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**DE VIS' BANDED SNAKE, *DENISONIA DEVISI* (SQUAMATA: ELAPIDAE):  
AN ADDITION TO THE ELAPID FAUNA OF SOUTH AUSTRALIA WITH  
NOTES ON ITS ECOLOGY AND CONSERVATION**

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**Abstract.**—Human-mediated disturbances appear to be ever-increasing and wide-ranging, and if we are to mitigate biodiversity loss, it is essential that we continue to survey and monitor both poorly known and well-understood ecosystems. This recommendation may be especially relevant for Australian herpetofauna, including many snake taxa, as many species are small, morphologically and/or behaviorally cryptic, and occur in specialized ecosystems. Here, we describe a westerly range extension and present the first records of the De Vis' Banded Snake (*Denisonia devisi*) in South Australia. We also describe the habitat and our observations of behavior, foraging, and refugia, and discuss potential conservation concerns and recommendations for this newly discovered population. Our discovery contextualizes the need for ongoing fauna surveys, especially near jurisdictional borders. Detection of new populations of fringing taxa will undoubtedly continue to occur across Australia and may have implications for conservation management.

**Key Words.**—batrachophagy; Chowilla floodplain; *Litoria raniformis*; Murray River; range extension; riparian; reptile; wetland

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#### INTRODUCTION

Human-mediated disturbances appear to be ever-increasing and wide-ranging, producing habitat degradation, fragmentation, and destruction; loss of biodiversity; and potentially irreversible consequences for essential ecosystem processes (Loreau et al. 2001; Sinclair and Byrom 2006; Murphy and Romanuk 2014). These effects may also be compounded by climate change (Reed et al. 2010; Pereira et al. 2012; Bowler et al. 2019), emphasizing the urgency for greater biodiversity conservation efforts. Therefore, if we are to mitigate biodiversity loss, it is essential that we continue to monitor not only remote or poorly understood ecosystems, but also areas with extensive survey histories if we are to identify any changes to biodiversity, including the discovery of species that may have been undetected in the past (Lindenmayer et al. 2012; Baumgardt et al. 2021). This recommendation may be especially relevant for Australian herpetofauna, as many species are small, morphologically and/or behaviorally cryptic, or occur in restricted or specialized ecosystems (How and Shine 1999; Geyle et al. 2021). The literature detailing new records and distribution extensions for Australian reptile taxa is voluminous

(e.g., Read 1994; Macdonald et al. 2013; Clemann et al. 2016; Scott and Biffin 2021; Beranek et al. 2022), and through taxonomic reappraisals, novel survey techniques, or monitoring jurisdictional boundaries, new populations may be encountered (e.g., Miller and Schwaner 1982; Schwaner and Miller 1984; Clemann et al. 2007; Madani 2020; Michael et al. 2020).

Australia hosts a diverse assemblage of native snakes, the majority of which are terrestrial elapids (Elapidae; Greer 1997; Cabrelli et al. 2014). Australian elapids are continentally widespread and diverse, numbering over 100 species across 26 genera (Wilson and Swan 2021). Elapids are venomous and highly variable in their respective ecologies, morphologies, geographic distributions, adaptive responses to anthropogenic disturbance, conservation requirements, and venom toxicities (Shine 1993; Greer 1997; Mirtschin et al. 2017; Wilson and Swan 2021).

The elapid genus *Denisonia* currently hosts two species, and each is nocturnal, is robust with moderately depressed and darkened heads with barred labial scales, and possesses large eyes with vertically elliptical pupils, smooth and glossy body scales, and 17 midbody scale rows (Wilson and Swan 2021). They are viviparous, primarily batrachophagous, and typically associated

with floodplains and riparian systems that receive significant seasonal inundation (Cogger 2014; Wilson and Swan 2021). The Ornamental Snake (*Denisonia maculata*) occupies low-lying cracking clay gilgais (shrink-swell depressions subject to seasonal inundation) of central-eastern Queensland (Qld). Owing to their specialized ecology, endemism to Qld, and exposure to anthropogenic disturbance, they are listed as Vulnerable in Qld and under the federal Environment Protection and Biodiversity Conservation (EPBC) Act (Covacevich et al. 1998; Cabrelli et al. 2014).

De Vis' Banded Snake (*Denisonia devisi*) is widespread through central and southern Qld and into central-northern New South Wales (NSW), where riparian cracking clay and alluvial flats support woodlands and shrublands (Wilson and Swan 2021). Allopatric populations occur in south-western NSW and north-western Victoria (Vic) in similar habitat along the Murray River (Clemann et al. 2007). Currently, *D. devisi* is listed as Least Concern by the International Union for Conservation of Nature (IUCN; Vanderduys et al. 2018), although in Vic, it is listed as Critically Endangered (Robertson and Coventry 2019). A robust, medium-sized elapid that attains 500–600 mm in total length, *D. devisi* typically exhibits a yellow- to orange-brown or olive basal coloration contrasted by dark brown-gray or orange streaks, reticulations, or banding that become irregular or broken at the flanks and vertebral midline (Wilson and Swan 2021). Herein, we describe a westerly range extension and present the first records of *D. devisi* in South Australia (SA). We also describe the habitat and our observations of behavior, foraging, and refugia, and discuss potential conservation concerns for this newly discovered population.

### MATERIALS AND METHODS

**Study site.**—The Chowilla floodplain constitutes one of the largest floodplains adjoining the Murray River and overlaps the junction of the NSW, SA, and Vic borders (Morelli and de Jong 1996; Kingsford 2000; Overton et al. 2006) in Australia. Although the Chowilla floodplain is recognized as the largest extant riverine forest in SA and is categorized under the Ramsar Convention as a wetland of international importance, the health of Chowilla vegetation communities and availability of water have each declined following river regulation (Maheshwari et al. 1995; Kingsford 2000; Overton et al. 2006). The Chowilla region experiences a semi-arid climate, contains many associated wetlands, and hosts extensive terrestrial and aquatic vegetation communities, supporting rich assemblages of invertebrates and vertebrates (O'Malley and Sheldon 1990; Sheldon and Lloyd 1990; Walker and Thoms 1993).

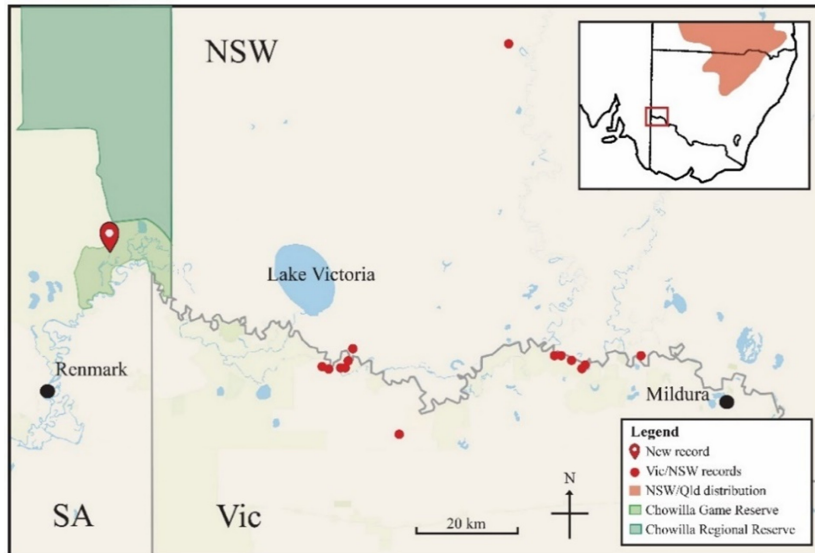
The Chowilla floodplain has attracted considerable attention, with focuses on riverine ecology, biodiversity, and conservation research (O'Malley and Sheldon 1990; Stewart et al. 2010). Few attempts, however, have been made to survey and document the herpetofauna of the region, with key exceptions being Bird and Armstrong (1990) and Brandle (2010). The results of Bird and Armstrong (1990), combined with records and specimens held by the South Australian Museum (SAM) at the time, provided an initial herpetofaunal diversity of 35 species for Chowilla. Brandle (2010) surveyed and discussed herpetofaunal diversity across the Murray Valley but failed to specify the diversity for Chowilla.

**Survey methods.**—On 17 February 2021, we conducted nocturnal spotlight surveys in the western portion of the Chowilla Game Reserve (33°56'50.3"S, 140°52'40.7"E), approximately 30 km northeast of Renmark, SA (Fig. 1). Our active search area approximated 4,500 m<sup>2</sup> and was located beside Monoman Creek, a tributary of the Murray River, and surrounding an isolated pool 30 m from the creek. We randomly traversed the search area and focused our efforts on cracking clay near water and beneath nearby trees and low vegetation. We did not catch herpetofauna, we only observed and photographed what we found. The maximum daytime temperature was 37.4° C and relative humidity at the time is unknown; however, the area collectively received 2.0 mm of rainfall in the preceding two weeks (<http://www.bom.gov.au/climate/dwo/202102/html/IDCJDW5059.202102.shtml>).

**Verification of a new population.**—To determine whether *D. devisi* had previously been recorded in SA, we reviewed relevant texts (Ehmann 1992; Cogger 2014; Robertson and Coventry 2019; Wilson and Swan 2021), articles (Shine 1983; Edwards and Tyler 1990; Clemann et al. 2007), online databases (Vanderduys et al. 2018; Atlas of Living Australia. 2021. *Denisonia devisi* Waite & Longman, 1920. De Vis' Banded Snake. Available from <https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:c9b85505-59d1-4d41-a105-088a3c3b48ec> [Accessed 21 February 2021]), and liaised with researchers at the SAM.

### RESULTS

Between 2219 and 2340, we found four adult *D. devisi* surrounding the above-mentioned isolated pool. The ambient temperature at time of first encounter was 22° C. We encountered the first individual (Fig. 2) at 2219 inactive at the base of a large River Red Gum (*Eucalyptus camaldulensis*; 12 m from the pool). We found two other individuals in soil cracks, one of which was partially exposed (10 m from water) and the other



**FIGURE 1.** Distribution of De Vis' Banded Snake (*Denisonia devisi*) in south-eastern Australia, with current records from South Australia, south-western New South Wales, and Victoria. Inset displays their distribution in northern New South Wales and southern Queensland. Records from the Atlas of Living Australia (*Denisonia devisi* Waite & Longman, 1920. De Vis' Banded Snake. Available from <https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:c9b85505-59d1-4d41-a105-088a3c3b48ec> [Accessed 21 February 2021]).

concealed yet visible within the crack (5 m from water). We located the fourth individual active atop cracking clay (3 m from water). Floristic diversity at the site agrees with other descriptions for the area (O'Malley and Sheldon 1990), with the dominant canopy vegetation consisting of *E. camaldulensis*, midstory Tangled Lignum (*Duma florulenta*), and sparse, unidentified grasses and shrubs on the surface (Fig. 3).

Of particular interest was the *D. devisi* encountered at 2248 and 10 m from the water. This individual was located with its head exposed and its body and tail concealed in a soil crack while biting onto the left hindlimb and thigh of a large (about 90 mm), adult

Southern Bell Frog (*Litoria raniformis*). The snake continually adjusted and strengthened its bite on the thigh of the frog as it periodically attempted to flee through erratic movements. To reduce observer disturbance, we ceased observations after 5 min. We returned 1 h later, and the snake and frog were absent, and we do not know the result of this predator-prey interaction.

## DISCUSSION

Here, we provide the first records of *D. devisi* in SA, despite previous biological surveys throughout the region and in the Chowilla floodplain (Bird and Armstrong



**FIGURE 2.** The first De Vis' Banded Snake (*Denisonia devisi*) encountered from the newly discovered population in South Australia. (Photographed by Scott G. Regan).



**FIGURE 3.** The habitat in which we located De Vis' Banded Snake (*Denisonia devisi*) in South Australia, Australia. (A) The isolated pool beside Monoman Creek around which four individuals were detected. (B) The soil-cracks beside the pool that are used by *D. devisi* for shelter and foraging. (Photographed by Connor Margetts).

1990; Brandle 2010). Our population marks a 45.6-km westerly range extension (from the nearest records in Vic) and most south-westerly known population of *D. devisi* in Australia. South Australia hosts a diverse elapid fauna, and with *D. devisi*, the known elapid diversity for SA increases to 37 species (Wilson and Swan 2021). Our preliminary observations of the habitat, behaviors (occupation of soil cracks and surface activity close to water), and activity times (nocturnal in warm conditions) are congruent with other records of *D. devisi* in Vic (Clemann et al. 2007; Robertson and Coventry 2019). Whether the SA, southern NSW, and Vic populations are continuous or disjunct is unknown. The discovery of *D. devisi* in SA emphasizes the value of greater survey efforts in riparian systems along the Murray-Darling basin, which is similarly reflected in the recent discovery of a southerly population of the wetland and frog-eating specialist elapid, Grey Snake (*Hemiaspis damelii*; Michael et al. 2020). Our discovery of this population contextualizes the need for

ongoing biodiversity monitoring, even in urban areas or those with extensive survey histories. Detection of new populations across state or territory borders for fringing taxa will undoubtedly continue to occur across Australia, which has implications for conservation management within those respective jurisdictions.

*Denisonia* are well-known for their primarily batrachophagous diets and our observation of a predatory interaction between *D. devisi* and *L. raniformis* is, to the best of our knowledge, the first record of a predator-prey interaction between these taxa. While not surprising considering the diversity of frog taxa known to be consumed by *Denisonia* species (Shine 1983), the total size of the prey item demonstrates the willingness of these snakes to prey on proportionally large food items. We also observed the *D. devisi* repeatedly strengthening its bite on the thigh of the frog, likely to hinder the frog from escaping while facilitating envenomation (Greer 1997). Although it is unknown whether the *L. raniformis* was ingested, observations of feeding behavior and predator-prey interactions in nocturnal and cryptic snake taxa are rare, emphasizing the importance of reporting feeding observations, particularly those concerning threatened prey taxa, such as *L. raniformis* (Wassens et al. 2010; Michael et al. In Press). The size disparity between *D. devisi* and *L. raniformis* is also of note, and the consumption of potentially dangerously large prey items has been discussed for other snake (Natusch et al. 2021) and serpentiform lizard species (Wall and Shine 2007). Natusch et al. (2021) suggests that the snake did not realize the total size of the frog, but chemoreception or movement elicited a strike response, nonetheless. Because *D. devisi* are ambush predators (Shine 1993; Reed and Shine 2002), we speculate that the snake may have been foraging or inactive near the surface and through chemoreception, detected and struck the *L. raniformis*.

**Conservation and management.**—With the confirmation of *D. devisi* in SA, consideration should be given to their conservation. We recommend initial surveys of suitable habitat throughout the Riverland region to determine the extent of their state distribution and potential threatening processes. Nocturnal spotlight surveys in riparian and cracking clay flats surrounding water in warm weather are an effective detection technique as alternative trapping methods are rarely used in these areas (Clemann et al. 2007). Liaison with NSW and Vic conservation authorities will be required to determine whether the SA, southern NSW, and Vic populations are connected and how management can be planned accordingly.

*Denisonia devisi* is currently listed as Least Concern by the IUCN (Vanderduys et al. 2018); however, Reed and Shine (2002) suggested that *D. devisi* is likely to

be susceptible to threatening processes because of its specialist ecology, which is apparent in the status and comparable ecology of the congeneric *D. maculata*. Climate change has also been identified as a threat to the persistence of *D. devisi*, which was assigned a medium-level climate change Vulnerability Score (Cabrelli et al. 2014). Clemann et al. (2007) cited the concerns of Reed and Shine (2002) for the small and apparently isolated Vic population of *D. devisi* and expressed further concerns for livestock grazing and timber removal, which we share for the SA population. The Murray River in SA is heavily regulated, used for anthropogenic purposes, and fringed by many townships, and the relative influence of these disturbances on dispersal, connectivity, and persistence of *D. devisi* populations is unknown.

Identifying the extent of the SA distribution of *D. devisi* is essential for developing effective management plans for both their conservation and river regulation, as the Murray River is one of the most regulated rivers in the world (Mosley et al. 2012; Bice et al. 2017). The Chowilla floodplain depends on the allocation of environmental water from upstream flows for inundation (Morelli and de Jong 1996; Kingsford 2000; Peake et al. 2011; Furst et al. 2014; Bice et al. 2017), which is required for lateral wetland connectivity and the reproduction of zooplankton, invertebrates, fish, and frogs, and the loss of wetland connectivity can extirpate populations (Walker 1985; Wassens et al. 2010; McGinness et al. 2014; Wedderburn et al. 2017; Rowe et al. 2021). Wetland connectivity may also strengthen populational sustainability for frogs afflicted with chytrid fungus, *Batrachochytrium dendrobatidis* (Heard et al. 2015), which is widespread in Australia and implicated in the extinction and decline of many frog taxa, including *L. raniformis* (Skerratt et al. 2007; Murray et al. 2011; Scheele et al. 2014; Gillespie et al. 2020).

As predators with specialized diets and foraging strategies are likely to be particularly susceptible to disturbance and extinction because of loss of prey (Webb and Shine 1998; Webb et al. 2008), we recommend ongoing and simultaneous chytrid testing and frog population monitoring to enable detection of chytrid outbreaks and any associated declines in prey-frog populations (Murray et al. 2011; Scheele et al. 2014). Meticulous planning and management of water resources and adequate allocation of environmental water into the Chowilla floodplain are also recommended. This would ensure that specialized predator-prey dynamics (e.g., frogs and snakes) are maintained and protected in the face of climatic change.

The SA population of *D. devisi* had so far remained undetected in an area close to human populace, which is likely attributable to their small size, nocturnality,

riparian ecology, and lack of surveys congruent with detection (Clemann et al. 2007; Michael et al. 2020). The nearby Vic population is susceptible to multiple threatening processes and has been declared as Critically Endangered (Robertson and Coventry 2019). Until further data are accrued for the SA population, recommendations for a state conservation status can be difficult to assert, although one can speculate that with a potentially limited distribution proximal to anthropogenic disturbance and comparable threats to those in Vic, a similar status may be afforded here. The ecological and dietary specializations of *D. devisi* and the proximity of this population to immediate and potential anthropogenic threats highlight that further study is required to underpin its conservation. Population monitoring is crucial for both *D. devisi* and their herpetofaunal prey, and understanding population densities and connectivity, and how these relationships may be mediated by water flows and river regulation, should be carefully and continuously studied, especially in the face of climatic change (Reed and Shine 2002; Lindenmayer et al. 2012; Cabrelli et al. 2014).

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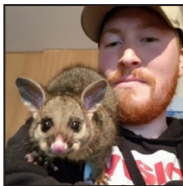
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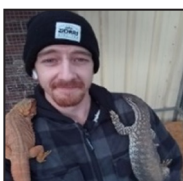
**HARRISON T. JONES** has extensive experience as a wildlife demonstrator, educator, and reptile breeder. He is particularly interested in the ecology, behavior, and captive husbandry of Australian varanid lizards. Harrison is also passionate about travelling and wildlife photography, having travelled across much of Australia. (Photographed by Harrison T. Jones).



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