

# Molecular phylogenetics and evolutionary history of the endemic land snail genus *Everettia* in northern Borneo

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## ABSTRACT

Borneo has gone through dramatic changes in geology and topography from the early Eocene until the early Pliocene and experienced climatic cycling during the Pleistocene. However, how these changes have shaped the present-day patterns of high diversity and complex distribution are still poorly understood. In this study, we use integrative approaches by estimating phylogenetic relationships, divergence time, and current and past niche suitability for the Bornean endemic land snail genus *Everettia* to provide additional insight into the evolutionary history of this genus in northern Borneo in the light of the geological vicariance events and climatic fluctuations in the Pleistocene. Our results show that northern Borneo *Everettia* species belong to two deeply divergent lineages: one contains the species that inhabit high elevation at the central mountain range, while the other contains lowland species. Species diversification in these lineages has taken place before the Pliocene. Climate changes during the Pleistocene did not play a significant role in species diversification but could have shaped contemporary species distribution patterns. Our results also show that the species-rich highland habitats have acted as interglacial refugia for highland species. This study of a relatively sedentary invertebrate supports and enhances the growing understanding of the evolutionary history of Borneo. Species diversification in *Everettia* is caused by geological vicariance events between the early Miocene and the Pliocene, and the distribution patterns were subsequently determined by climatic fluctuations in the Pleistocene.

**Subjects** Biodiversity, Biogeography, Ecology, Evolutionary Studies, Zoology

**Keywords** Mount Kinabalu, Sabah, Sarawak, Kalimantan, Dyakiidae, Mount Tambuyukon, Biogeography, Species distribution modelling

## BACKGROUND

Borneo, the third-largest island in the world, is one of the Earth's biodiversity hotspots (*Mackinnon et al., 1996; Myers et al., 2000*). Its biodiversity has been shaped by a long

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