Zootaxa 3390: 1–18 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

Molecular phylogeny and morphological revision of the *Ctenotus labillardieri* (Reptilia: Squamata: Scincidae) species group and a new species of immediate conservation concern in the southwestern Australian biodiversity hotspot

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Abstract

Ctenotus is the largest and most diverse genus of skinks in Australia with at least 97 described species. We generated large mitochondrial and nuclear DNA data sets for 70 individuals representing all available species in the *C. labillardieri* species-group to produce the first comprehensive phylogeny for this clade. The widespread *C. labillardieri* was sampled extensively to provide the first detailed phylogeographic data set for a reptile in the southwestern Australian biodiversity hotspot. We supplemented our molecular data with a comprehensive morphological dataset for the entire group, and together these data are used to revise the group and describe a new species. The morphologically highly variable species *C. labillardieri* comprises seven well-supported genetic clades that each occupy distinct geographic regions. The phylogeographic patterns observed in this taxon are consistent with studies of frogs, plants and invertebrates, adding strength to emerging biogeographic hypotheses in this iconic region. The species *C. catenifer*, *C. youngsoni*, and *C. gemmula* are well supported, and despite limited sampling both *C. catenifer* and *C. gemmula* show substantial genetic structure. The threatened *C. lancelini* from Lancelin Island and the adjacent mainland is the sister taxon to a new species from the Swan Coastal Plain, which we describe as *C. ora* **sp. nov.** This species is a habitat specialist, occurring primarily in sandy regions south of Perth that currently are under intense development. *Ctenotus ora* **sp. nov.** should be considered for conservation attention immediately.

Key words: cryptic species, lizard, skink, ND2, ATP, southwestern Australia, biodiversity hotspot, Swan Coastal Plain

Introduction

Southwestern Australia (SWA) is an iconic region, increasingly renowned for its high levels of biodiversity and endemism. It is recognized as one of the world's top 25 "biodiversity hotspots" (Cincotta *et al.* 2000; Myers *et al.* 2000), based largely on its highly diverse and endemic flora (Beard *et al.* 2000). More recent phylogeographic studies on SWA plants have demonstrated that plant genetic diversity is even more extreme than previously thought, with current taxonomy a gross underestimate of the true diversity (Byrne *et al.* 2003a,b; Hopper & Gioia 2004; Byrne & Hines 2004; Byrne 2007; Byrne & Hopper 2008;). A similar theme is emerging from genetic studies on SWA animals, including frogs (Driscoll 1998a,b; Berry 2001; Edwards 2007a,b; Edwards *et al.* 2007, 2008; Morgan *et al.* 2007), and invertebrates (Main 1996, 1999; Horwitz & Adams 2000; Gouws *et al.* 2006; Cooper *et al.* 2011; Rix & Harvey 2012).

Combining what is know about phylogeographic patterns of SWA taxa, it appears that major climatic and physical features occurring across SWA have been important in regional diversification. Climatic features, including strong rainfall and temperature gradients, have provided barriers to gene flow between Hopper's (1979) High Rainfall Zone (HRZ) and Transitional Rainfall Zone (TRZ) of SWA (Dodson & Macphail 2004; Hopper & Gioia 2004) (Figure 1). Furthermore, physical barriers including the subdued mountains of the Stirling Ranges and Darling Scarp, and granite outcrops, seem important for diversification (Wheeler & Byrne 2006; Yates *et al.* 2007; Byrne & Hopper 2008; Rix & Harvey 2012), especially in coastal areas subject to eustatic sea-level fluctuations (Rabosky *et al.* 2004; Edwards 2008). Southwestern Australia also has been divided into a number of biogeographic subregions (Interim Biogeographic Regionalisation of Australia [IBRA]) based on broad landscape distinc-

Accepted by L.L. Grismer: 15 May 2012; published: 17 Jul. 2012