



<http://dx.doi.org/10.11646/zootaxa.3887.5.5>

<http://zoobank.org/urn:lsid:zoobank.org:pub:1EA381C9-4FEB-427B-98EA-CBAE8C4362F6>

## Re-examination of *Hemidactylus tenkatei* van Lidth de Jeude, 1895: Populations from Timor provide insight into the taxonomy of the *H. brookii* Gray, 1845 complex (Squamata: Gekkonidae)

ANDREW KATHRINER<sup>1</sup>, MARK O'SHEA<sup>2</sup> & HINRICH KAISER<sup>3,4</sup>

<sup>1</sup>Department of Biology, Villanova University, 800 Lancaster Avenue, Villanova, Pennsylvania 19085, USA; present address: Department of Herpetology, Bronx Zoo, 2300 Southern Boulevard Bronx, New York 10460, USA

<sup>2</sup>Faculty of Science and Engineering, University of Wolverhampton, Wulfruna Street, Wolverhampton, West Midlands WV1 1LY, United Kingdom; and West Midland Safari Park, Bewdley, Worcestershire DY12 1LF, United Kingdom

<sup>3</sup>Department of Biology, Victor Valley College, 18422 Bear Valley Road, Victorville, California 92395, USA; and Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, DC 20013, USA

<sup>4</sup>Corresponding author. E-mail [hinrich.kaiser@yvc.edu](mailto:hinrich.kaiser@yvc.edu)

### Abstract

Recent herpetofaunal investigations in Timor-Leste revealed populations similar to *Hemidactylus brookii* Gray, 1845 in four of 13 districts. In order to properly identify these populations, we examined their relationships to other *H. brookii*-complex populations, notably those from nearby Roti Island, Indonesia (to which the name *H. tenkatei* van Lidth de Jeude, 1895 has been applied) and topotypic Bornean samples. We evaluated both meristic and mensural data from a set of specimens that included the type material of *H. brookii* and *H. tenkatei*, and we generated nuclear (*RAG1*) and mitochondrial (*ND2*) DNA sequence data for Timor-Leste specimens and a topotypical Bornean specimen presumed to represent *H. brookii sensu stricto*. Morphologically, Timorese geckos are clearly distinct from *H. brookii* and identical to *H. tenkatei*. Our molecular data show that the Bornean specimen thought to be *H. brookii* is genetically congruent with Timor-Leste specimens, and this specimen is therefore identified as *H. tenkatei*. Our data also reveal that the Burmese species *H. subtriedroides* Annandale, 1905 is distinct from both *H. tenkatei* and *H. brookii*. While the current data do not allow us to determine with certainty whether *H. tenkatei* is the oldest available name for these widespread forms, it is the only name that can be reliably applied at this time.

**Key words:** *Hemidactylus tenkatei*, *H. brookii*, *H. subtriedroides*, Timor-Leste, Borneo, Roti, taxonomy

### Introduction

The genus *Hemidactylus* Oken, 1817 is one of the most species-rich clades of geckos with a trans-continental distribution (Kluge 1969). Currently represented by 127 species (Uetz 2014), these nocturnal geckos have adapted to a diverse array of habitat types including the tropics and subtropics of Africa, Asia, northern South America, the Caribbean, and Mediterranean Europe (Bauer *et al.* 2010b). Considering their adaptive plasticity, the majority of *Hemidactylus* species (approx. 94%) have relatively small distributions in Africa and Asia, while eight species, including *H. brookii*, *H. frenatus* Schlegel in Duméril and Bibron, 1836, *H. garnotii* Duméril and Bibron, 1836, *H. mabouia* Moreau de Jonnés, 1818, *H. persicus* Anderson, 1872, *H. platyurus* (Schneider, 1792), *H. parvimaclatus* Deraniyagala, 1953, and *H. turcicus* Linnaeus, 1758, are present in both the New and Old Worlds, having spread throughout these regions through the agency of humans (Carranza & Arnold 2006). Of these, *H. brookii* has one of the widest distributions and perhaps the most convoluted taxonomic history.

Herpetofaunal surveys in Timor-Leste, Asia's newest country, revealed several *brookii*-like populations (Fig. 1A) in four of the country's 13 districts (Kaiser *et al.* 2011; O'Shea *et al.* 2012; Sanchez *et al.* 2012). These were preliminarily identified as *H. cf. tenkatei* by O'Shea *et al.* (2012) and Sanchez *et al.* (2012), given their apparent similarity to *H. tenkatei* van Lidth de Jeude, 1895, a name coined to identify *brookii*-complex geckos from the nearby island of Roti. This name had fallen into disuse after being synonymized with *H. brookii* by de Rooij (1915), but two recent inquiries into the validity of *H. tenkatei* by Rösler and Glaw (2010) and Mahony (2011) led to the

attaches a taxon name to a tissue sample, a physical voucher specimen must be available, and this voucher must conform to the parameters represented by the type specimen of that taxon.

Unless as part of a trail of evidence in taxonomy the link between the past (i.e., a holotype, or a type series) and the present (the voucher specimen from which the tissue sample was extracted) is demonstrated, and information is provided to make these links reproducible (e.g., by providing accession numbers for both the voucher specimen and the corresponding tissue sample), the analysis must be considered inconclusive and ultimately of questionable value. This is not only a problem for taxonomists, it is also a problem for those who use or allocate public resources and expect reliable outcomes (Löbl 2014). We freely admit that verifying these links may be a tall order in some circumstances, due to high logistical cost in attempts to evaluate type specimens, unfamiliarity with the morphology of a group under investigation, or simply general time constraints. However, molecular studies are still invariably rooted in the morphology of real animals, and some of the challenges surrounding the identities of *H. brookii* and *H. tenkatei*, as identified in the works of Bauer *et al.* (2010a), Rösler and Glaw (2010), and Mahony (2011), might have been recognized and addressed had the type specimens been viewed together.

We appreciate the efforts to conduct broad molecular investigations with a biogeographic (as opposed to a taxonomic) focus, and we understand that evaluations of type material adds a layer of significant complexity to such studies: finding and evaluating specimens for each and every tissue sample used or for each DNA sequence obtained (such as from GenBank), makes for a significant workload. However, given that many GenBank accessions have not been verified (and we and others have identified a variety of taxonomic incongruities with these accessions; D. Mulcahy, pers. comm.), we urge extreme caution, and certainly communication with the depositor of a sequence, before the taxon name listed on GenBank is used to represent a species, sight unseen.

## Acknowledgments

Our studies in Timor-Leste have benefited greatly from the support of Their Excellencies, former President José Ramos-Horta, Prime Minister Xanana Gusmão, and Minister Ágio Pereira. Their assistance in times of need and their friendship has been much appreciated, and we are thankful to have the leadership of this young nation take such an active role in studies of biodiversity. We are also thankful to Claudia Abate-Debat, former special advisor in the Prime Minister's Office, whose enthusiasm for our work has been a constant source of encouragement; when doors needed to be opened, Claudia was there to open them. We thank Manuel Mendes, Director of National Parks, who not only granted us our collecting permits but also gave us many ideas and advice. Surveys like ours are not possible without the assistance of many individuals who help with the fieldwork, and we thank our students from Victor Valley College who made the long trip to Timor-Leste, particularly Jester Ceballos, Eric Leatham, David Taylor, Scott Heacox, and Caitlin Sanchez. Thanks also go to our Timorese collaborators, who have progressed from being students into professionals. We thank Venancio Lopes Carvalho, Luis Lemos de Araujo, Agivedo Varela Ribeiro, Zito Afranio Soares, and Paulo Pinto. For their critical support with logistics we thank Kieran Glasspole and Paulo Aniceto (Rentló Car Rental), Ed and Gareth Turner (Air Timor), Ian Groucott (of the airline Emirates), and the management and staff at Timor Lodge Hotel and Com Beach Resort. We gratefully acknowledge the help of Steve Gotte, Ken Tighe, and Jeremy Jacobs (USNM), Patrick Campbell and Barry Clarke (BMNH), and Esther Dondorp (RMNH) for their help with cataloging or loaning specimens, x-rays, and for accommodating our research visits. We are deeply thankful for the support of our colleagues Lee Grismer and Indraneil Das for making their photographs of *H. tenkatei* available, although neither of them knew the true identity of their subjects at the time of the photo session. Financial assistance for equipment and supplies was partially provided by a Title V Grant to Victor Valley College. Student travel was partially financed by grants from the Associated Student Body at Victor Valley College, and by donations from Pamela MacKay and Melinda Fisher. This paper is Contribution No. 14 from the Tropical Research Initiative at Victor Valley College.

## Literature cited

- Annandale, N. (1905) Notes on some oriental geckos in the Indian museum, Calcutta, with descriptions of new forms. *Annals & Magazine of Natural History*, Series 7, 15, 26–32.  
<http://dx.doi.org/10.1080/03745480509443635>

- Bauer, A.M., de Silva, A., Greenbaum, E. & Jackman, T. (2007) A new species of day gecko from high elevation in Sri Lanka, with a preliminary phylogeny of Sri Lankan *Cnemaspis* (Reptilia, Squamata, Gekkonidae). *Zoosystematics and Evolution*, 83 (S1), 22–32.
- Bauer, A.M., Giri, V.B., Greenbaum, E., Jackman, T.R., Dharne, M.S. & Shouche, Y.S. (2008) On the systematics of the gekkonid genus *Teratolepis* Günther, 1869: another one bites the dust. *Hamadryad*, 33, 13–27.
- Bauer, A.M., Jackman, T.R., Greenbaum, E., de Silva, A., Giri, V.B. & Das, I. (2010a) Molecular evidence for the taxonomic status of *Hemidactylus brookii* group taxa (Squamata: Gekkonidae). *Herpetological Journal*, 20, 129–138.
- Bauer, A.M., Jackman, T.R., Greenbaum, E., Giri, V.B. & de Silva, A. (2010b) South Asia supports a major endemic radiation of *Hemidactylus* geckos. *Molecular Phylogenetics and Evolution*, 57, 343–352.  
<http://dx.doi.org/10.1016/j.ympev.2010.06.014>
- Boulenger, G.A. (1885) *Catalogue of the lizards in the British Museum (Natural History). Second Edition. Vol. 1. Gekkonidae, Eublepharidae, Uroplatidae, Pygopodidae, Agamidae*. Taylor & Francis, London, United Kingdom, xii + 436 pp.
- Boulenger, G.A. (1890) *The fauna of British India, including Ceylon and Burma. Reptilia and Batrachia*. Taylor & Francis, London, United Kingdom, xviii + 541 pp.
- Boulenger, G.A. (1898) A list of reptiles and batrachians from Ombai, East Indian archipelago. *Annals and Magazine of Natural History*, 7, 1 (2) 122–124.  
<http://dx.doi.org/10.1080/00222939808677938>
- Carranza, S. & Arnold, E.N. (2006) Systematics, biogeography, and evolution of *Hemidactylus* geckos (Reptilia: Gekkonidae) elucidated using mitochondrial DNA sequences. *Molecular Phylogenetics and Evolution*, 38, 531–545.  
<http://dx.doi.org/10.1016/j.ympev.2005.07.012>
- Carranza, S., Arnold, E.N., Mateo, J.A. & Lopez-Jurado, L.F. (2000) Long-distance colonization and radiation in gekkonid lizards, *Tarentola* (Reptilia: Gekkonidae), revealed by mitochondrial DNA sequences. *Proceedings of the Royal Society of London, Series B*, 267, 637–649.  
<http://dx.doi.org/10.1098/rspb.2000.1050>
- Carranza, S., Arnold, E.N., Thomas, R.H., Mateo, J.A. & Lopez-Jurado, L.F. (1999) Status of the extinct giant lacertid lizard *Gallotia simonyi simonyi* (Reptilia: Lacertidae) assessed using mtDNA sequences from museum specimens. *Herpetological Journal*, 9, 83–86.
- Das, I. & Sukumaran, J. (2007) Confirmation of *Hemidactylus brookii* Gray, 1845 from Borneo. *Gekko*, 5, 18–20.
- de Rooij, N. (1915) *The reptiles of the Indo-Australian Archipelago. Vol. 1. Lacertilia, Chelonia, Emydosauria*. E.J. Brill, Amsterdam, 384 pp.
- Greenbaum, E., Bauer, A.M., Jackman, T.R., Vences, M. & Glaw, F. (2007) A phylogeny of the enigmatic Madagascan geckos of the genus *Uroplatus* (Sauria: Gekkonidae). *Zootaxa*, 1493, 41–51.
- Huelsenbeck, J.P. & Ronquist, F. (2001) MrBayes: Bayesian inference of phylogeny. *Bioinformatics*, 17, 754–755. [Oxford]  
<http://dx.doi.org/10.1093/bioinformatics/17.8.754>
- Kaiser, H., Carvalho, V.L., Ceballos, J., Freed, P., Heacox, S., Lester, B., Richards, S.J., Trainor, C.R., Sanchez, C. & O'Shea, M. (2011) The herpetofauna of Timor-Leste: a first report. *ZooKeys*, 109, 19–86.  
<http://dx.doi.org/10.3897/zookeys.109.1439>
- Kluge, A.G. (1969) The evolution and geographic origin of the New World *Hemidactylus mabouia-brookii* complex (Gekkonidae, Sauria). *Miscellaneous Publications of the Museum of Zoology, University of Michigan*, 138, 1–78.
- Löbl, I. (2014) Overestimation of molecular and modeling methods and underestimation of traditional taxonomy leads to real problems in assessing and handling of the world's biodiversity. *Zootaxa*, 3768 (4), 497–500.  
<http://dx.doi.org/10.11646/zootaxa.3768.4.7>
- Mahony, S. (2011) Taxonomic revision of *Hemidactylus brookii* Gray: a re-examination of the type series and some Asian synonyms, and a discussion of the obscure species *Hemidactylus subtriedruss* Jerdon (Reptilia: Gekkonidae). *Zootaxa*, 3042, 37–67.
- Murray, J.A. (1884a) Additions to the reptilian fauna of Sind. *Annals and Magazine of Natural History, Series 5*, 14 (80), 97–106.  
<http://dx.doi.org/10.1080/00222938409459777>
- Murray, J.A. (1884b) *The Vertebrate Zoology of Sind. A Systematic Account with Descriptions of all the Known Species of Mammals, Birds, and Reptiles Inhabiting the Province*. Richardson & Co., London, xvi + 424 pp.  
<http://dx.doi.org/10.5962/bhl.title.57275>
- O'Shea, M., Sanchez, C., Heacox, S., Kathriner, A., Carvalho, V.L., Ribeiro, A., Soares, Z.A., de Araujo, L.L. & Kaiser, H. (2012) First update to herpetofaunal records for Timor-Leste. *Asian Herpetological Research*, 3, 114–126.  
<http://dx.doi.org/10.3724/sp.j.1245.2012.00114>
- Posada, D. & Crandall, K.A. (1998) Modeltest: testing the model of DNA substitution. *Bioinformatics*, 14, 817–818. [Oxford]  
<http://dx.doi.org/10.1093/bioinformatics/14.9.817>
- Rösler, H. & Glaw, F. (2010) Morphological variation and taxonomy of *Hemidactylus brookii* Gray, 1845, *Hemidactylus angulatus* Hallowell, 1854, and similar taxa (Squamata, Sauria, Gekkonidae). *Spixiana*, 33, 139–160.
- Sabaj Pérez, M.H.E. (2014) Standard symbolic codes for institutional resource collections in herpetology and ichthyology: an online reference. Version 5.0. Available from: <http://www.asih.org/resources> (accessed 4 November 2014)
- Sanchez, C., Carvalho, V.L., Kathriner, A., O'Shea, M. & Kaiser, H. (2012) First report on the herpetofauna of the Oecusse

- District, an exclave of Timor-Leste. *Herpetology Notes*, 5, 137–149.
- Tamura, K., Stecher, G., Peterson, D., Filipski, A. & Kumar, S. (2013) MEGA6: Molecular Evolutionary Genetics Analysis Version 6.0. *Molecular Biology and Evolution*, 30, 2725–2729.  
<http://dx.doi.org/10.1093/molbev/mst197>
- Uetz, P. (2014) The Reptile Database. Available from: <http://www.reptile-database.org> (accessed 1 August 2014)
- van Lidth de Jeude, T.W. (1895) Reptiles from Timor and neighbouring islands. *Notes from the Leiden Museum*, 16, 119–127.
- Weiss, A.J. & Hedges, S.B. (2007) Molecular phylogeny and biogeography of the Antillean geckos *Phyllodactylus wirshingi*, *Tarentola americana*, and *Hemidactylus haitianus* (Reptilia, Squamata). *Molecular Phylogenetics and Evolution*, 45, 409–416.  
<http://dx.doi.org/10.1016/j.ympev.2007.01.006>