

# Multiple-step vertical colonization of the subterranean environment: Brazilian troglobitic catfishes as case studies

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Authors :

Name	Email	Country
Trajano Eleonora	etrajano@usp.br	Brazil
Bichuette Maria Elina	bichuette@uol.com.br	Brazil

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A two-step vertical colonization model has been hypothesized to explain the coexistence of adaptations to small, confined spaces and to large spaces in the troglobitic catfish, *Rhamdiopsis krugi* (Siluriformes: Heptapteridae) found in the upper phreatic zone in Chapada Diamantina karst area, northeastern Brazil. Such adaptations are, respectively, miniaturization, reduction of lateral line, and slender, sinuous body, and very developed pseudotympanum and broadened head and snout. Herein, we propose a further step, which is the adaptation to the deep phreatic zone, for *Rhamdiopsis* sp. from the contiguous Campo Formoso karst area, characterized by dark pink coloration of skin (for hypoxic conditions), large amount of subdermal fatty tissue reserves and very slow growth rate, with extremely high longevity (up to 30+ years in laboratory) (for nutrient deprivation). Likewise, a multiple step model is proposed for troglobitic catfishes genus *Ituglanis* (Siluriformes: Trichomycteridae) from São Domingos karst area, Central Brazil. Colonization of the subterranean realm through the epikarst would explain miniaturization, as observed in *I. epikarsticus*, followed by occupation of larger spaces below it. Dispersion through epikarst explains the disjunct distribution of these catfishes inside caves. *I. bambui* and *I. ramiroi* are typical dwellers of slow-moving waters in caves. A third step, adaptation to life in a food-rich lotic environment, would account for a secondary increase on body size observed in *Ituglanis passensis*, that retains the lowered number of vertebrae and reduced lateral line as a trace of past miniaturization.