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Delineating *Paralaoma annabelli*, a Minute Land Snail Impacted by the 2019–2020 Wildfires in Australia

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Abstract. The 2019–2020 megafires in eastern Australia have devastated large parts of the known distributional range of the minute land snail *Paralaoma annabelli*, prompting conservation concerns for this species. However, this species is poorly defined thus hampering its accurate identification and the delineation of its distribution. Most crucially, it has been questionable if and how *P. annabelli* could be distinguished from another Australian congener, *Paralaoma morti.* This systematic ambiguity posed a problem in assessing the impact of the 2019–2020 wildfires in Australia on this species. Herein, we demonstrate, based on comparative morphometrics as well as analyses of mitochondrial and nuclear DNA, that *P. annabelli* is indeed distinct from a second widespread species of *Paralaoma*, which is identified as *P. morti* by some workers. Yet, sequences of *P. morti* cluster closely with non-Australian sequences of the globally distributed species *P. servilis*. Therefore, the taxonomic status of *P. morti* in relation to *P. servilis* remains to be investigated.

Our comparative morphological analyses revealed that *P. annabelli* is significantly smaller than *P. morti*, has a significantly flatter shell, more elongated aperture, lower spire, and tighter coiling whorls. With the revised diagnosis of *P. annabelli*, we have delineated its distribution in New South Wales based on the examination of all available museum samples. We show that *P. annabelli* is primarily found at higher elevations in the Great Dividing Range while *P. morti* is widespread in eastern Australia. In addition, molecular phylogenetic analyses reveal that the genera *Pseudiotula*, *Iotula*, *Trocholaoma* and *Miselaoma*, all described based only on shell characteristics, form a single clade with the abovementioned species of *Paralaoma*. This reveals the inadequacies of a purely shell-based taxonomy in punctids and highlights the need for a more integrative approach to punctid systematics.

Introduction

In the aftermath of the 2019–2020 megafires in eastern Australia, which were unprecedented in both scale and severity (Boer *et al.*, 2020; Collins *et al.*, 2021), over 60 species of native Australian land snails were identified to be of particular conservation concern, as substantial parts of their known distributions had been burnt by these fires (Hyman *et al.*, 2020; Marsh *et al.*, 2021; Legge *et al.*, 2022).

The minute punctid land snail *Paralaoma annabelli* Shea & Griffiths, 2010 endemic to south-eastern Australia, is one of the species of conservation concern, as up to 38%

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