



## Phylogeny, taxonomy, and zoogeography of the genus *Gekko* Laurenti, 1768 with the revalidation of *G. reevesii* Gray, 1831 (Sauria: Gekkonidae)

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## Abstract

A review of the taxonomy, phylogeny, and zoogeography of all currently recognized *Gekko* species is provided based on morphology (including size, scalation, color, and pattern) and mitochondrial and nuclear DNA sequence data. We distinguish six morphological (phenotypic) species groups within the gekkonid genus *Gekko*: the *G. gekko*, *G. japonicus*, *G. monarchus*, *G. petricolus*, *G. porosus*, and *G. vittatus* groups, all of which receive support from molecular phylogenetics. The taxon *G. reevesii*, formerly evaluated as a synonym of *G. gekko*, is revalidated herein at specific rank. Furthermore, a preliminary identification key of all currently recognized *Gekko* taxa is provided.

**Key words:** gekko, morphology, phylogeny, taxonomy, molecular phylogenetics, species groups, revalidation, *Gekko reevesii*, biogeography

## Introduction

The genus *Gekko* is a moderately species-rich genus of the Gekkonidae sensu stricto (Gamble *et al.* 2008a), comprising 45 named species, all of which have their native distributions in the Old World, from India eastwards to Melanesia. Members of the genus are typical of the family in possessing large eyes with transparent brilles, vertical pupils, and clutches of two calcareous-shelled eggs. They may be diagnosed within the Gekkonidae by their broad fingers and toes, all bearing undivided scansors and the absence of claws on digit I of the manus and pes. *Gekko* species are egg gluers, exhibit brood care, and include some of the most vocal of all geckos.

Biological knowledge of *Gekko* species is highly variable. Whereas, for example, morphology, ethology, reproduction, ecology and distribution are well known for species such as *G. badenii*, *G. gekko*, *G. grossmanni*, *G. monarchus*, *G. petricolus*, *G. smithii*, and *G. vittatus*, these data are only poorly known or completely lacking in other *Gekko* species. The best known species in the genus is *G. gekko*, which is regularly used as a research subject in interdisciplinary studies and experiments. Valuable basic knowledge about the biology of reptiles in general has been obtained by studying this species, for example in the fields of adhesion mechanisms (Autumn *et al.* 2002), endocrinology (Chiu *et al.* 1970, Chiu & Phillips 1971, 1972), ethology (e.g., Gonzales *et al.* 1990; Losos 1990; Brilllet & Paillette 1991; Bruce & Neary 1995 a, b; Tang *et al.* 2001), genetic divergence (Liu *et al.* 2000; Zhang *et al.* 2006; Qin *et al.* 2007), karyology (e.g., Cohen *et al.* 1967; Solleder & Schmidt 1984; Wu & Zhao 1984; Sharma & Kasid 1992; Du *et al.* 2002), morphology (e.g., Russell 1975, 1981, 1982; Maderson & Chiu 1981; Ma & Xia 1990; Russell & Bauer 1990; Moore *et al.* 1991; Hoogland *et al.* 1994; Loew 1994; Köppel & Authier 1995; Zhang *et al.* 1997; Zaaf *et al.* 2001; Chan *et al.* 2006), mitogenomics (Han & Zhou 2005; Zhou *et al.* 2006), neurobiology (e.g., Northcutt & Butler 1974; Stoll & Voorn 1985; Hoogland & Vermeulen-Vander Zee 1990, 1993, 1995; Smeets & Jomker 1990; Smeets *et al.* 2001;), physiology (e.g., Werner 1972; Chiu *et al.* 1985; Sievert & Hutchison 1988; Mirwald & Perry 1991; Rumping & Jayne 1996; Andrews & Bertram 1997), and vision (Yokoyama & Blow 2001).

The taxonomic history of the genus *Gekko* began with Laurenti 1768 (species typica *Lacerta gekko* Linnaeus, 1758, by tautonymy), who provided a diagnosis based, in part on Seba's (1734) statements and illustrations. By the end of the 19th century, only eight species were recognized in the genus *Gekko* (see Boulenger 1885). Subsequently, through the comprehensive research of Taylor (see Adler 1989) in the Philippines (1920–1921) and in Thailand (1958–1960), the number of species in the genus *Gekko* increased markedly (five *Gekko* species were described during that period, of which four are still valid). Three additional species were later described from the Philippines by Brown and Alcalá between 1962 and 1978.

In the most recent overview on gekkonid taxonomy, Kluge (2001) listed 28 species in the genus *Gekko*. Since 2004, fourteen additional *Gekko* species have been described: *G. ernstkelleri*, *G. scientiaventura*, and *G. canhi* (Rösler *et al.* 2005, 2006, 2010), *G. shibatani* and *G. vertebralis* (Toda *et al.* 2008), *G. nutaphandi* (Bauer *et al.* 2008), *G. russelltraini*, *G. takouensis*, and *G. canaensis* (Ngo *et al.* 2009; Ngo & Gamble 2010, 2011), *G. crombota* and *G. rossi* (Brown *et al.* 2008, 2009), *G. carusadensis* (Linkem *et al.* 2010), *G. vietnamensis* (Nguyen 2010) as well as *G. lauhachindaei* (Panitvong *et al.* 2010). In addition, some taxa listed as synonyms by Kluge (2001) have subsequently been revalidated (*G. melli*; Rösler *et al.* 2005) or their taxonomic status is still insufficiently resolved (*G. liboensis*, *G. mindorensis*, *G. scabridus*; Ferner *et al.* 2001, Kluge 2001, Zhao & Adler 1993). Nguyen *et al.* (2010) recently synonymized *G. ulikovskii* with *G. badenii*.