989a. A record of a triploid gecko, *Hemidactylus stejnegeri* from the northern Philippines. *Japanese Journal of Herpetology* 13(2):35–39.
- OTA, H., AND T. HIKIDA. 1989b. A new triploid *Hemidactylus stejnegeri* (Gekkonidae: Sauria) from Taiwan, with comments on morphological and karyological variation in the *H. garnotti-vietnamensis* complex. *Journal of Herpetology* 23:50–60.
- PAWAR, S., AND A. BIRAND. 2001. *A Survey of Amphibians, Reptiles, and Birds in Northeast India*. CERC Technical Report #6. Center for Ecological Research and Conservation, Mysore, India. 180 pp.
- SHARMA, R.C. 2002. *The Fauna of India and the Adjacent Countries. Reptilia, Volume II (Sauria)*. Zoological Survey of India, Kolkata, India. xxv + 430 pp.
- SHUKLA, V.N. 1984. A new species of the lizard *Hemidactylus* from Kanpur (India). *Indian Journal of Zoology* 24:81–83.
- SMITH, M. A. 1935. *The Fauna of British India, Including Ceylon and Burma. Reptilia and Amphibia. Vol. II—Sauria*. Taylor & Francis Ltd., London, UK. xii + 445 pp.
- TAYLOR, E. H. 1963. The lizards of Thailand. *University of Kansas Science Bulletin* 44(14):687–1077.
- TIKADER, B.K., AND R.C. SHARMA. 1992. *Handbook Indian Lizards*. Zoological Survey of India, Calcutta, India. xv + 250 pp.
- ULBER, T., AND E. ULBER. 1991. *Cosymbotus platyurus* (Schneider). *Sauria*, Supplement 13:201–204.
- WERMUTH, H. 1965. Liste der rezenten Amphibien und Reptilien. Gekkonidae, Pygopodidae, Xantusiidae. *Das Tierreich* 80:1–246.
- ZHAO, E., AND K. ADLER. 1993. *Herpetology of China*. Society for Study of Amphibians and Reptiles, Ithaca, New York, USA. 522 pp.
- ZHAO, E., ED. 2003. *Coloured Atlas of Sichuan Reptiles*. Sichuan Provincial Bureau of Forestry <<actual publisher is unclear>> 292 pp.
- ZUG, G.R. 1990. Lizards of Fiji: natural history and systematics. *Bishop Museum Bulletin in Zoology* 2:1–136.