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The identity of the Javan Krait, *Bungarus javanicus* Kopstein, 1932 (Squamata: Elapidae): evidence from mitochondrial and nuclear DNA sequence analyses and morphology

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Abstract

The Javan Krait (*Bungarus javanicus* Kopstein, 1932) was described on the basis of a single specimen that had been discovered subsequent to its delivery of lethal bites to two sleeping people in a rice field hut. Until 1936, only two additional specimens were found in the vicinity of the type locality near Cirebon on the north coast of West Java province, Indonesia. The taxonomic status of *B. javanicus* has remained doubtful due to its great similarity to the common and widely distributed Malayan Krait (*Bungarus candidus*), from which it was distinguished only by its black (*vs.* black-and-white banded) colouration. We rediscovered *B. javanicus* near its type locality in 1993 and obtained substantial series of black kraits in West and Central Java provinces in 1996 and 1998. We provide a detailed redescription of the type specimen and the two other specimens of *B. javanicus* available to Kopstein. We then use nucleotide sequences of the mitochondrial cytochrome *b* gene to estimate relationships among 27 black and black-and-white banded kraits from Java and Bali. In addition, we use exon-primed intron-crossing primers to analyze a sequence segment of the alpha-bungarotoxin (A31) gene from ten black and black-and-white banded kraits from these islands. Four mitochondrial haplotypes were identified which exhibited minimal sequence divergence and no correlation to colouration. In particular, both external phenotypes were found in the same genealogical lineage near Indramayu, where black kraits and black-and-white banded *B. candidus* occur in syntopy. Neither the nucleotide sequence of intron 2 nor partial exon 2 and 3 sequences of the alpha-bungarotoxin (A31) gene exhibited variation within the sample from Java and Bali. Intron 2 sequence divergence between the Javan kraits and the closely related *Bungarus multicinctus* is 1.1%. Morphological examination of specimens of *B. javanicus* and *B. candidus* from Java revealed no differences beyond colouration. The combined evidence identifies the locally strong populations of black kraits in Java as conspecific with local *B. candidus*. Their regional dichromatism includes two fundamentally different patterns for predator avoidance, and is interpreted as the result of increased genetic fixation of mutations in one or several instable genes (which can cause similar pattern abnormalities in various species of *Bungarus*), in the course of the colonization of the alluvial plains of northern Java. These plains are of very recent origin and likely offered selective pressures different from those in older parts of the island, rendering both black and black-and-white banded phenotypes successful in predator avoidance.

Key words: Reptilia, Squamata, Elapidae, *Bungarus*, *Bungarus candidus*, *Bungarus javanicus*, *Bungarus multicinctus*, alpha-bungarotoxin, Bali, biogeography, cytochrome *b*, ecomorph, genetic differentiation, Indonesia, intron, Java, mitochondrial DNA, molecular taxonomy, morphological characters, nuclear DNA, snake, Southeast Asia, venomous

Introduction

In the night from 3 to 4 July 1931, two men sleeping in a hut on a paddy field near the village Matanghadji in north-western Java were bitten by a black snake. Almost immediately after killing the snake, both men suf-

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