

ORIGINAL ARTICLE

Out of the trap: A new phytohelm-breeding species of *Philautus* and an updated phylogeny of Bornean bush frogs (Anura: Rhacophoridae)

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Abstract

Bush frogs of the genus *Philautus* are a species-rich group of the Asian tree frogs Rhacophoridae, which are known for their diverse reproductive biology. Within *Philautus*, reproduction has been described via endotrophic tadpoles and by direct terrestrial development. Here, we provide results of phylogenetic analyses based on the most comprehensive sampling of Bornean *Philautus* to date. As a result of an integrative taxonomic study using mitochondrial and nuclear markers, along with morphological and bioacoustic data, we describe a spectacular new species of this genus from the island of Borneo. The ecology of the new species of *Philautus* is closely associated with the carnivorous pitcher plant, *Nepenthes mollis*. The unusually large eggs are laid in the fluid of the pitcher and the endotrophic tadpoles, characterized by reduced mouthparts, small oral orifice and large intestinal yolk mass, complete their development in this environment. Molecular data and synapomorphic larval characters support the sister group relationship of the new species to *P. macroscelis*: both belong to the early diverged lineages in the *Philautus* tree, whose phylogenetic relationships could not be fully resolved. The new record of endotrophic tadpoles challenges again the hypothesis that terrestrial direct development is the plesiomorphic mode in this genus. Further, we discuss the nature of the frog-plant interaction that could represent a new case of mutualism. The frog provides the plant with a source of nitrogen by depositing yolk-rich eggs in the liquid of the pitcher. The plant, on the other hand, offers an exclusively protected space for the development of tadpoles in a habitat that otherwise has few permanent bodies of water and many competing frog species.

KEYWORDS

direct development, endotrophy, evolution, mutualism, *Nepenthes*

Abstrakt

Die artenreiche Gattung *Philautus* gehört zu den Ruderfröschen (Rhacophoridae), die für ihre vielfältige Fortpflanzungsbiologie bekannt sind. Innerhalb von *Philautus* wurde bisher die Fortpflanzung mit endotrophen Kaulquappen und durch Direktentwicklung