

A new species of *Cyrtodactylus* (Squamata: Gekkonidae) from the karst forest of northern Laos

NICOLE SCHNEIDER¹, TRUONG QUANG NGUYEN^{2,3,8}, MINH DUC LE^{4,5,6},
LIPHONE NOPHASEUD⁷, MICHAEL BONKOWSKI² & THOMAS ZIEGLER^{1,2}

¹AG Zoologischer Garten Köln, Riehler Straße 173, D-50735 Köln, Germany. E-mail: schneider.nicole87@googlemail.com and ziegler@koelnerzoo.de

²Zoological Institute, Department of Terrestrial Ecology, University of Cologne, Zülpicher Strasse 47b, D-50674 Cologne, Germany. E-mail: m.bonkowski@uni-koeln.de

³Institute of Ecology and Biological Resources, Vietnam Academy of Science and Technology, 18 Hoang Quoc Viet, Hanoi, Vietnam. Email: nqt2@yahoo.com

⁴Faculty of Environmental Sciences, Hanoi University of Science, Vietnam National University, 334 Nguyen Trai Road, Hanoi, Vietnam. E-mail: le.duc.minh@hus.edu.vn

⁵Centre for Natural Resources and Environmental Studies, Hanoi National University, 19 Le Thanh Tong, Hanoi, Vietnam

⁶Department of Herpetology, American Museum of Natural History, Central Park West at 79th Street, New York, New York 10024

⁷Faculty of Science, National University of Laos, Dong Dok Campus, Vientiane, Lao PDR. E-mail: nophasead2007@yahoo.com

⁸Corresponding author

Abstract

We describe a new species of the gekkonid genus *Cyrtodactylus* on the basis of two specimens collected from limestone forests of Luang Prabang Province, northern Laos. Morphologically, the new species is distinguishable from its congeners by a combination of the following diagnostic characters: maximum SVL 86.1 mm; supralabials 9 or 10; infralabials 7–9; dorsal tubercles in 15 or 16 rows at midbody; ventral scale rows 34–36 at midbody; precloacal groove absent; femoral scales not distinctly enlarged; precloacal pores absent in females (unknown in males); subdigital lamellae under the fourth finger 18 or 19, under the fourth toe 18–20; subcaudals not transversally enlarged; dorsal bands white, 4 or 5 between limb insertions plus another one between hind limbs; tail banded. Based on molecular analyses, the new species is clustered in the same clade with *C. wayakonei* and two other species from Luang Prabang and Houaphan provinces.

Key words: Bent-toed gecko, limestone forest, phylogeny, taxonomy, Luang Prabang Province

Introduction

With 186 recognized species, *Cyrtodactylus* is one of the most diverse genera of lizards in terms of species richness (Uetz & Hosek 2014). Since 2010, 63 species have been described in the genus and most of these new discoveries were from Southeast Asian countries (Nguyen *et al.* 2013; Ziegler *et al.* 2013; Grismer *et al.* 2014; Luu *et al.* 2014; Phung *et al.* 2014; Pauwels & Sumontha 2014; Pauwels *et al.* 2013, 2014; Schneider *et al.* 2014; Uetz & Hosek 2014). A major factor for the high species diversity of bent-toed geckos in Southeast Asia is the presence of a large area of tropical rain forest and a number of species complexes. For instance, 10 new species have been described within the *Cyrtodactylus irregularis* species complex from the Indochina region and eight new species were discovered in the *C. pulchellus* species complex from the Thai-Malay Peninsula (Grismer *et al.* 2012; Sumontha *et al.* 2012; Nguyen *et al.* 2013; Schneider *et al.* 2014). In Laos, nine species of *Cyrtodactylus* are currently recognized and seven of them have been recorded from limestone karst forests, namely *C. interdigitalis* Ulber, 1993 and *C. pageli* Schneider, Nguyen, Schmitz, Kingsada, Auer & Ziegler, 2011 from Vientiane Province; *C. lomyenensis* Ngo & Pauwels, 2010, *C. roesleri* Ziegler, Nazarov, Orlov, Nguyen, Vu, Dang, Dinh & Schmitz, 2010, and *C. jaegeri* Luu, Calame, Bonkowski, Nguyen & Ziegler, 2014 from Khammuane Province; *C. wayakonei* Nguyen, Kingsada, Rösler, Auer & Ziegler, 2010 from Luang Nam Tha Province; and *C. teyniei* David, Nguyen,

Acknowledgements

We are grateful to S. Wayakone, S. Bounphanmy, B. Praxaysombath (Vientiane) and V. Kanyasone (Luang Prabang) for supporting our field research in Laos. Export of collected specimens was done due to the export permit Nr. 139/13 signed by the CITES Management Authority of Lao PDR. T. Q. Nguyen thanks A. Teynié (Aubière), C. X. Le, T. H. Tran (Hanoi), T. Pagel (Cologne), W. Böhme and D. Rödder (Bonn) for support of his research. Thanks to H. T. Duong (Hanoi) for laboratory assistance. We are grateful to A. Bauer (Villanova), S. N. Nguyen (Ho Chi Minh City), and O. S. G. Pauwels (Brussels) for reviewing the manuscript. Thanks to E. Sterling (New York) and K. Koy (Berkeley) for providing the map. Field survey in Luang Prabang Province was funded by the Alexander von Humboldt Foundation for TQN (VIE 1143441) and Cologne Zoo for NS. Research of T. Q. Nguyen was funded by the Alexander von Humboldt Foundation (VIE 1143441).

References

- Bauer, A.M. (2002) Two new species of *Cyrtodactylus* (Squamata: Gekkonidae) from Myanmar. *Proceedings of the California Academy of Sciences*, 53, 73–86.
- Bauer, A.M. (2003) Descriptions of seven new *Cyrtodactylus* (Squamata: Gekkonidae) with a key to the species of Myanmar. *Proceedings of the California Academy of Sciences*, 54, 463–498.
- Bauer, A.M., Kunya, K., Sumontha, M., Niyomwan, P., Panitvong, N., Pauwels, O.S.G., Chanhome, L. & Kunya, T. (2009) *Cyrtodactylus erythrops* (Squamata: Gekkonidae), a new cave-dwelling gecko from Mae Hong Son Province, Thailand. *Zootaxa*, 2124, 51–62.
- Bauer, A.M., Kunya, K., Sumontha, M., Niyomwan, P., Pauwels, O.S.G., Chanhome, L. & Kunya, T. (2010) *Cyrtodactylus dumnnui* (Squamata: Gekkonidae), a new cave-dwelling gecko from Chiang Mai Province, Thailand. *Zootaxa*, 2570, 41–50.
- Bauer, A.M., Pauwels, O.S.G. & Chanhome, L. (2002) A new species of cave-dwelling *Cyrtodactylus* (Squamata: Gekkonidae) from Thailand. *The Natural History Journal of Chulalongkorn University*, 2, 19–29.
- Bauer, A.M., Sumontha, M. & Pauwels, O.S.G. (2003) Two new species of *Cyrtodactylus* (Reptilia: Squamata: Gekkonidae) from Thailand. *Zootaxa*, 376, 1–18.
- Blyth, E. (1859) Report of the Curator, Zoological Department, for February to May meetings, 1859. *Journal and Proceedings of the Asiatic Society of Bengal*, 28, 271–298.
- Blyth, E. (1861) Proceedings of the Society. Report of the Curator. *Journal and Proceedings of the Asiatic Society of Bengal*, xxix (1860), 87–115.
- Boulenger, G.A. (1893) Concluding report on the reptiles and batrachians obtained in Burma by Signor L. Fea, dealing with a collection made in Pegu and Karin Hills in 1887–1888. *Annali del Museo civico di storia naturale di Genova*, 2, 303–347.
- Chan-ard, T. & Makchai, S. (2011) A new insular species of *Cyrtodactylus* Gray, 1827 (Squamata, Gekkonidae), from the Surin Islands, Phang-nga Province, Southern Thailand. *The Thailand Natural History Museum Journal*, 5, 7–15.
- Darevsky, I.S. & Szczerbak, N.N. (1997) A new gecko of the genus *Gonydactylus* (Sauria: Gekkonidae) with a key to the species from Vietnam. *Asiatic Herpetological Research*, 7, 19–22.
- David, P., Nguyen, T.Q., Schneider, N. & Ziegler, T. (2011) A new species of the genus *Cyrtodactylus* Gray, 1827 from central Laos (Squamata: Gekkonidae). *Zootaxa*, 2833, 29–40.
- David, P., Teynié, A. & Ohler, A. (2004) A new species of *Cyrtodactylus* Gray 1827 (Reptilia: Squamata: Gekkonidae) from southern Laos. *The Raffles Bulletin of Zoology*, 52, 621–627.
- Geissler, P., Nazarov, R., Orlov, N.L., Böhme, W., Phung, T.M., Nguyen, T.Q. & Ziegler, T. (2009) A new species of the *Cyrtodactylus irregularis* complex (Squamata: Gekkonidae) from southern Vietnam. *Zootaxa*, 2161, 20–32.
- Gray, J.E. (1828) A synopsis of the genera of Saurian reptiles in which some new genera are indicated, and the others reviewed by actual examination. *Philosophical Magazine, London*, 2, 54–58.
- Grismar, L.L., Belabut, D.M., Quah, E.S.H., Chan, K.O., Wood, P.L. & Hasim, R. (2014) A new species of karst forest-adapted Bent-toed Gecko (genus *Cyrtodactylus* Gray, 1827) belonging to the *C. swoderi* complex from a threatened karst forest in Perak, Peninsular Malaysia. *Zootaxa*, 3755 (5), 434–446.
<http://dx.doi.org/10.11646/zootaxa.3755.5.3>
- Grismar, L.L., Wood, P.L., Quah, E.S.H., Anuar, S., Muin, M.A., Sumontha, M., Ahmad, N., Bauer, A.M., Wangkulangkul, S., Grismar, J.L. & Pauwels, O.S.G. (2012) A phylogeny and taxonomy of the Thai-Malay Peninsula Bent-toed Geckos of the *Cyrtodactylus pulchellus* complex (Squamata: Gekkonidae): combined morphological and molecular analyses with descriptions of seven new species. *Zootaxa*, 3520, 1–55.
- Heidrich, A., Rösler, H., Vu, N.T., Böhme, W. & Ziegler, T. (2007) Another new *Cyrtodactylus* (Squamata: Gekkonidae) from Phong Nha – Ke Bang National Park, central Truong Son, Vietnam. *Zootaxa*, 1445, 35–48.
- Hoang, Q.X., Orlov, N.L., Ananjeva, N.B., Johns, A.G., Hoang, T.N. & Dau, V.Q. (2007) Description of a new species of the genus *Cyrtodactylus* Gray, 1827 (Squamata: Sauria: Gekkonidae) from the karst of North Central Vietnam. *Russian*

- Journal of Herpetology*, 14, 98–106.
- Ivanova, N.V., de Waard, J. & Hebert, P.D.N. (2006) An inexpensive, automation-friendly protocol for recovering high-quality DNA. *Molecular Ecology Notes*, 6, 998–1002.
- Le, M., Raxworthy, C.J., McCord, W.P. & Mertz, L. (2006) A molecular phylogeny of tortoises (Testudines: Testudinidae) based on mitochondrial and nuclear genes. *Molecular Phylogenetics and Evolution*, 40, 517–531.
<http://dx.doi.org/10.1016/j.ympev.2006.03.003>
- Luu, V.Q., Calame, T., Bonkowski, M., Nguyen, T.Q. & Ziegler, T. (2014) A new species of *Cyrtodactylus* (Squamata: Gekkonidae) from Khammouane Province, Laos. *Zootaxa*, 3760 (1), 54–66.
<http://dx.doi.org/10.11646/zootaxa.3760.1.3>
- Luu, V.Q., Nguyen, T.Q., Calame, T., Hoang, T.T., Southichack, S., Bonkowski, M. & Ziegler, T. (2013) New country records of reptiles from Laos. *Biodiversity Data Journal*, 1, 1–14.
<http://dx.doi.org/10.3897/bdj.1.e1015>
- Luu, V.Q., Nguyen, T.Q., Do, H.Q. & Ziegler, T. (2011) A new *Cyrtodactylus* (Squamata: Gekkonidae) from Huong Son limestone forest, Hanoi, northern Vietnam. *Zootaxa*, 3129, 39–50.
- Mahony, S. (2009) Taxonomic status of *Cyrtodactylus khasiensisiamaiensis* (Smith, 1940) and description of a new species allied to *C. chrysopylos* Bauer, 2003 from Myanmar (Reptilia: Gekkonidae). *Hamadryad*, 34, 62–74.
- Nazarov, R.A., Orlov, N.L., Nguyen, S.N. & Ho, C.T. (2008) Taxonomy of naked-toe geckos *Cyrtodactylus irregularis* complex of South Vietnam and description of a new species from Chu Yang Sin Natural Park (Krong Bong District, Dac Lac Province, Vietnam). *Russian Journal of Herpetology*, 15, 141–156.
- Nazarov, R., Poyarkov, N.A., Orlov, N.L., Phung, T.M., Nguyen, T.T., Hoang, D.M. & Ziegler, T. (2012) Two new cryptic species of the *Cyrtodactylus irregularis* complex (Squamata: Gekkonidae) from southern Vietnam. *Zootaxa*, 3302, 1–24.
- Ngo, T.V. (2008) Two new cave-dwelling species of *Cyrtodactylus* Gray (Squamata: Gekkonidae) from Southwestern Vietnam. *Zootaxa*, 1909, 37–51.
- Ngo, T.V. (2011) *Cyrtodactylus martini*, another new karst-dwelling *Cyrtodactylus* Gray, 1827 (Squamata: Gekkonidae) from Northwestern Vietnam. *Zootaxa*, 2834, 33–46.
- Ngo, T.V. (2013) *Cyrtodactylus dati*, a new forest dwelling Bent-toed Gecko (Squamata: Gekkonidae) from southern Vietnam. *Zootaxa*, 3616 (2), 151–164.
<http://dx.doi.org/10.11646/zootaxa.3616.2.4>
- Ngo, T.V. & Bauer, A.M. (2008) Descriptions of two new species of *Cyrtodactylus* Gray, 1827 (Squamata: Gekkonidae) endemic to southern Vietnam. *Zootaxa*, 1715, 27–42.
- Ngo, T.V. & Chan, K.O. (2010) A new species of *Cyrtodactylus* Gray, 1826 (Squamata: Gekkonidae) from Khanh Hoa Province, southern Vietnam. *Zootaxa*, 2504, 47–60.
- Ngo, T.V. & Chan, K.O. (2011) A new karstic cave-dwelling *Cyrtodactylus* Gray (Squamata: Gekkonidae) from Northern Vietnam. *Zootaxa*, 3125, 51–63.
- Ngo, T.V. & Grismer, L.L. (2010) A new karst dwelling *Cyrtodactylus* (Squamata: Gekkonidae) from Son La Province, northwestern Vietnam. *Hamadryad*, 35, 84–95.
- Ngo, T.V. & Grismer, L.L. (2012) A new endemic species of *Cyrtodactylus* Gray (Squamata: Gekkonidae) from Tho Chu Island, southwestern Vietnam. *Zootaxa*, 3228, 48–60.
- Ngo, T.V., Grismer, L.L. & Grismer, J.L. (2008) A new endemic cave dwelling species of *Cyrtodactylus* Gray, 1827 (Squamata: Gekkonidae) in Kien Giang Biosphere Reserve, Southwestern Vietnam. *Zootaxa*, 1967, 53–62.
- Ngo, T.V., Grismer, L.L. & Grismer, J.L. (2010) A new species of *Cyrtodactylus* Gray, 1827 (Squamata: Gekkonidae) in Phu Quoc National Park, Kien Giang Biosphere Reserve, Southwestern Vietnam. *Zootaxa*, 2604, 37–51.
- Ngo, T.V. & Pauwels, O.S.G. (2010) A new cave-dwelling species of *Cyrtodactylus* Gray, 1827 (Squamata: Gekkonidae) from Khammuane Province, southern Laos. *Zootaxa*, 2730, 44–56.
- Nguyen, S.N., Le, N.T.T., Tran, D.T.A., Orlov, N.L., Lathrop, A., Macculloch, R.D., Le, D.T.T., Jin, J.-Q., Nguyen, L.T., Nguyen, T.T., Hoang, D.D., Che, J., Murphy, R.W. & Zhang, Y.-P. (2013) Phylogeny of the *Cyrtodactylus irregularis* species complex (Squamata: Gekkonidae) from Vietnam with the description of two new species. *Zootaxa*, 3737 (4), 399–414.
<http://dx.doi.org/10.11646/zootaxa.3737.4.4>
- Nguyen, S.N., Orlov, N.L. & Darevsky, I.S. (2006) Descriptions of two new species of the genus *Cyrtodactylus* Gray, 1827 (Squamata: Sauria: Gekkonidae) from southern Vietnam. *Russian Journal of Herpetology*, 13, 215–226.
- Nguyen, T.Q., Kingsada, P., Rösler, H., Auer, M. & Ziegler, T. (2010) A new species of *Cyrtodactylus* (Squamata: Gekkonidae) from northern Laos. *Zootaxa*, 2652, 1–16.
- Orlov, N.L., Nguyen, Q.T., Nazarov, R.A., Ananjeva, N.B. & Nguyen, S.N. (2007) A new species of the genus *Cyrtodactylus* Gray, 1827 and redescription of *Cyrtodactylus paradoxus* (Darevsky et Szczerbak, 1997) [Squamata: Sauria: Gekkonidae]. *Russian Journal of Herpetology*, 14, 145–152.
- Pauwels, O.S.G., Bauer, A.M., Sumontha, M. & Chanhome, L. (2004) *Cyrtodactylus thirakhupti* (Squamata: Gekkonidae), a new cave-dwelling gecko from southern Thailand. *Zootaxa*, 772, 1–11.
- Pauwels, O.S.G. & Sumontha, M. (2014) *Cyrtodactylus samroiyot*, a new limestone-dwelling Bent-toed Gecko (Squamata: Gekkonidae) from Prachuap Khiri Khan Province, peninsular Thailand. *Zootaxa*, 3755 (6), 573–583.
<http://dx.doi.org/10.11646/zootaxa.3755.6.4>

- Pauwels, O.S.G., Sumontha, M., Latinne, A. & Grismer, L.L. (2013) *Cyrtodactylus sanook* (Squamata: Gekkonidae), a new cave-dwelling gecko from Chumphon Province, southern Thailand. *Zootaxa*, 3635 (3), 275–285.
<http://dx.doi.org/10.11646/zootaxa.3635.3.7>
- Pauwels, O.S.G., Sumontha, M., Panitvong, N. & Varaguttanonda, V. (2014) *Cyrtodactylus khelangensis*, a new cave-dwelling Bent-toed Gecko (Squamata:Gekkonidae) from Lampang Province, northern Thailand. *Zootaxa*, 3755 (6), 584–594.
<http://dx.doi.org/10.11646/zootaxa.3755.6.5>
- Peters, W. (1871) Über neue Reptilien aus Ostafrika und Sarawak (Borneo), vorzüglich aus der Sammlung des Hrn. Marquis J. Doria zu Genua. *Königlich Preussische Akademie der Wissenschaften zu Berlin*, 566–581.
- Phung, T.M., van Schingen, M., Ziegler, T. & Nguyen, T.Q. (2014) A third new *Cyrtodactylus* (Squamata: Gekkonidae) from Ba Den Mountain, Tay Ninh Province, southern Vietnam. *Zootaxa*, 3764 (3), 347–363.
<http://dx.doi.org/10.11646/zootaxa.3764.3.5>
- Posada, D. & Crandall, K.A. (1998) MODELTEST: testing the model of DNA substitution. *Bioinformatics*, 14, 817–818.
<http://dx.doi.org/10.1093/bioinformatics/14.9.817>
- Ronquist, F., Teslenko, M., van der Mark, P., Ayres, D.L., Darling, A., Höhna, S., Larget, B., Liu, L., Suchard, M.A. & Huelsenbeck, J.P. (2012) MrBayes 3.2: efficient Bayesian phylogenetic inference and model choice across a large model space. *Systematic Biology*, 61, 539–542.
<http://dx.doi.org/10.1093/sysbio/sys029>
- Rösler, H., Vu, T.N., Nguyen, T.Q., Ngo, T.V. & Ziegler, T. (2008) A new *Cyrtodactylus* (Squamata: Gekkonidae) from central Vietnam. *Hamadryad*, 32, 125–140.
- Schneider, N., Nguyen, T.Q., Schmitz, A., Kingsada, P., Auer, M. & Ziegler, T. (2011) A new species of karst dwelling *Cyrtodactylus* (Squamata: Gekkonidae) from northwestern Laos. *Zootaxa*, 2930, 1–21.
- Schneider, N., Phung, T.M., Le, M.D., Nguyen, T.Q. & Ziegler, T. (2014) A new *Cyrtodactylus* (Squamata: Gekkonidae) from Khanh Hoa Province, southern Vietnam. *Zootaxa*, 3785 (4), 518–532.
<http://dx.doi.org/10.11646/zootaxa.3785.4.2>
- Smith, M.A. (1917) Descriptions of new reptiles and a new batrachian from Siam. *Journal of the Natural History Society of Siam*, 2, 221–225.
- Smith, M.A. (1920) Reptiles and batrachians collected on Pulo Condore. *Journal of Natural History Society of Siam*, 4, 93–97.
- Smith, M.A. (1921) New or little-known reptiles and batrachians from southern Annam (Indo-China). *Proceedings of the Zoological Society of London*, 1921, 423–440.
- Smith, M.A. (1923) Notes on reptiles and batrachians from Siam and Indo-China (No. 2). *Journal of the Natural History Society of Siam, London*, 6, 47–53.
- Smith, M.A. (1940) The amphibians and reptiles obtained by Mr. Ronald Kaulback in Upper Burma. *Records of the Indian Museum*, 42, 465–486.
- Sumontha, M., Panitvong, N. & Deelin, G. (2010) *Cyrtodactylus auribalteatus* (Squamata: Gekkonidae), a new cave-dwelling gecko from Phitsanulok Province, Thailand. *Zootaxa*, 2370, 53–64.
- Sumontha, M., Pauwels, O.S.G., Kunya, K., Nitkul, A., Samphanthamit, P. & Grismer, L.L. (2012) A new forest-dwelling gecko from Phuket Island, Southern Thailand, related to *Cyrtodactylus macrotuberculatus* (Squamata: Gekkonidae). *Zootaxa*, 3522, 61–72.
- Swofford, D.L. (2001) PAUP*. *Phylogenetic Analysis Using Parsimony (* and Other Methods)*, version 4. Sinauer Associates, Sunderland, Massachusetts.
- Taylor, E.H. (1962) New oriental reptiles. *The University of Kansas Science Bulletin*, 43, 209–263.
- Theobald, W. (1876) Descriptive catalogue of the reptiles of British India. *Thacker, Spink & Co., Calcutta*, xiii, 238 pp.
- Teynié, A. & David, P. (2010) *Voyages naturalistes au Laos. Les Reptiles*. Editions Revoir, Nohantent, France, 315 pp.
- Thompson, J.D., Gibson, T.J., Plewniak, F., Jeanmougin, F. & Higgins, D.G. (1997) The ClustalX windows interface: Flexible strategies for multiple sequence alignment aided by quality analysis tools. *Nucleic Acids Research*, 25, 4876–4882.
- Uetz, P. & Hosek, J. (Eds.) (2014) The Reptile Database. Available from: <http://www.reptile-database.org> (accessed 1 April 2014)
- Ulber, T. (1993) Bemerkungen über cyrtodactyline Geckos aus Thailand nebst Beschreibungen von zwei neuen Arten (Reptilia: Gekkonidae). *Mitteilungen aus dem Zoologischen Museum in Berlin*, 69, 187–200.
<http://dx.doi.org/10.1002/mmnz.19930690202>
- Ziegler, T., Nazarov, R., Orlov, N., Nguyen, T.Q., Vu, T.N., Dang, K.N., Dinh, T.H. & Schmitz, A. (2010) A third new *Cyrtodactylus* (Squamata: Gekkonidae) from Phong Nha – Ke Bang National Park, Vietnam. *Zootaxa*, 2413, 20–36.
- Ziegler, T., Phung, T.M., Le, M.D. & Nguyen, T.Q. (2013) A new *Cyrtodactylus* (Squamata: Gekkonidae) from Phu Yen Province, southern Vietnam. *Zootaxa*, 3686 (4), 432–446.
<http://dx.doi.org/10.11646/zootaxa.3686.4.2>
- Ziegler, T., Rösler, H., Herrmann, H.-W. & Vu, T.N. (2002) *Cyrtodactylus phongnhakebangensis* sp. n., ein neuer Bogenfingergecko aus dem annamitischen Karstwaldmassiv, Vietnam. *Herpetofauna*, 24, 11–25.