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A significant range extension for the mountain skink *Liopholis montana* (Donnellan, Hutchinson, Dempsey & Osborne, 2002) on the Western Uplands of Victoria

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The mountain skink *Liopholis montana* (Squamata: Scincidae) is a medium-sized (snout-vent length up to 111 mm), recently described (Donnellan et al., 2002) scincid lizard native to southeast Australia. *Liopholis montana* have two discrete colour pattern morphs: plain-backed (without dorsal markings) and patterned (with dorsal markings), of which the former occurs more frequently (Chapple et al., 2008). This species is found in montane to alpine environments between 900 and 1800 m elevation in the southern Great Dividing Range (GDR; Donnellan et al., 2002). In Victoria, it is recorded from the Highlands - Southern Fall; Highlands - Northern Fall; Victorian Alps; East Gippsland Uplands; and Monaro Tablelands bioregions. The species also extends into New South Wales and Australian Capital Territory via the Australian Alps bioregion (Fig. 1). It is largely associated with rocky habitats, such as boulder outcrops or rock screes, typically in subalpine woodland or open dry forest communities (Robertson and Coventry, 2019).

Given its relatively recent (2002) description, little has been published about the species' biology and population trends; hence, it is currently considered '*Data Deficient*' on the Advisory List of Threatened Vertebrate Fauna in Victoria (DSE, 2013). It is also listed as '*Near Threatened*' on the IUCN Red List of Threatened Species because its area of occupancy is likely less than 2000 km^2 and populations appear to be severely fragmented (Clemann et al., 2018). However, a recent IUCN assessment of *Liopholis montana* has been submitted, which will likely result in the species being listed in a more severe threat category (N. Clemann, pers. comm.).

Biogeographical context. In Victoria, the GDR provides high-elevation habitats along a mountain chain oriented east–west. Mountains of eastern Victoria (i.e., the Eastern Uplands) are extensive with elevations up to 1986 m; by comparison, mountains of western Victoria (i.e., the Western Uplands) are topographically subdued with high points rarely exceeding 500 m (Fig. 1; Joyce et al., 2003). The GDR is frequently punctuated by low-elevation gaps, in both the Eastern and Western Uplands (Joyce et al., 2003). Most notable of these gaps is the relatively low (~300 m) Kilmore Gap (Hills, 1975) north of Melbourne, an indistinct section of the GDR largely covered by Newer Volcanic lava flows (Joyce, 1992; Boyce, 2013). The Kilmore Gap is mostly treeless (Fig. 1), and marks the separation of the Western Uplands from the Eastern Uplands (Joyce, 1992). Gaps such as this likely have important biogeographical implications for montane fauna associated with the GDR. For example, some lizard species, including the skinks *Egernia saxatilis* Cogger, 1960 and *Pseudemoia spenceri* (Lucas & Frost, 1894), and the agamid *Rankinia diemensis* (Gray, 1841), largely occur as isolated and widely disjunct populations confined to 'islands' of montane forest surrounded by 'seas' of low-elevation valleys and plains.

Similarly, *Liopholis montana* occurs as disjunct populations in the Eastern Uplands (Chapple et al., 2005; Fig. 1); however, unlike the aforementioned species it has not been recorded from the Western Uplands (i.e., uplands west of Kilmore Gap). Here, we present details of a recently discovered *L. montana* population from the Western Uplands (which is also part of the Central Victorian Uplands bioregion), extending the species' known distribution significantly further west of any previous records.

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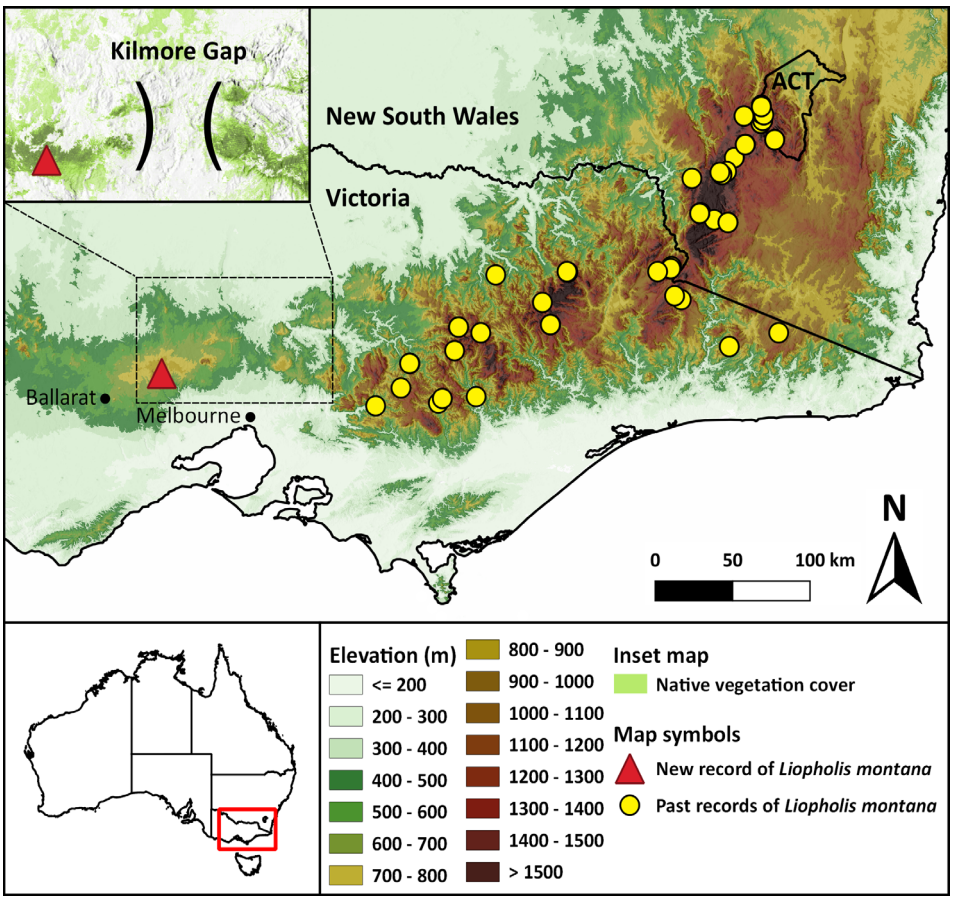

Figure 1. Elevation map of the Great Dividing Range in southeast Australia showing the new *Liopholis montana* locality on the Western Uplands and past records of the species obtained from the Victorian Biodiversity Atlas, BioNet Atlas, and Atlas of Living Australia (ALA); three ALA records, which we confirmed to be erroneous, were removed prior to map production. Inset map shows the extent of native vegetation, emphasising the wide disjunction in forest habitat across the Kilmore Gap (black curved bars) that separates the new locality from the species' main distribution.

Observation. On 12 December 2020 at approximately 17:30 h (EST), the authors discovered several individuals of *Liopholis montana* in Wombat State Forest (SF; -37.46°S, 144.27°E) ~35 km north-east of Ballarat, Victoria, Australia. Six adult and seven juvenile specimens were observed active or basking on low rocks and logs along a ~30 m transect. A given individual of *L. montana* was located no more than ~5 m from a conspecific, and on multiple occasions, juveniles were basking close to adults and entering the same shelter sites. When disturbed, lizards retreated beneath logs, into log crevices, or into burrows beneath partially embedded rocks. While most individuals lacked dorsal patterning (Fig. 2A), two adults and two juveniles had dorsal markings consisting of large, irregular black flecks (Fig. 2B). Other scincid species observed at the site using the same microhabitats as *L. montana* include *Carinascincus coventryi* (Rawlinson, 1975), *Eulamprus tympanum* (Lönnberg & Andersson, 1915), and *Lampropholis guichenoti* (Duméril & Bibron, 1839).

The site is a dry, north-facing hillside at 620 m elevation. The vegetation community comprises shrubby foothill forest with a partially open canopy, largely composed of mixed-age *Eucalyptus dives* up to 15 m tall. The ground strata include dense accumulations of leaf litter and coarse woody debris with tussock-forming species (e.g., *Lomandra filiformis* and *Poa sieberiana*) and low–medium shrubs, including *Banksia marginata*, *Dillwynia glaberrima*, *Epacris impressa*, *Hakea decurrens*, and *Leptospermum continentale*. The

site was last burned in 2008 during a prescribed burn (State Government of Victoria, 2021).

Discussion

Until now, the western range limit of *Liopholis montana* has been recognised as the Upper Yarra Valley in Victoria (Donnellan et al., 2002; Clemann et al., 2018; Robertson and Coventry, 2019), as indicated by the record at Upper Yarra Reservoir (ALA, 2020) of specimen D1089, a paratype from the species' description (Donnellan et al., 2002). Our discovery of an outlying *L. montana* population in Wombat SF extends the geographical range of this species approximately 150 km further west of this record, and is the first record of the species from the Western Uplands (Fig. 1).

There is evidence of phylogeographical structure in *Liopholis montana* between NSW and ACT, wherein high-elevation populations are genetically divergent across deep forest valleys (Chapple et al., 2005). However, no genetic study to date (Donnellan et al., 2002; Chapple et al., 2005) has incorporated Victorian specimens, although such a study is underway at the time of writing (N. Clemann, pers. comm.). Given the species' apparent restriction to high-elevation areas of the GDR, the Wombat SF population is likely isolated from conspecifics on the Eastern Uplands across the Kilmore Gap (Fig. 1). Whether *L. montana* is divergent over this gap in the GDR, and the historical factors driving that divergence, could be explored in a phylogeographic investigation. Additionally, habitat distribution modelling could be employed to predict the spatial occurrence of suitable habitat for the species, allowing the identification of other outlying populations. The reason we may want to do so is that peripheral and isolated populations tend to be valuable from a conservation perspective (Hardie and Hutchings, 2010). For example, the isolated population of *Rankinia diemensis* restricted to the Grampians (i.e., the western edge of the Western Uplands) is deeply divergent from conspecifics on the Eastern Uplands, and is therefore considered an 'evolutionary significant unit' (ESU; Ng et al., 2014). While *R. diemensis* as a species is not threatened, the Grampians population is considered critically endangered in Victoria (DSE, 2013), owing to its isolation, genetic uniqueness, and susceptibility to threats such as inappropriate fire regimes (Ng et al., 2014). In a similar manner, further research may identify the outlying Wombat SF population of *L. montana* as an ESU—which may require targeted management actions.

In addition to the geographical anomaly of the Wombat SF population, it is also located at an unusual elevation for the species. The lower elevational limit of *Liopholis montana* is widely cited as 900 m (Donnellan et al., 2002; Chapple et al., 2005; Clemann et al., 2018); however, the new population is located at 620 m. The existence of this exceptionally low population indicates that the species is not entirely restricted to montane, subalpine, and alpine environments. We suggest that this potentially ecologically marginal population of *L. montana* can provide a range of research opportunities, particularly for investigating elevational differences in life-histories and physiological adaptation between high versus low populations (e.g., Senior et al., 2019).

There have been few attempts to survey herpetofauna in Wombat SF (reviewed in Irvin et al., 2003) and it is

Figure 2. (A) Plain-backed adult and (B) patterned juvenile *Liopholis montana* found in Wombat State Forest ~35 km north-east of Ballarat, Victoria. Photos: J. Farquhar.

plausible that *Liopholis montana* occurs elsewhere in Wombat SF and other forested areas of the Western Uplands, but has gone undetected or misidentified as its congener *Liopholis whitii* (Lacépède, 1804). We recommend that targeted searches be undertaken throughout the region to further understand the species' extent of occurrence in the Western Uplands.

Potential threats to *Liopholis montana* in Wombat SF. *Introduced predators.*—Cats and foxes are major predators of reptiles (Woinarski et al., 2018), and both species have been detected in Wombat SF (Macak, 2012). The most recent independent review of Regional Forest Agreements (RFAs; long-term agreements for the sustainable use of forested areas) in Victoria for the period 2009–2014 (Wilkinson, 2018) found that the RFAs' milestone of developing pest control programs had not been achieved, and that there has been no pest animal control in Wombat SF. The degree to which *L. montana* is susceptible to mortality from introduced predators in Wombat SF is unknown and warrants investigation.

Logging.—Commercial native timber logging is considered a threat to *Liopholis montana* across its distribution (Clemann et al., 2018) and Wombat SF has a long history of timber harvesting (Houghton, 1980). While there has been little commercial logging in Wombat SF since 2002 (Poynter, 2005), much of the forest is currently zoned as available for logging (including the location of the new *L. montana* population). In 2020 the Australian and Victorian governments renewed the 2000 West Victoria Regional Forest Agreement which allows native forest logging to proceed on public land until 2030 (G. Osborne, pers. comm.). Consequently, VicForests' (a government-backed commercial logging enterprise) recently approved Timber Utilisation Plan includes approximately 60 coupes targeted for logging in Wombat SF (VicForests, 2020). This is despite the recommendations from the Victorian Environment Assessment Council (VEAC, 2019) to establish a new large national park for the region (i.e., Wombat–Lerderderg National Park) to protect its high biodiversity values.

Fire.—Fire maps indicate that Wombat SF has seldom been burned by wildfires in the past 20 years, but that prescribed burning occurs throughout (State Government of Victoria, 2021). The *L. montana* site was last burned in 2008 and much of the same area is scheduled for prescribed burns between 2020 and 2023 (DELWP, 2020). The current aim of such burns is to manage the risk of bushfires for the protection of life and property, with ecological management being a secondary consideration (K. Tolhurst, pers. comm.). Fire research in the Wombat SF indicates that repeated low-intensity prescribed fires can significantly reduce the amount of coarse woody debris (Aponte et al., 2014). At the *L. montana* site, coarse woody debris was abundant and we observed many *L. montana* basking on logs, sheltering within log crevices, or retreating to the surface of litter beneath logs. Thus, prescribed fires (or firewood collection) could have some impact on *L. montana* through the removal of logs, but it remains unclear whether logs are essential for the species at this locality, or are merely an opportunistically-used habitat feature. The species also shelters in burrows; hence, it may be somewhat resilient to direct mortality from fire, provided it has access to burrowing opportunities (e.g., Atkins et al., 2015). The shading effects associated with dense regrowth of vegetation following fire can reduce the availability of thermally-suitable basking sites for reptiles (Michael et al., 2010). This is likely to be especially problematic for species such as *L. montana*, which have permanent retreats with associated basking sites, and have high fidelity to such sites (N. Clemann, pers. comm.). Further research on the species' habitat use, in the context of fire ecology, can identify the ideal fire regime for the persistence of *L. montana* in forest ecosystems such as Wombat SF.

Rock displacement.—Many species in the *Liopholis* genus, including *L. montana*, typically occur in areas where individuals can construct burrows beneath exfoliated surface rocks. These rocks, and hence the important refuge sites they constitute, can be displaced during human activates such as logging, mining, track construction and maintenance, rock-stacking, and people lifting rocks in search of reptiles (Michael et al., 2010; N. Clemann, pers. comm.). All such activities likely pose a threat to the persistence of *L. montana* in Wombat SF by reducing the availability of refuge sites.

Conclusion. Protecting biodiversity is challenging in the context of introduced predators, ongoing habitat clearance, a rapidly changing climate, increasing fire frequency, and human disturbance of key habitat elements such as rocks—especially if we still lack fundamental knowledge of where such diversity is located. A considerable amount of intraspecific diversity can be found within the total set of isolated populations at the edge of a species' distribution (Macdonald et al., 2017). Accordingly, a more comprehensive survey effort is required to locate these isolated populations, even in regions which we may think of as being already well-surveyed. *Liopholis montana* appears to be a poorly understood species in general, and the fact that

this lizard has remained undetected in Wombat SF until now, despite its close proximity to major population centres (e.g., Melbourne, Ballarat), is perhaps a subtle warning as to how incomplete our knowledge remains of reptile distributions in southeast Australia.

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References

ALA (2020): *Liopholis montana*. Atlas of Living Australia. Available at https://biocache.ala.org.au/occurrences/search?taxa=liopholis+montana. Accessed on 27 December 2020.

Aponte, C., Tolhurst, K.G., Bennett, L.T. (2014): Repeated prescribed fires decrease stocks and change attributes of coarse woody debris in a temperate eucalypt forest. Ecological Applications **24**(5): 976–989.

Atkins, Z., Clemann, N., Robert, K.A. (2015): Does shelter site selection aid persistence of a threatened alpine lizard? Assessing *Liopholis guthega* populations a decade after severe fire in southeastern Australia. Journal of Herpetology **49**(2): 222–229.

Boyce, J. (2013): The Newer Volcanics Province of southeastern Australia: a new classification scheme and distribution map for eruption centres. Australian Journal of Earth Sciences **60**(4): 449–462.

Chapple, D.G., Hutchinson, M.N., Maryan, B., Plivelich, M., Moore, J.A., Keogh, J.S. (2008): Evolution and maintenance of colour pattern polymorphism in *Liopholis* (Squamata: Scincidae). Australian Journal of Zoology **56**(2): 103–115.

Chapple, D.G., Keogh, J.S., Hutchinson, M.N. (2005): Substantial genetic substructuring in southeastern and alpine Australia revealed by molecular phylogeography of the *Egernia whitii* (Lacertilia: Scincidae) species group. Molecular Ecology **14**(5): 1279–1292.

Clemann, N., Hutchinson, M., Robertson, P., Chapple, D.G., Gillespie, G., Melville, J., Michael, D. (2018): *Liopholis montana*. The IUCN Red List of Threatened Species 2018: e.T109478522A109478529. Available at https://dx.doi.org/10.2305/IUCN.UK.2018-1.RLTS.T109478522A109478529.en. Accessed 27 December 2020.

DELWP (2020): Joint Fuel Management Program FFMVIC Midlands (Eastern), 2020–2021 to 2022–2023. The State of Victoria, Department of Environment, Land, Water and Planning. Available at https://www.ffm.vic.gov.au/bushfire-fuel-and-risk-management/joint-fuel-management-program. Accessed on 25 January 2021.

Donnellan, S.C., Hutchinson, M.N., Dempsey, P., Osborne, W.S. (2002): Systematics of the *Egernia whitii* species group (Lacertilia: Scincidae) in south-eastern Australia. Australian Journal of Zoology **50**(5): 439–459.

DSE (2013): Advisory list of threatened vertebrate fauna in Victoria. Victorian Department of Sustainability and Environment, East Melbourne.

Hardie, D.C., Hutchings, J.A. (2010): Evolutionary ecology at the extremes of species' ranges. Environmental Reviews **18**: 1–20.

Hills, E.S. (1975): Physiography of Victoria. An Introduction to Geomorphology. Fifth Edition. Melbourne, Victoria, Australia, Whitcombe & Tombs.

Houghton, N. (1980): Timber and Gold: a history of sawmills and tramways of the Wombat Forest, 1855–1940. Light Railway Research Society of Australia, Melbourne.

Irvin, M., Westbrooke, M., Gibson, M. (2003): Effects of repeated low-intensity fire on reptile populations of a mixed eucalypt foothill forest in south-eastern Australia, research report no. 65. Fire Management, Department of Sustainability and Environment, Victoria.

Joyce, E.B., Webb, J.A. (co-ordinators), Dahlhaus, P.G., Grimes, K.G., Hill, S.M., Kotsonis, A., et al. (2003): Chapter 18—Geomorphology: the evolution of Victorian landscapes. In: Geology of Victoria, vol. 23, p. 533–561. Birch, W., Ed., Melbourne, Victoria, Australia, Geological Society of Australia Special Publication.

Joyce, E.B. (1992): The West Victorian Uplands of southeastern Australia: origin and history. Earth Surface Processes and Landforms **17**(4): 407–418.

Macak, P.V. (2012) Small ground mammal habitat associations in Wombat State Forest. Arthur Rylah Institute for Environmental Research. Unpublished client report to the Wombat Biodiversity Working Group/Wombat Forest Care Inc. Department of Sustainability and Environment, Heidelberg, Victoria.

Macdonald, S.L., Llewelyn, J., Moritz, C., Phillips, B.L. (2017): Peripheral isolates as sources of adaptive diversity under climate change. Frontiers in Ecology and Evolution **5**: 88.

Michael, D.R., Lindenmayer, D.B., Cunningham, R.B. (2010): Managing rock outcrops to improve biodiversity conservation in Australian agricultural landscapes. Ecological Management & Restoration **11**(1): 43–50.

Ng, J., Clemann, N., Chapple, S.N., Melville, J. (2014): Phylogeographic evidence links the threatened 'Grampians' Mountain Dragon (*Rankinia diemensis* Grampians) with Tasmanian populations: conservation implications in south-eastern Australia. Conservation Genetics **15**(2): 363–373.

Poynter, M. (2005): Collaborative forest management in Victoria's Wombat State Forest—will it serve the interests of the wider community? Australian Forestry **68**(3): 192–201.

Robertson, P., Coventry, A.J. (2019): Reptiles of Victoria: a guide to identification and ecology Clayton South, CSIRO Publishing.

Senior, A.F., Atkins, Z.S., Clemann, N., Gardner, M.G., Schroder, M., While, G.M., Wong, B.B.M., Chapple, D.G. (2019): Variation in thermal biology of three closely related lizard species along an elevation gradient. Biological Journal of the Linnean Society **127**(2): 278–291.

State Government of Victoria (2021): eMap Forest Fire Management Viewer. Available at https://emap.ffm.vic.gov.au. Accessed on 27 January 2021.

VicForests (2020): Approved Timber Utilisation Plan. December 2020. The State of Victoria. Available at https://www.vicforests.com.au/static/uploads/files/approved-tup-20201215-002-wffxmzzahmrs.pdf. Accessed on 25 January 2021.

VEAC (2019): Central West Investigation, Final Report, June 2019. Melbourne, Victoria, Australia, Victorian Environmental Assessment Council.

Wilkinson, G. (2018): Independent Review of the Report on Progress with Implementation of the Victorian Regional Forest Agreements (RFAs): Period 3 – 2009–2014. Available at https://www.agriculture.gov.au/sites/default/files/sitecollectiondocuments/forestry/rfa/vic-rfa-period3.pdf. Accessed on 25 January 2021.

Woinarski, J.C.Z., Murphy, B.P., Palmer, R., Legge, S.M., Dickman, C.R., Doherty, T.S., et al. (2018): How many reptiles are killed by cats in Australia? Wildlife Research **45**(3): 247–266.

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