

Cryptic Diversity: Identifying Two Morphologically Similar Species of Invasive Apple Snails in Peninsular Malaysia

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Abstract : Invasive snails in the genus *Pomacea* have spread across Southeast Asia including Peninsular Malaysia. Apart from significant economic costs to wetland crops, very little is known about the snails' effects on native species, and wetland function through their alteration of macrophyte communities. This study was conducted to establish diagnostic characteristics of *Pomacea* species in the Malaysian environment using genetic and morphological criteria. Snails were collected from eight localities in northern and central regions of Peninsular Malaysia. The mitochondrial COI gene of 52 adult snails was amplified and sequenced. Maximum likelihood analysis was used to analyse species identity and assess phylogenetic relationships among snails from different geographic locations. Shells of the two species were compared using geometric morphometric analysis and covariance analyses. Shell height accounted for most of the observed variation between *P. canaliculata* and *P. maculata*, with the latter possessing a smaller mean ratio of shell height: aperture height ($p < 0.0001$) and shell height to shell width (give $p < 0.0001$). Genomic and phylogenetic analysis demonstrated the presence of two monophyletic taxa, *P. canaliculata* and *P. maculata*, in Peninsular Malaysia samples. *P. maculata* co-occurred with *P. canaliculata* in 5 localities, but samples from 3 localities contained only *P. canaliculata*. This study is the first to confirm the presence of two of the most invasive species of *Pomacea* in Peninsular Malaysia using a genomic approach. *P. canaliculata* appears to be the more widespread species. Despite statistical differences, both quantitative and qualitative morphological characteristics demonstrate much interspecific overlap and intraspecific variability; thus morphology alone cannot reliably verify species identity. Molecular techniques for distinguishing between these two highly invasive *Pomacea* species are needed to understand their specific ecological niches and develop effective protocols for their management.

Keywords : *Pomacea canaliculata*, *Pomacea maculata*, invasive species, phylogenetic analysis, geometric morphometric analysis

Conference Title : ICCB 2017 : International Conference on Conservation Biology

Conference Location : Singapore, Singapore

Conference Dates : November 09-10, 2017