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by

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ABSTRACT. Coolah Tops, c. 360 km northwest of Sydney, at the western end of the Liverpool Range, in central western New South Wales, is a fertile basalt plateau that rises to over 1000 m, and so is cooler and wetter than the surrounding drier and hotter western slopes. It represents a western outlier of tall moist montane forest and may therefore have served as a mesic refuge during arid climatic cycles. Despite its high biodiversity and biogeographical interest, Coolah Tops National Park and the surrounding area was very poorly represented in natural history museum collections. This report details the results of two field trips that Australian Museum Research Institute (AMRI) vertebrate staff made to Coolah Tops in May and November 2018. During these surveys, 109 vertebrate species were recorded in the National Park. In total, 160 specimens and associated tissues of 39 species were added to Australian Museum collections. An additional 51 tissue samples from three bird and six mammal species, as well as 13 skeletal remains of six mammal species were also added. This field work has continued to document the vertebrate biodiversity of Coolah Tops National Park and has significantly increased the AM's holding of specimens and genetic samples from this biologically significant area of NSW. Some of this recently collected material has already been incorporated into several research projects and it will continue to be utilized by AMRI and other researchers for decades to come.

Introduction

Despite its high biodiversity, the phylogeography of mesic southeastern Australia remains poorly understood (Byrne *et al.*, 2011). In eastern New South Wales, the role of the peaks of the Great Dividing Range in providing mesic refugia during past aridity cycles and the impacts of major river valleys as barriers to gene flow in shaping the phylogeography of the region is only just being recognized and explored (Chapple *et al.*, 2011; Frankham *et al.*, 2012; Hazlitt *et al.*, 2014). However, ongoing research is hampered by a lack of suitable samples from key taxa and areas.

Coolah Tops, c. 360 km northwest of Sydney, in central western New South Wales, lies at the western end of the Liverpool Range (Fig. 1), and is a fertile basalt plateau that rises to over 1000 m elevation (NPWS, 2002). As Coolah Tops is cooler and wetter than the surrounding lowlands, it is likely to have served as a mesic refuge for fauna and flora during previous arid climatic cycles. The tall moist forests of Coolah Tops are in contrast to the drier forests and woodlands that dominate the surrounding lowlands (Kavanagh, 1995). However, this close proximity of different habitats has resulted in an area of great biological interest, where eastern and western faunas occur in close proximity and sometimes intermingle.

Keywords: fishes; reptiles; amphibians; birds; mammals; molecular genetics; Australian Museum

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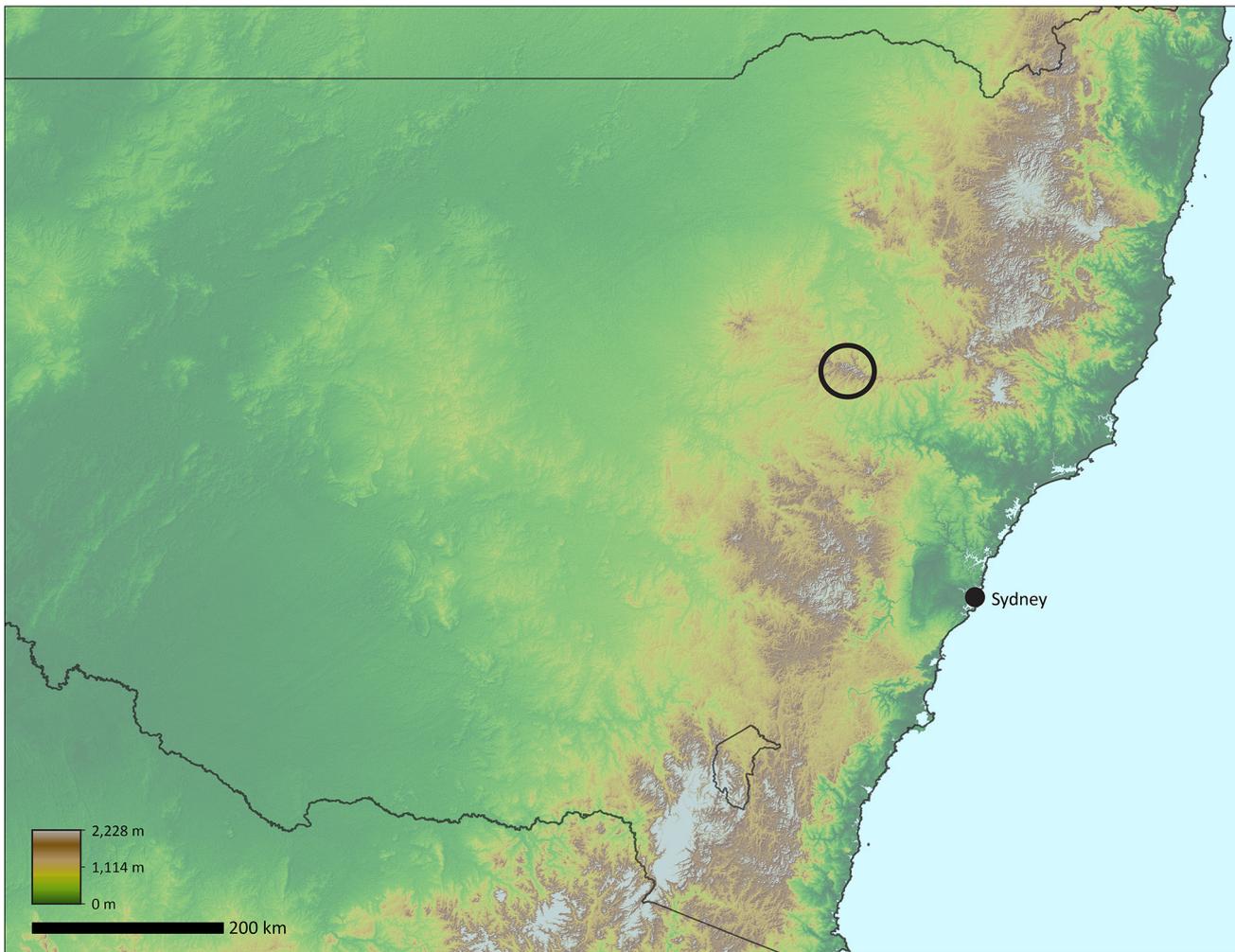


Figure 1. Elevation map of New South Wales, Australia, showing the location of Coolah Tops (circled) at the western end of a spur running off the Great Dividing Range.

As Coolah Tops is a western outlier of moist montane forest habitat, many faunal species, more typical of the tall wet forests of the Great Dividing Range reach or approach the western limit of their range at Coolah Tops (NPWS, 2002). These include the Weasel Skink, *Saproscincus mustelina*, Tussock Skink, *Pseudemoia pagenstecheri*, Red-browed Treecreeper, *Climacteris erythroptera*, Brown Gerygone, *Gerygone mouki*, Greater Glider, *Petauroides volans* and Brown Antechinus, *Antechinus stuartii*.

Coolah Tops also has significant areas of unlogged old growth eucalypt forest containing an abundance of the tree hollows that are so important to much of Australian forest fauna. As a consequence, the area also supports a high density of arboreal marsupials (NPWS, 2002).

The Coolah Tops plateau is the catchment for numerous creeks. Those on the north side feed the Namoi and Macquarie Rivers, eventually flowing west into the Murray/Darling River System, while those on the south side feed into the Goulburn River, flowing east to the Hunter River. The montane aquatic fauna is therefore sourced from two highly distinct river catchments but is poorly understood.

During the 1990s a variety of faunal surveys were undertaken to document the fauna (focusing on terrestrial vertebrates) of Coolah Tops (Coles *et al.*, 1994; Kavanagh, 1995; NPWS, 1993, 1998; Shields *et al.*, 1995). However, these surveys resulted in few voucher specimens or genetic samples being lodged in natural history museum collections. As a consequence, there was an inability to anchor and document the faunal records, allow species identifications to be confirmed, hedge against ongoing taxonomic changes or

provide samples for ongoing research (Clemann *et al.*, 2014).

Despite the significance, high biodiversity and biogeographical interest of Coolah Tops (NPWS, 2002), specimens from the area are poorly represented in natural history museum collections. For example, the Australian Museum (AM) collection contained no fish or bird specimens from Coolah Tops and only three bird specimens from the surrounding area; O.5499 Australian Raven, *Corvus coronoides*; O.65791 Red-rumped Parrot, *Psephotus haematonotus* and O.71134 Eastern Rosella, *Platycercus eximius*. For mammals, specimens of only two species from Coolah Tops were represented in the AM collection; four *Antechinus stuartii* (M.35109–12) and one *Petauroides volans* (M.26844), including frozen tissues. An additional seven mammal specimens were from the surrounding area, including one Spotted-tailed Quoll, *Dasyurus maculatus* (M.9798), two Common Dunnart, *Sminthopsis murina* (M.7863, M.7880), three *A. stuartii* (M.11544–46) and one Koala, *Phascolarctos cinereus* (M.47208). Amphibians from Coolah Tops were represented by three specimens of *Crinia*; one Common Eastern Froglet, *Crinia signifera* (R.175993) and two specimens of *Crinia* sp. (R.152153–54), both with frozen tissues.

Although far from comprehensive, a greater diversity of reptile species from Coolah Tops were represented in the Australian Museum (AM) collection with specimens from 11 species. For elapid snakes, there are only specimens of two species from Coolah Tops, one Red-bellied Black Snake, *Pseudechis porphyriacus* (R.141447) and one Eastern Brown Snake, *Pseudonaja textilis* (R.184686). Another specimen of *P. textilis* (R.147409) is from the surrounding area. Nine



Figure 2. AMRI Mammals and Herpetology research team at Coolah Tops, May 2018. Front row from left, Anja Divljan, Sandy Ingleby, Stephen Mahony back row from left, Mark Eldridge, Harry Parnaby. Photo by Jules Farquhar.

species of skink from Coolah Tops were represented in the AM collection. Two specimens of Red-throated Skink, *Acritoscincus platynotus* (R.152186–87), both with frozen tissues; four specimens of Copper-tailed Skink, *Ctenotus taeniolatus* (R.141448, R.152189–91), three with frozen tissues; 14 specimens of Eastern Water Skink, *Eulamprus quoyii* (R.152169–76, R.152180–85), all with frozen tissues; 11 specimens of Three-toed Earless Skink, *Hemiergis talbingoensis* (R.152155–60, R.152192–96), nine with frozen tissues; one damaged specimen tentatively identified as a Friendly Sunskink, *Lampropholis amricula* (R.152165), with frozen tissues; one specimen of Montane Sunskink, *Lampropholis caligula* (R.158617); two specimens of Delicate Garden Skink, *Lampropholis delicata* (R.152164, R.152179) both with frozen tissues; 12 specimens of Tussock Skink, *Pseudemoia pagenstecheri* (R.141446, R.152161–63, R.152166–68, R.152177–78, R.152188, R.161385–86), nine with frozen tissues; and one specimen of Weasel Skink, *Saproscincus mustelinus* (R.162090). There are no specimens in AM collection of varanids, agamids or geckos from Coolah Tops. An additional two reptile specimens were from the surrounding lower elevation area; one Excitable Delma, *Delma tinctoria* (R.175738) and one Common Dwarf Skink, *Menetia greyii* (R.175739).

In May and November 2018, staff from the Australian Museum Research Institute (AMRI) conducted field work in Coolah Tops to improve our understanding and sampling of its vertebrate fauna.

Methods

Researchers from the Australian Museum Research Institute (AMRI) conducted two 2-week field trips to Coolah Tops during May and November 2018 (Fig. 2). Surveys were conducted for mammals, birds, reptiles and amphibians, as well as fishes. The May field trip included AMRI staff from Ornithology and Ichthyology (30 April–7 May), as well as Herpetology and Mammalogy (7–14 May). The November field trip included AMRI staff from Herpetology (19–27 November) and Mammalogy (25–30 November).

Fishes

Conditions were very dry in May and none of the waterfalls were flowing, but small pools were present along some of the watercourses. Electrofishing and seine netting were used to sample fishes in the existing pools (Fig. 3).

Reptiles and amphibians

Searches were conducted in a range of habitats within Coolah Tops. Reptile activity in May was relatively low due to the dry conditions and cold weather. In November spotlighting and amphibian auditory surveys were also conducted. Weather in the November trip became unsuitably cold in the first week and then very wet in the second week, limiting survey activity.



Figure 3. AMRI's Sally Reader and Amanda Hay electrofishing at Talbragar Falls, Coolah Tops National Park. Photo by Michael Murphy.



Figure 4. AMRI's Leah Tsang removing a male Golden Whistler, *Pachycephala pectoralis*, from a mistnet. Photo by Richard Major.



Figure 5. AMRI's Anja Divljan and Mark Eldridge checking a small mammal trap line. Photo by Sandy Ingleby.

Birds

Searches for birds were conducted in a range of habitats within Coolah Tops, and were recorded by capture, sight, and call recognition, or a combination of these. Mist-netting was conducted in several habitats in the vicinity of Bracken's Cottage during the May visit (Fig. 4).

Mammals

Elliott and small cage trapping for small-medium terrestrial mammals, was conducted in a range of habitats in both May and November (total 1209 trap nights). Trap lines consisted of 20 Elliot traps placed 10 m apart, with additional single cage traps placed at the beginning, middle and end of the trap line (Fig. 5). Spot-lighting surveys were conducted at night for arboreal mammals, by walking along roads. Harp trapping (29 trap nights) and in November trip-lining (0.5 night) for microbats was also conducted. Trapping in November was limited due to high winds and heavy rainfall (only 84 Elliot/cage trap nights; 9 harp trap nights). The echolocation calls of bats were monitored and identified to species using two Anabat Express™ (Titely-Scientific) bat detectors at different sites each for 6 nights during May. Detectors were mounted on tree trunks 1.5 m above ground and operated continuously from dusk to dawn. Bat species identifications were undertaken from manual inspection of call sequences using AnalookW software to check for species that are easily detected but difficult to capture in harp traps. Both detectors were deployed in November but failed following a software upgrade.

Genetic analysis

Some small mammal and reptile species can be difficult to definitively identify on morphological criteria alone. We therefore used standard genetic methods (Eldridge *et al.*, 2017) to generate segments of several mitochondrial DNA (mtDNA) genes to confirm species identification by comparison with known specimens of the likely and related species (see Appendix 6 for details of specimens examined). Samples from Coolah Tops specimens from the following mammalian genera were examined; *Antechinus*, *Vespadelus*, *Nyctophilus* and *Chalinolobus*. We also examined the previously collected skink specimen from Coolah Tops tentatively identified as *Lampropholis amiculata* (R.152165) in order to clarify its identity. Total genomic DNA was extracted from 10 mg tissue using the Bioline Isolate II Genomic DNA Kit, following manufactures instructions.

For the skinks, a 642 bp fragment of the mtDNA gene NADH dehydrogenase 4 (ND4) was amplified using the primers ND4F and Leu (Arévalo *et al.*, 1994). PCRs were conducted in 25 µl reactions using 10–20 ng of genomic DNA, 1× Reaction Buffer (Bioline MyTaqRed Reagent Buffer; Bioline, Australia), 2 pmol primers and Bioline MyTaqRed DNA polymerase (0.5 unit). Thermocycling was performed on an Eppendorf Mastercycler Pro S (Eppendorf, Hamburg, Germany) under the following conditions; initial denaturation (94°C for 2 min); denaturation (94°C for 20 s); annealing (55–50°C for 40 s, 1 degree decrements) and extension (72°C for 50 s) followed by 30 cycles of denaturation (94°C for 20 s); annealing (50°C for 40 s) and extension (72°C for 50 s) with a final extension (5 min at 72°C). Novel DNA sequences are available from GenBank (MT163292–MT163297).



Figure 6. Mountain Galaxias, *Galaxias olidus* caught at Coolah Tops National Park. Photo by Sally Reader.

For *Antechinus*, a partial fragment (c. 450 bp) of the mtDNA control region was amplified using the primers H16498 and L15999 (Fumagalli *et al.*, 1997). PCRs were as described above and thermocycling was carried out under the following conditions; initial denaturation (94°C for 2 min); 36 cycles of denaturation (94°C for 20 s); annealing (60°C for 40 s) and extension (72°C for 50 s) followed by a final extension (5 min at 72°C). Novel DNA sequences are available from GenBank (MT163298–MT163313).

For microbats, fragments of two mtDNA genes, cytochrome b (cytb: c. 400 bp) and cytochrome oxidase 1 (CO1: c. 600 bp), were PCR amplified using the primers: cytb-L14841(F) and H15149(R) under conditions previously described by Eldridge *et al.* (2017) and CO1-BAK1490 (F) and BAK2198 (R) under conditions previously described by Neaves *et al.* (2018). For eastern Australian *N. geoffroyi* and southern *V. darlingtoni* a CO1 fragment was amplified using alternative primers LCO1490 (F) and HCO2198 (R) Folmer *et al.* (1994) under the PCR conditions outlined above except that the annealing temperature was 52°C. Novel DNA sequences are available from GenBank (MT216500–MT216514, MT246209–MT246264, MT246593–MT246658).

PCR products were visualized on a 2% E-gel (Life Technologies Corp. #G5018-02), then purified using ExoSAP-IT reagent (ThermoFisher Scientific #78201.1.ML) and sequenced on an AB 3730xl Sequencer at the Australian Genome Research Facility (AGRF), Sydney. Sequences were edited using SEQUENCHER v5.4 (Gene Codes Corporation, Ann Arbor, USA) and aligned using CLUSTALW in MEGA 7.0.21 (Kumar *et al.*, 2016).

The evolutionary history of haplotypes was inferred using Maximum Likelihood (ML), as well as Bayesian inference. The most appropriate evolutionary model was determined using MEGA 7.0.21 (Kumar *et al.*, 2016). ML analysis, with 500 bootstraps was carried out in MEGA 7.0.21 using the T92+G model (*Antechinus*, *Lampropholis*) or HKY model (microbats). Initial trees for the heuristic search were obtained automatically by applying Neighbor-Join and BioNJ algorithms to a matrix of pairwise distances estimated using the Maximum Composite Likelihood (MCL) approach, and then selecting the topology with superior log likelihood value. Bayesian inference was carried out using MrBayes 3.2.6 (Ronquist *et al.*, 2012), using HKY+G model (*Antechinus*) and HKY+I model (*Lampropholis*). Metropolis-Coupled Markov Chain Monte Carlo sampling was used to calculate posterior probability using default settings for priors. Two independent analyses ran simultaneously with four chains per run (1 cold, 3 hot), for 1 million generations sampling every 100 generations to obtain 10,000 sampled trees. TRACER 1.5 (Rambaut & Drummond, 2009) was used to check for chain convergence and adequate Effective Sample Size (> 200). Both ML and Bayesian inference resolved trees of similar topology.

Results and discussion

Fishes

Electrofishing and seine netting succeeded in capturing a single species, the Mountain Galaxias, *Galaxias olidus* in five watercourses (Fig. 6). Tolerant to very cold water this species is widely distributed in streams draining both sides of the Great Dividing Range, up to 1800 m elevation (Allen *et al.*, 2003). Samples were obtained from the Namoi and Macquarie River catchments, but no water could be located in creeks of the Hunter River catchment. A total of 35 specimens were collected and five genetic samples (one per watercourse) (Appendix 1). Notably no introduced species of fishes were found.

Reptiles and Amphibians

A total of 17 reptile and two amphibian species were recorded (Tables 1 and 2). Fourteen of the reptiles and two of the amphibian species were sampled, with a total of 51 specimens and associated tissues collected from 16 species (Appendices 2 and 3).

Cold weather in May kept reptile activity to a minimum, and the team targeted its efforts on searching for sheltering reptiles. The most common reptiles were cold-tolerant skinks such as *H. talbingoensis* and *S. mustelinus*. Less commonly encountered in the plateau's Snow Gum forest were *L. delicata* and *L. caligula*. Interestingly, *L. delicata* is often the most abundant and dominant species in forests further east.

Several species were found only in larger rocky outcrops with deep cracking boulders, including Cunningham's Skink, *Egernia cunninghami* and the Tree Skink, *Egernia striolata* (Fig. 7). While these species were previously known to occur at Coolah Tops, these high elevation populations may be isolated from other populations of their species. Previously a lack of samples from Coolah Tops had meant no genetic study had been conducted assessing the degree of isolation of the Coolah Tops populations. However, genetic analysis of the *E. striolata* specimens sampled at Coolah Tops showed only slight differentiation from populations sampled further east and northeast on the Central and Northern Tablelands (Sadlier *et al.*, 2019). Recently a population of 'striolata' group skinks from high elevation at Mt Kaputar was recognized as a distinct species (Sadlier *et al.*, 2019). Detailed genetic analysis of the *E. cunninghami* samples from Coolah Tops is currently underway, but initial results show this population to be genetically differentiated from populations to the east on the Walcha basalts and Moonbi granite ranges.

Table 1. Reptile species recorded at Coolah Tops during the 2018 surveys.

common name	species	May 2018	Nov 2018
Jacky dragon	<i>Amphibolurus muricatus</i>	—	T
Three-toed earless skink	<i>Hemiergis talbingoensis</i>	S	T
Tussock skink	<i>Pseudemoia pagenstecheri</i>	T	T
Red-throated skink	<i>Acritoscincus platynotus</i>	—	T
Elegant snake-eyed skink	<i>Cryptoblepharus pulcher</i>	T	T
Copper-tailed skink	<i>Ctenotus taeniolatus</i>	T	T
Eastern water skink	<i>Eulamprus quoyii</i>	—	T
Cunningham's skink	<i>Egernia cunninghami</i>	T	T
Tree skink	<i>Egernia striolata</i>	T	T
White's skink	<i>Liopholis whitii</i>	T	T
Montane sunskink	<i>Lampropholis caligula</i>	T	T
Delicate garden skink	<i>Lampropholis delicata</i>	T	T
Weasel skink	<i>Saproscincus mustelinus</i>	T	—
Robust velvet gecko	<i>Nebulifera robusta</i>	—	T
Thick-tailed gecko	<i>Underwoodisaurus milii</i>	—	T
Red-bellied black-snake	<i>Pseudechis porphyriacus</i>	S	S
Eastern brown snake	<i>Pseudonaja textilis</i>	T	S

T = captured, *S* = sighted, — = not sighted



Figure 7. A Tree Skink, *Egernia striolata* recorded at Coolah Tops, a species of interest for comparative genetic studies with other NSW populations. Photo by Stephen Mahony.

Table 2. Amphibian species recorded at Coolah Tops during the 2018 surveys.

common name	species	May 2018	Nov 2018
Peron's tree frog	<i>Litoria peronii</i>	—	T, C
Common eastern froglet	<i>Crinia signifera</i>	T	T, C

T = captured, *S* = sighted, *C* = call record, — = not sighted, no call recorded



Figure 8. A Montane Sunskink, *Lampropholis caligula* a species of biogeographical interest for future studies. Photo by Stephen Mahony.

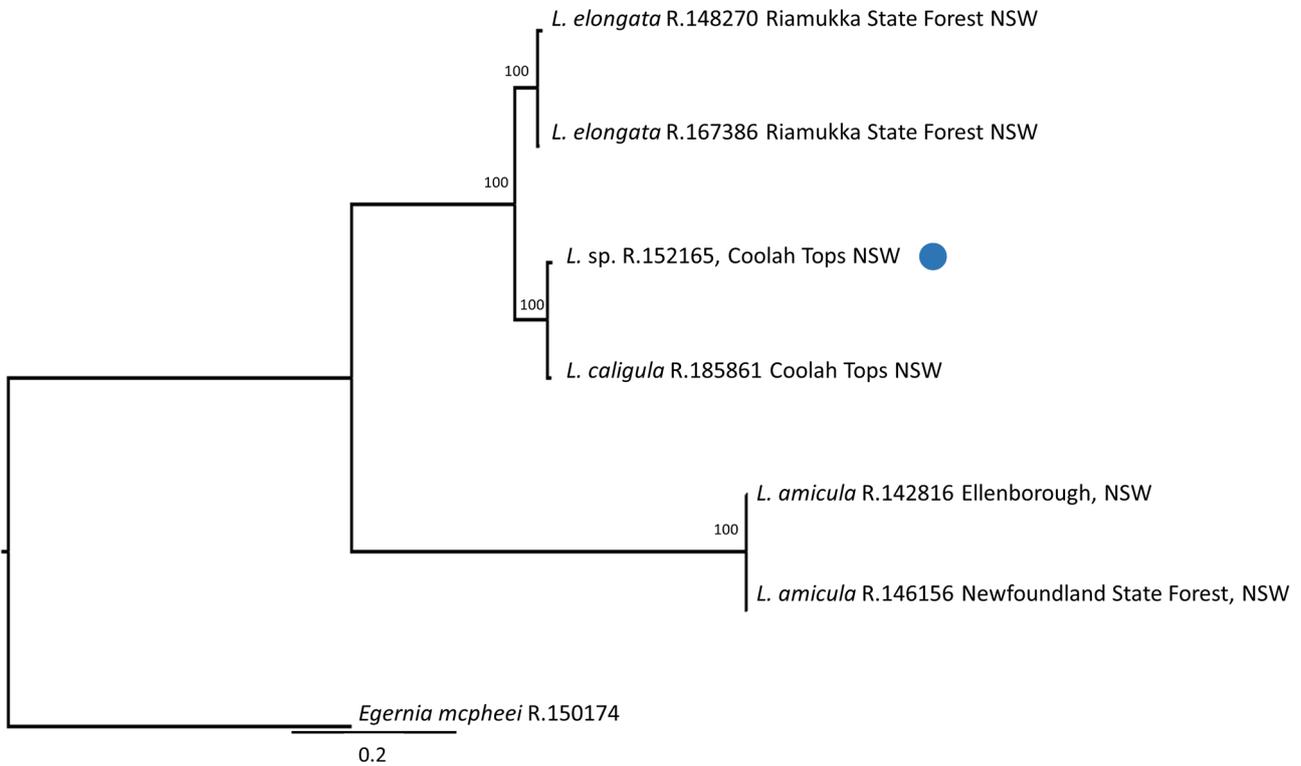


Figure 9. Phylogenetic relationships (ML) of a *Lampropholis* specimen sampled at Coolah Tops ●, compared to confirmed *L. amacula*, *L. caligula* and *L. elongata* specimens from southeastern Australia based on c. 640 bp of mtDNA ND4 sequence.

November surveys were initially productive with numerous small skink species encountered including species not in abundance during May such as *Acritoscincus platynotus* and *Pseudemoia pagenstecheri*. Further samples were collected of *L. caligula* (Fig. 8) for which only one specimen had been encountered in May. These samples will provide the opportunity to compare the isolated Coolah Tops population of this high elevation, range restricted species with those found further east around Barrington Tops (Cogger, 2014). Nocturnal surveys of ponds and creek systems detected two species of frogs, Peron's Tree Frog, *Litoria peronii* and *Crinia signifera*, both of which were detected calling. Nocturnal surveys of rocky outcrops in the north of the Park detected Robust Velvet Gecko, *Nebulifera robusta* and Thick-tailed Gecko, *Underwoodisaurus milli*, the first Gekkota recorded in the Park. Weather later in the week became increasingly cold reducing reptile and amphibian activity. Further surveys are likely to detect additional reptile and frog species.

Genetic analysis of R.152165 the previously collected damaged skink specimen tentatively identified as *Lampropholis amicula* revealed that it actually represented a specimen of *L. caligula* (Fig. 9). This correction to the specimen identification means that *L. amicula* has now not been recorded in the Park.

Birds

A total of 62 bird species were recorded, 45 species in May and 54 species in November when summer migrants were present (Table 3). A total of 12 bird species were sampled: 27 specimens and associated tissues were collected from 11 species, as well as 15 blood or feather samples from three species (Fig. 10, Appendix 4). Of particular interest, were samples from Golden Whistlers, *Pachycephala pectoralis*, Eastern Yellow Robins, *Eopsaltria australis* and Crimson Rosellas, *Platycercus elegans* from the western part of their range in NSW, at high elevation (>1000 m above sea level). Threatened species that were recorded include Barking Owl, *Ninox connivens*, Powerful Owl, *Ninox strenua*, Varied Sittella, *Daphoenositta chrysoptera* and Scarlet Robin, *Petroica boodang* all listed as *Vulnerable* under NSW legislation. The only introduced bird species recorded was the Common Blackbird, *Turdus merula* which was frequently seen in the Tea-Tree, *Leptospermum polygalifolium* thickets of swamp habitat.



Figure 10. A Laughing Kookaburra, *Dacelo novaeguineae* recorded at Coolah Tops from which a blood sample was collected for the AMRI tissue collection. Photo by Richard Major.

Table 3. Bird species recorded at Coolah Tops during the 2018 surveys.

common name	species	May 2018	Nov 2018
Pacific black duck	<i>Anas superciliosa</i>	—	S
Wedge-tailed eagle	<i>Aquila audax</i>	S	S
Whistling kite	<i>Haliastur sphenurus</i>	—	S
Nankeen kestrel	<i>Falco cenchroides</i>	—	S
Masked plover	<i>Vanellus miles</i>	—	S
** Powerful owl	<i>Ninox strenua</i>	S	—
** Barking owl	<i>Ninox connivens</i>	C	S
Boobook owl	<i>Ninox boobook</i>	S	C
Australian owllet-nightjar	<i>Aegotheles cristatus</i>	C	—
Laughing kookaburra	<i>Dacelo novaeguineae</i>	S, T	S
Sacred kingfisher	<i>Todiramphus sanctus</i>	—	S
Yellow-tailed black cockatoo	<i>Calyptorhynchus funereus</i>	S	S
Sulphur-crested cockatoo	<i>Cacatua galerita</i>	S	S
King parrot	<i>Alisterus scapularis</i>	S	S
Crimson rosella	<i>Platycercus elegans</i>	S, T	S
Eastern rosella	<i>Platycercus eximius</i>	—	S
Rainbow lorikeet	<i>Trichoglossus moluccanus</i>	—	S
Musk lorikeet	<i>Glossopsitta concinna</i>	S	S
Dollarbird	<i>Eurystomus orientalis</i>	—	S
Eastern koel	<i>Eudynamis orientalis</i>	—	S
Satin bowerbird	<i>Ptilonorhynchus violaceus</i>	—	S
White-throated tree-creeper	<i>Cormobates leucophaea</i>	S, T	S
Red-browed tree-creeper	<i>Climacteris erythrops</i>	S	—
Superb fairy wren	<i>Malurus cyaneus</i>	S, T	S
Eastern spinebill	<i>Acanthorhynchus tenuirostris</i>	S	S
Yellow-faced honeyeater	<i>Caligavis chrysops</i>	S, T	S
Noisy miner	<i>Manoria melanocephala</i>	S	S
Red wattlebird	<i>Anthochaera carunculata</i>	S	S
White-eared honeyeater	<i>Nesoptilotis leucotis</i>	S	S
White-naped honeyeater	<i>Melithreptus lunatus</i>	S	—
Spotted pardalote	<i>Pardalotus punctatus</i>	S	S
Striated pardalote	<i>Pardalotus striatus</i>	S	S
White-browed scrubwren	<i>Sericornis frontalis</i>	S, T	S
Buff-rumped thornbill	<i>Acanthiza reguloides</i>	S, T	S
Brown thornbill	<i>Acanthiza pusilla</i>	S, T	S
Striated thornbill	<i>Acanthiza lineata</i>	S, T	S
Yellow thornbill	<i>Acanthiza nana</i>	S	—
Eastern whipbird	<i>Psophodes olivaceus</i>	C	C
Spotted quail-thrush	<i>Cinclosoma punctatum</i>	S	—
Grey butcherbird	<i>Cracticus torquatus</i>	S	S
Pied butcherbird	<i>Cracticus nigrogularis</i>	S	S
Australian magpie	<i>Gymnorhina tibicen</i>	S	S
Pied currawong	<i>Strepera graculina</i>	S	S
** Varied sittella	<i>Daphoenositta chrysoptera</i>	S	—
Rufous whistler	<i>Pachycephala rufiventris</i>	—	S
Golden whistler	<i>Pachycephala pectoralis</i>	S, T	S
Grey shrike-thrush	<i>Colluricincla harmonica</i>	S	S
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>	—	S
Common Cicadabird	<i>Edolisoma tenuirostre</i>	—	S
Willie wagtail	<i>Rhipidura leucophrys</i>	S	S
Grey fantail	<i>Rhipidura albiscapa</i>	S	—
Lead flycatcher	<i>Myiagra rubecula</i>	—	S
Magpie lark	<i>Grallina cyanoleuca</i>	S	S
Australian raven	<i>Corvus coronoides</i>	S	S
White-winged chough	<i>Corcorax melanorhamphos</i>	S	S
** Scarlet robin	<i>Petroica boodang</i>	—	S
Eastern yellow robin	<i>Eopsaltria australis</i>	S, T	S
Welcome swallow	<i>Hirundo neoxena</i>	S	S
Spine-tailed swift	<i>Hirundapus caudactis</i>	—	S
Silvereye	<i>Zosterops lateralis</i>	S	S
Bassian thrush	<i>Zoothera lunulata</i>	—	S
* Common blackbird	<i>Turdus merula</i>	S	S

* introduced species; ** listed threatened species;

T = captured, S = sighted, C = call record, — = not sighted, no call recorded

Mammals

A total of 27 mammal species were recorded, 26 species in May and 21 species in November (Table 4). A total of 15 mammal species were sampled: 47 specimens and associated tissues were collected from 11 species, as well as 36 tissue samples (ear or wing biopsies) from six of these species (Appendix 5). Skeletal remains of six species were also collected (Appendix 5).

Terrestrial mammals

Short-beaked Echidnas, *Tachyglossus aculeatus* were regularly sighted throughout the Park, both during the day and at night. Activity was higher in November than in May.

Despite the very dry conditions, a diversity of native terrestrial mammals was observed (Table 4). Eastern Grey Kangaroos, *Macropus giganteus*, Red-necked Wallabies, *Notamacropus rufogriseus*, Common Wombats, *Vombatus ursinus* and Swamp Wallabies, *Wallabia bicolor* were regularly sighted throughout the Park. However, by the November trip, as the drought continued, many individuals were visibly in poor condition. *Macropus giganteus* and *N. rufogriseus* were the most frequently seen, especially feeding in open grassy areas in the early morning and late afternoon. For example, in November over 30 *M. giganteus* and 15 *N. rufogriseus* were typically seen each afternoon/evening grazing in the cleared grassy area around Bracken's Hut. *Wallabia bicolor* were also seen each day on both trips but in lower numbers as they are not a highly social species, and as predominantly a browser, less frequently emerge from dense cover (Van Dyck & Strahan, 2008). The Common

Wallaroo, *Osphranter robustus* was only occasionally seen within the Park, most often near or on the slopes and escarpments. It was more commonly observed in the hilly country outside the Park.

Sightings of *V. ursinus*, as well as active burrows and fresh scats were also encountered each day in both May and November. Most sightings were at dusk or at night although several individuals with sarcoptic mange were observed feeding during the day.

Skeletal remains of four *M. giganteus*, four *V. ursinus*, one *N. rufogriseus* and one *W. bicolor* were collected (Appendix 5).

During the May trapping, seven *Antechinus* (4 males, 3 females) were captured (Table 5, Appendix 5). Although Coolah Tops is assumed to be within the distribution of *A. stuartii*, some of the specimens captured had pale eye-rings which is more typical of the Agile Antechinus, *A. agilis* (Van Dyck & Strahan, 2008). However, genetic analysis confirmed that despite the presence of a pale eye-ring the *Antechinus* sampled at Coolah Tops were *A. stuartii* (Fig. 11). This result suggests that the morphological criteria used to distinguish between these species needs to be reevaluated.

No other native small mammals were captured. The lack of captures, or verifiable records, of Bush Rats, *Rattus fuscipes* from Coolah Tops remains curious as this species is typically highly abundant in similar habitats to the east.

Arboreal mammals

Four possum species were observed, including high densities of *Petauroides volans* and Common Ringtail Possums,

Table 4. Mammal species recorded at Coolah Tops during the 2018 surveys.

common name	species	May 2018	Nov 2018
Short-beaked echidna	<i>Tachyglossus aculeatus</i>	S	S
Brown antechinus	<i>Antechinus stuartii</i>	T	—
Common wombat	<i>Vombatus ursinus</i>	S	S
** Greater glider	<i>Petauroides volans</i>	S	S
Common ringtail possum	<i>Pseudocheirus peregrinus</i>	S	S
Sugar glider	<i>Petaurus breviceps</i>	S	—
Common brush-tailed possum	<i>Trichosurus vulpecula</i>	S	—
Eastern grey kangaroo	<i>Macropus giganteus</i>	S	S
Common wallaroo	<i>Osphranter robustus</i>	S	S
Red-necked wallaby	<i>Notamacropus rufogriseus</i>	S	S
Swamp wallaby	<i>Wallabia bicolor</i>	S	S
* Fallow deer	<i>Dama dama</i>	S	S
* Cattle	<i>Bos taurus</i>	S	—
* Goat	<i>Capra hircus</i>	S	—
* Feral pig	<i>Sus scrofa</i>	S	S
* European rabbit	<i>Oryctolagus cuniculus</i>	S	S
* European red fox	<i>Vulpes vulpes</i>	C	S
* House mouse	<i>Mus musculus</i>	—	T
Large forest bat	<i>Vespadelus darlingtoni</i>	T	T
Little forest bat	<i>Vespadelus vulturinus</i>	T	T
Gould's long-eared bat	<i>Nyctophilus gouldi</i>	T	T
Lesser long-eared bat	<i>Nyctophilus geoffroyi</i>	T	T
Gould's wattled bat	<i>Chalinolobus gouldii</i>	T	T
Chocolate wattled bat	<i>Chalinolobus morio</i>	T	T
** Large-eared pied bat	<i>Chalinolobus dwyeri</i>	T	—
White-striped mastiff bat	<i>Austronomus australis</i>	C	C
** Eastern false pipistrelle	<i>Falsistrellus tasmaniensis</i>	T	T

* Introduced species; ** listed threatened species;

T = captured, S = sighted, C = call record, — = not sighted, no call recorded

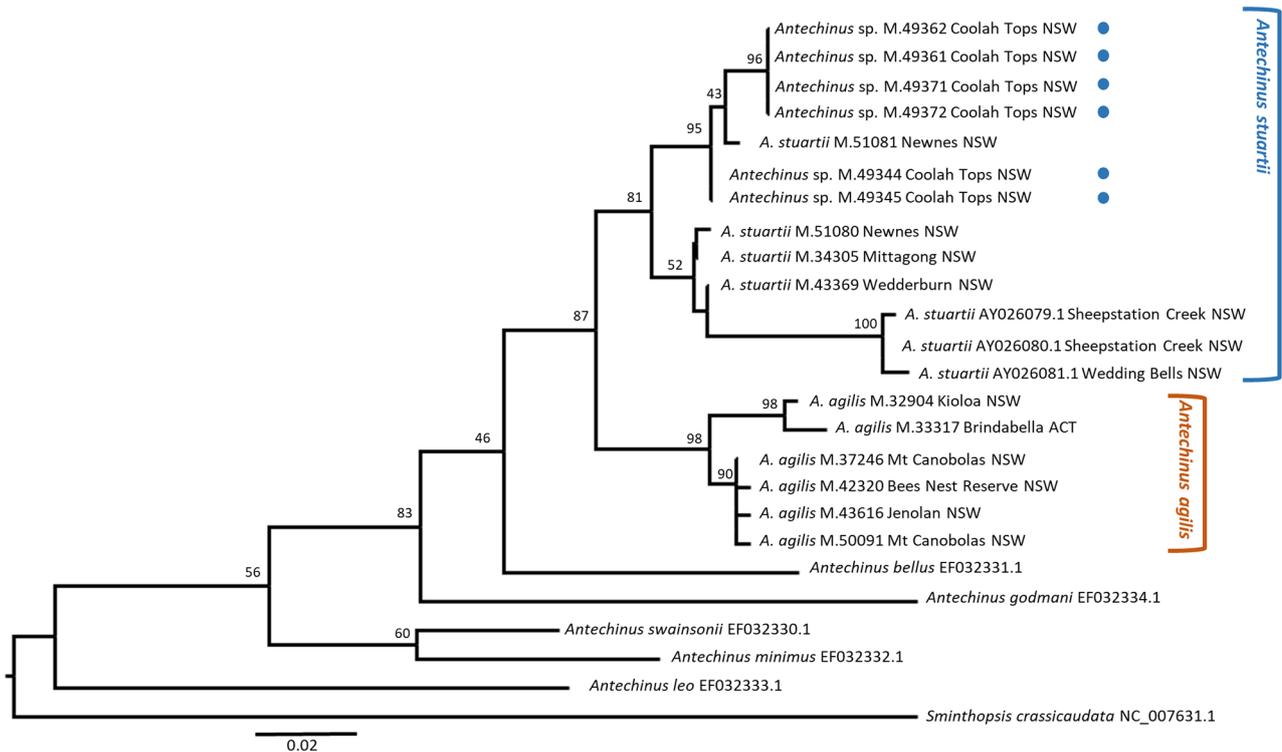


Figure 11. Phylogenetic relationships of *Antechinus specimens* sampled at Coolah Tops ●, compared to confirmed *A. stuartii* and *A. agilis* specimens from southeastern Australia based on c. 450 bp of mtDNA control region sequence.

Table 5. Morphological measurements (mm) of *Antechinus stuartii* captured at Coolah Tops in May 2018.

sex	n		head/body	tail	hindfoot	ear	weight (g)
male	3	mean	90.2	85.1	17.3	14.9	21.8
		SD	5.7	1.6	1.0	0.6	3.9
female	3	mean	85.2	76.5	16.7	15.8	15.7
		SD	3.8	7.0	1.2	1.5	0.6

Pseudocheirus peregrinus, as has previously been reported (Kavanagh, 1995; NPWS, 1998). Sugar Gliders, *Petaurus breviceps* were also regularly seen and heard, but the Common Brush-tail Possum, *Trichosurus vulpecula* was rarely observed. For example, in May during an 800 m walked transect along Hildegard Rd from Bracken’s Hut between 7.30–8.30 pm 23 *Petauroides volans*, 15 *Pseudocheirus peregrinus*, 3 *Petaurus breviceps* and 1 *T. vulpecula* were seen. Several severed tails of *Petauroides volans*, as well as assorted skeletal remains were collected from under a Powerful Owl roost tree (Appendix 5).

Microbats

The presence of nine microbat species was documented (Table 4), including two threatened species, the Large-eared Pied Bat, *Chalinolobus dwyeri* (Fig. 12) and the Eastern Falsistrelle, *Falsistrellus tasmaniensis*, both listed as *Vulnerable* under NSW legislation. All of these species were recorded during previous bat surveys of the area decades ago (e.g., Hoye, 1986; Coles *et al.*, 1994), but as no voucher specimens were taken during these surveys, it is valuable to now be able to confirm species identifications, particularly given the extensive changes in bat species taxonomy that have occurred over the past 25 years (Jackson & Groves, 2015) and to provide reference material to ensure continued

accurate species identities in the light of taxonomic changes that are likely in the future.

A total of 214 microbats (150 males, 55 females, 9 unrecorded) were captured, representing 8 species (see Table 6 for standard morphological measurements); 77 were captured using harp traps in May and 137 were captured in November using harp traps (120) and trip-lining (17). The presence of an additional species, the White-striped Mastiff Bat, *Austronomus australis*, was detected most nights from its audible calls recorded with ultrasonic bat detectors.

The majority of bats captured (69%) were of a single species the Large Forest Bat, *Vespadelus darlingtoni* and the second most frequently trapped was the Chocolate Watted Bat, *Chalinolobus morio* (11% of captures). These two species made up 80% of bats captured. For the remaining six species, captures were of between 2 and 13 individuals.

Most bats captured (73%) were adult males. Biased sex ratios at this spatial scale have been recorded in a wide range of bat genera, both within Australia and in temperate zone bat faunas of other continents but remains a poorly understood phenomenon. Possibilities include altitudinal or spatial segregation of sexes at certain times of year; chance proximity to predominantly male roost sites; increased male activity during the mating season or habitat selection arising from gender differences in reproductive or thermal physiology.



Figure 12. A Large-eared Pied Bat, *Chalinolobus dwyeri* recorded at Coolah Tops and listed as *Vulnerable* in NSW and nationally. Photo by Sandy Ingleby.

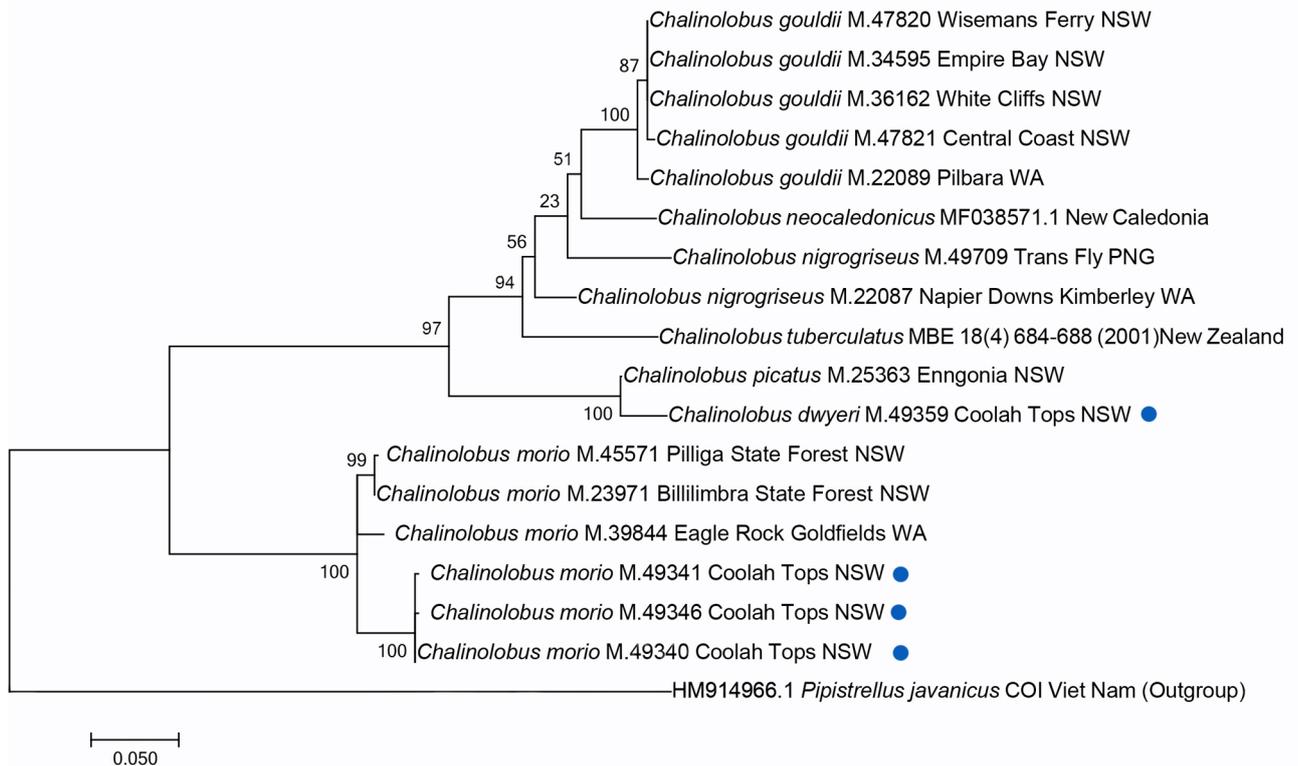


Figure 13. Phylogenetic relationships (ML) of *Chalinolobus* specimens sampled at Coolah Tops ●, compared to other *Chalinolobus* species from Australasia based on 526 bp of mtDNA CO1 sequence. Partial cytb sequence data yielded a tree of similar topology.

Table 6. Morphological measurements (mm) of eight microbat species (*Falsistrellus*, *Nyctophilus*, *Chalinolobus*, *Vespadelus*) captured at Coolah Tops.

species	sex	n	forearm	n	weight (g)	n	head/body	tail	ear	
<i>F. tasmaniensis</i>	M	1	53.6	1	19.9	—	—	—	—	
	F	mean	3	53.7	3	22.6	2	69.5	53.2	17.8
		SD		1.2		3.5		4.9	0.2	0.5
		range		52.3–54.4		19.0–26.0		66.0–73.0	53.0–53.3	27.4–18.1
<i>N. gouldi</i>	M	mean	9	38.6	9	7.6	5	50.7	43.3	27.4
		SD		0.5		0.33		2.1	2.9	1.1
		range		37.8–39.3		7.3–8.2		47.0–52.0	41.1–47.0	25.9–28.8
<i>N. geoffroyi</i>	M	mean	7	35.6	7	6.2	5	49.0	42.4	25.8
		SD		0.8		0.5		2.1	2.3	0.5
		range		34.4–36.8		5.6–7.1		46.2–51.2	40.6–46.2	25.2–26.6
<i>C. dwyeri</i>	M	mean	2	39.9	2	8.3	—	—	—	
		SD		0.2		0.8		—	—	—
		range		39.7–40.0		7.7–8.9		—	—	
	F	1	40.3	1	11	1	56	50.3	18.9	
<i>C. gouldii</i>	M	mean	2	45.0	2	13.5	2	55.8	55.4	16.0
		SD		1.1		1.4		6.7	6.6	0.6
		range		44.2–45.8		12.5–14.5		51.0–60.5	50.7–60.0	15.6–16.4
<i>C. morio</i>	M	mean	16	37.9	10	7.9	5	51.4	43.2	11.7
		SD		0.9		0.6		1.7	2.6	1.0
		range		36.3–40.0		6.9–8.9		49.8–54.0	40.0–46.6	10.2–12.7
	F	mean	2	38.4	2	8.4	1	55.3	49.8	12.3
		SD		0.6		0.7		—	—	
		range		37.9–38.8		7.9–8.9		—	—	
<i>V. vulturinus</i>	M	mean	4	28.4	4	4.2	4	41.3	32.6	12.4
		SD		0.7		0.7		1.3	2.5	1.1
		range		27.5–29.1		3.6–5.2		40.0–43.0	29.0–34.5	11.4–14.0
	F	mean	9	29.5	9/4	4.7	4	43	33.3	12.2
		SD		0.5		0.2		1	1.2	0.3
		range		28.8–30.2		4.2–4.8		40.5–44.0	32.0–34.4	10.3–12.4
<i>V. darlingtoni</i>	M	mean	89	35.0	17	6.4	6	46.0	36.1	12.9
		SD		0.8		0.6		3.0	1.2	0.6
		range		32.4–36.5		5.2–7.4		43.5–51.7	34.9–37.4	12.3–13.9
	F	mean	17	35.8	6	6.7	4	50.6	36.1	12.6
		SD		0.9		1.9		5.6	2.5	1.4
		range		33.6–37.4		3.5–9.0		44.0–57.0	33.1–39.0	10.4–13.4

Chalinolobus

A total of 29 specimens of *Chalinolobus* were captured; 24 *C. morio*, 10 in May (8 males, 2 females) and 14 in November (10 males, 4 females), three *C. dwyeri* (2 male, 1 female) in May, and two Gould's Wattled Bat, *C. gouldii* (both male) in November.

Genetic analysis revealed little divergence amongst specimens of *C. gouldii* sampled from Coolah Tops and across Australia (Fig 13). In contrast, two divergent clades were identified within sampled *C. morio*, with both clades being present in western NSW (Fig. 13). These clades showed similar levels of divergence as *C. dwyeri* and Little Pied Bat, *C. picatus* (Fig. 13). Additional sampling across the transcontinental distribution of *C. morio*, as well as further genetic and morphological analyses will be required to resolve whether these clades represent cryptic species.

Documenting the continued presence of the *C. dwyeri* at Coolah Tops, where it was first recorded in the area in 1986 (Hoye, 1986), was especially significant. This species is poorly known and has a limited distribution in NSW and Queensland (Van Dyck & Strahan, 2008). It is rarely captured in harp traps but in May three were trapped at different sites at

the western end of the Park. However, none were captured in November. Unlike most of the bat species detected at Coolah Tops, *C. dwyeri* roosts in caves, rock overhangs and disused mine tunnels but colonies are never larger than a few dozen individuals (Hoye & Schulz, 2008), unlike some cave bats that form colonies of many thousands (Churchill, 2008).

Vespadelus

A total of 161 specimens of *Vespadelus* were captured; 148 *V. darlingtoni*, 46 (39 males, 7 females) in May and 102 (67 males, 27 females, 8 unsexed) in November; and 13 Little Forest Bats, *V. vulturinus* three (1 male, 2 females) in May and 10 (3 males, 7 females) in November.

Six individual *Vespadelus* proved difficult to identify to species based on morphological criteria and were thought to potentially be specimens of the Southern Forest Bat, *V. regulus* or Eastern Forest Bat, *V. pumilus*, which are intermediate in size between *V. darlingtoni* and *V. vulturinus* (Van Dyck & Strahan, 2008). Genetic analysis, however, confirmed that only two *Vespadelus* species were present in the samples we collected at Coolah Tops: *V. darlingtoni* and *V. vulturinus* (Fig. 14). Previous bat surveys (e.g., Hoye, 1986;

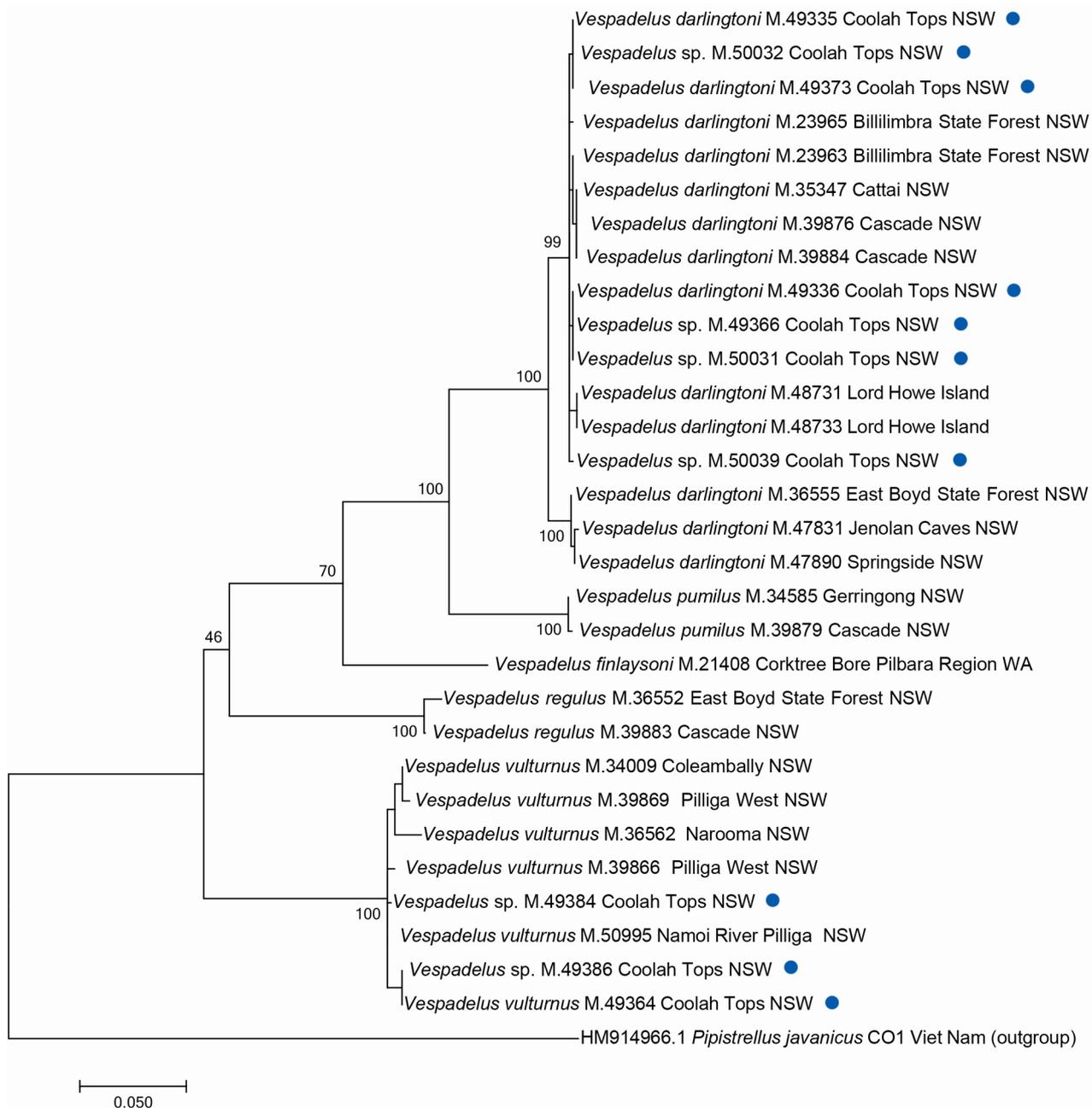


Figure 14. Phylogenetic relationships (ML) of *Vespadelus* specimens sampled at Coolah Tops ●, compared to other *Vespadelus* species from across Australia based on 598 bp of mtDNA COI sequence. Partial cytb sequence data yielded a tree of similar topology.

Coles *et al.*, 1994) have reported *V. regulus* and *V. pumilus* at Coolah Tops, but in the absence of voucher specimens, these species identifications cannot be confirmed although both species could be expected from the area.

Nyctophilus

A total of 20 specimens of *Nyctophilus* were captured; nine Gould's Long-eared Bats, *N. gouldi*, seven in May, two in November (all male), and 11 Lesser Long-eared Bats, *N. geoffroyi*, six in May (all male) and five in November (2 male, 2 female, 1 unrecorded).

Genetic analysis confirmed the presence of two species of *Nyctophilus* at Coolah Tops; *N. gouldi* and *N. geoffroyi*. Interestingly, for both *Nyctophilus* species, major genetic divergence and a lack of monophyly was present within comparative samples from across Australia (Fig. 15). This suggests that previously unrecognized species are present within both *N. gouldi* and *N. geoffroyi* as currently defined, with

western and eastern Australian populations being highly distinct (Fig. 15). Additional sampling, as well as further genetic and morphological analyses will be required to resolve this.

In eastern Australia both *N. geoffroyi* and *N. gouldi* show significant morphological variation at the same locality. It has not been clear whether this variation represents a high level of individual variation or is due to the presence of unrecognized species. The genetic analysis of Coolah Tops specimens of *Nyctophilus* has therefore provided a valuable benchmark for determining morphological field identification criteria by confirming that cryptic species are not present in these species at Coolah Tops.

Falsistrellus

Four individuals of *F. tasmaniensis* were captured, two in May (1 male, 1 female) and two in November (2 females). All were captured at the same location. This species is close to the western distributional limit in this region of NSW

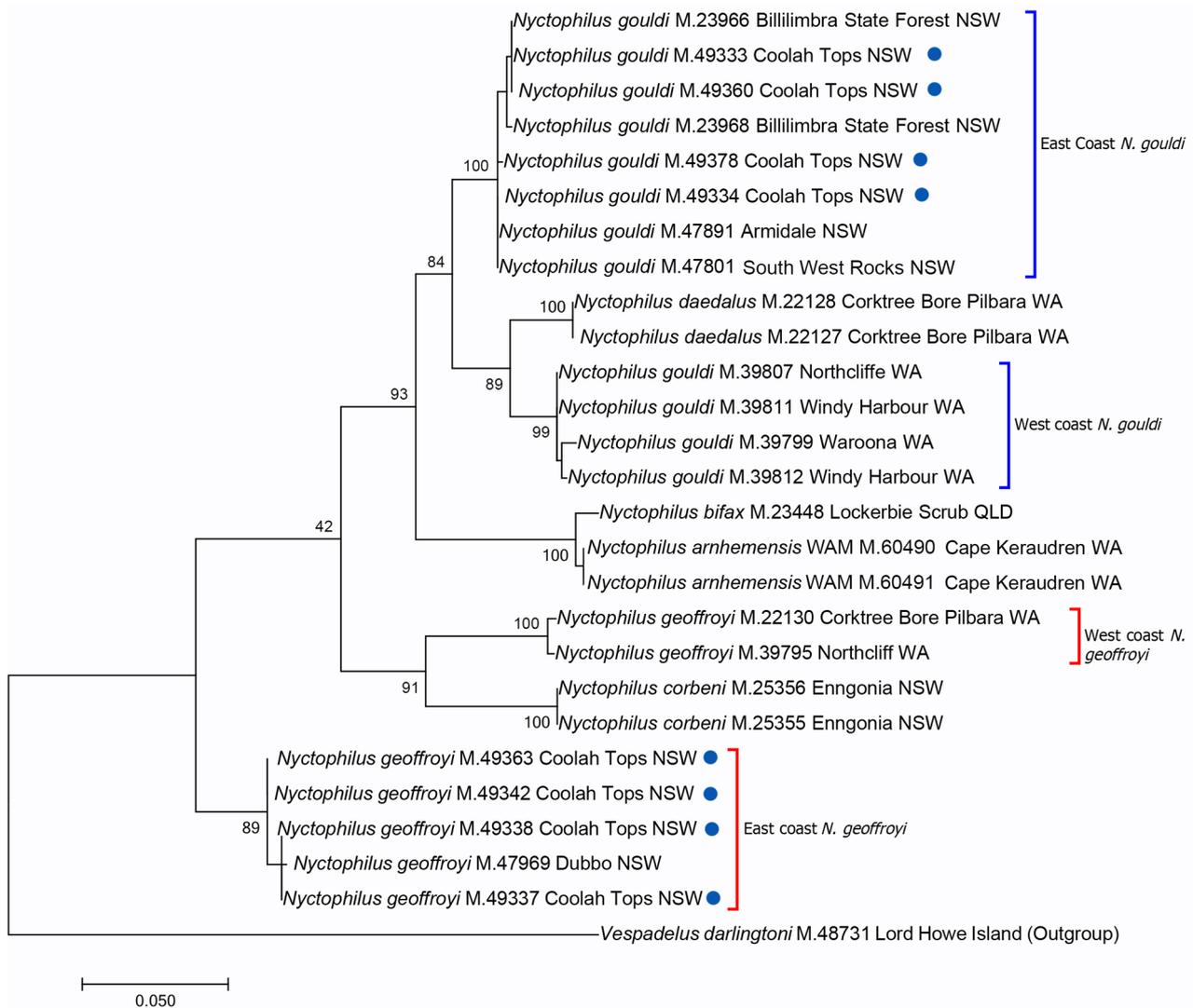


Figure 15. Phylogenetic relationships (ML) of *Nyctophilus* specimens sampled at Coolah Tops ●, compared to other *Nyctophilus* species from across Australia based on 602 bp of mtDNA COI sequence. Partial cytb sequence data yielded a tree of similar topology.

(Pennay *et al.*, 2011) and is typically trapped in relatively low numbers and represented 6% of bats trapped by Coles *et al.* (1994). Like the majority of bat species in the region, it roosts colonially in hollows in old trees but very little is known of its ecology or movements. Law *et al.* (2008) reported an opportunistic record of a long distance movement by a banded female trapped 88 km from its original trap site three years earlier in subcoastal NSW. This suggests the possibility that populations of this species utilize resources across a large spatial scale.

Two additional bat species captured in the area by Coles *et al.* (1994) were not encountered during this survey. These are the Greater Broad-nosed Bat, *Scoteanax rueppellii*, listed as *Vulnerable* under NSW legislation, and another species “*Mormopterus planiceps*”. The latter cannot be assigned to currently recognized species due to a recent taxonomic revision that split “*M. planiceps*” into several species (Reardon *et al.*, 2014) but on distributional grounds is likely to be either the Eastern Freetail Bat, *Ozimops ridei* or possibly the Southeastern Freetail Bat, *O. planiceps*, or less likely, the Inland Freetail Bat, *O. petersi*. Although neither species was retained as a voucher specimen, measurements given by Coles *et al.* (1994) of forearm length (51.5 mm) and body weight (20 g) support their identification of *Scoteanax rueppellii* as it is unusually large for males of the otherwise

externally similar *F. tasmaniensis*. We also accept their identification of *Mormopterus* (now *Ozimops*), which is a highly distinctive group of bats, though species recognition remains difficult.

Four bat species not recorded during this or earlier surveys possibly occur in the study area based on their overall distribution within NSW (Churchill, 2008). Three of these are listed as *Vulnerable* under NSW legislation, while the fourth, the cave roosting Eastern Horseshoe Bat, *Rhinolophus megaphyllus*, occurs in other regions of the western slopes of NSW (Murphy, 2014). The latter species has highly distinctive echolocation calls that were not recorded during extensive call monitoring during May 2018. Either the species does not occur in the study area, is an erratic visitor, or else it occurs close to the cave systems in the area that were not sampled during this study. Similar comments apply for the cave dwelling Eastern Bentwing Bat, *Miniopterus oceanensis*, which is known to undergo long distance regional movements utilising transient cave roost sites. The hollow roosting Yellow-bellied Sheath-tail Bat, *Saccolaimus flaviventris*, is a high-flying species that is infrequently trapped, and potentially visits the region seasonally. The stream foraging specialist, the Large-footed Myotis, *Myotis macropus*, was not captured in a mist net survey at Norfolk Falls (Hoye, 1986). The occurrence of



Figure 16. Bracken's Hut, fieldwork base for AMRI teams in Coolah Tops National Park. Photo by Richard Major.

this species in streams west of the Dividing Range is very poorly known.

Two seasonally nomadic flying fox species, the Little Red Flying Fox, *Pteropus scapulatus*, and the Grey-headed Flying fox, *P. poliocephalus*, were not recorded in the area but could visit opportunistically in response to flowering events of eucalypt food trees (Churchill, 2008).

Introduced mammals

Of the 27 mammal species recorded within the Park, seven (26%) species were introduced. The most commonly sighted introduced species was Fallow Deer, *Dama dama*, with individuals and small herds (2–5 individuals) being sighted most days. While not mentioned in the 2002 *Plan of Management* (NPWS, 2002) *D. dama* is clearly now well established in the Park and a cause of concern with trampling and browsing damage evident in some areas (e.g., Tea-Tree swamp habitat). Feral Pigs, *Sus scrofa*, were also regularly sighted especially along creek lines where evidence of their foraging was apparent. Goats, *Capra hircus*, and Cattle, *Bos taurus*, were much more common in the cleared grazing land outside the Park but were also regularly seen, or droppings detected, inside the Park; the goats appearing to favor slopes and areas of escarpment. Evidence and sightings of European Rabbits, *Oryctolagus cuniculus* were widespread but most common in cleared grassy areas. The European Red Fox, *Vulpes vulpes*, was heard once in May and sighted once in November. Within the National Park, we only recorded the introduced House Mouse, *Mus musculus*, in and around Bracken's Hut (Fig. 16).

Conclusion

The Australian Museum Research Institute's two field trips to Coolah Tops National Park have continued to document the vertebrate biodiversity of the Park recording the presence of 109 species. This fieldwork has also significantly increased the AM's holding of specimens and genetic samples from this biologically significant area of NSW. A total of 43 vertebrate species were sampled; 160 specimens and associated tissues of 39 species; an additional 51 tissue samples from three bird and six mammal species, as well as 13 skeletal remains of six mammal species were added to the AM collections. Some of this material has already been incorporated into several research projects and will continue to be utilized by researchers for decades to come.

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Appendices

Appendix 1. Mountain Galaxias (*Galaxias olidus*) sampled in May 2018, Coolah Tops National Park, New South Wales.

reg. no.	sample type	location
I.47903-001	Lot, 4 wet specimens	Talbragar Creek (31°45'22"S 150°06'14"E)
I.47903.002	frozen tissue	
I.47904-001	Lot, 12 wet specimens	Base of Norfolk Falls (31°44'52"S 150°00'42"E)
I.47904.002	frozen tissue	
I.47905-001	Lot, 6 wet specimens	above falls, Cox's Creek (31°43'57"S 150°00'40"E)
I.47905.002	frozen tissue	
I.47906-001	Lot, 7 wet specimens	base of falls, Talbragar Creek (31°45'18"S 150°06'16"E)
I.47906.002	frozen tissue	
I.47907-001	Lot, 6 wet specimens	base of Bald Hills (Bounty Creek) falls (31°45'22"S 150°00'49"E)
I.47907.002	frozen tissue	

Appendix 2. Reptiles sampled during May and November 2018, Coolah Tops National Park, NSW and environs.

reg. no.	sample type	family	species	location
R.185774	wet specimen	Elapidae	<i>Pseudonaja textilis</i>	State Forest Rd (31°45'10"S 149°54'03"E)
R.185774.001–2	frozen tissues			
R.185768*	wet specimen	Scincidae	<i>Lampropholis caligula</i>	Shepherds Peak Trail (31°49'24"S 150°11'59"E)
R.185768.001*	frozen tissue			
R.185860	wet specimen	Scincidae	<i>Lampropholis caligula</i>	Shepherds Peak Trail (31°49'25"S 150°12'08"E)
R.185860.001	frozen tissue			
R.185861	wet specimen	Scincidae	<i>Lampropholis caligula</i>	Shepherds Peak Trail (31°49'25"S 150°12'08"E)
R.185861.001	frozen tissue			
R.185869	wet specimen	Scincidae	<i>Lampropholis caligula</i>	Shepherds Peak Trail (31°49'25"S 150°11'59"E)
R.185869.001–2	frozen tissues			
R.185875	wet specimen	Scincidae	<i>Lampropholis caligula</i>	Shepherds Peak Trail (31°49'25"S 150°12'08"E)
R.185787	wet specimen	Scincidae	<i>Lampropholis delicata</i>	Rocky Creek (31°42'20"S 150°00'50"E)
R.185787.001	frozen tissue			
R.185788	wet specimen	Scincidae	<i>Lampropholis delicata</i>	Shepherds Peak Trail (31°49'25"S 150°12'09"E)
R.185788.001	frozen tissue			
R.185852	wet specimen	Scincidae	<i>Lampropholis delicata</i>	Brackens Hut (31°45'01"S 150°01'37"E)
R.185852.001	frozen tissue			
R.185853	wet specimen	Scincidae	<i>Lampropholis delicata</i>	Brackens Hut (31°45'01"S 150°01'37"E)
R.185853.001	frozen tissue			
R.185857	wet specimen	Scincidae	<i>Lampropholis delicata</i>	Brackens Hut (31°45'11"S 150°01'55"E)
R.185857.001	frozen tissue			
R.185859	wet specimen	Scincidae	<i>Lampropholis delicata</i>	Brackens Hut (31°44'59"S 150°01'54"E)
R.185859.001	frozen tissue			
R.185870	wet specimen	Scincidae	<i>Lampropholis delicata</i>	Norfolk Falls (31°44'52"S 150°00'45"E)
R.185870.001	frozen tissue			
R.185769*	wet specimen	Scincidae	<i>Saproscincus mustelinus</i>	Shepherds Peak Trail (31°49'28"S 150°12'04"E)
R.185769.001*	frozen tissue			
R.185770*	wet specimen	Scincidae	<i>Saproscincus mustelinus</i>	Shepherds Peak Trail (31°49'28"S 150°12'04"E)
R.185770.001*	frozen tissue			
R.185771	wet specimen	Scincidae	<i>Saproscincus mustelinus</i>	Forest Road (31°47'50"S 150°10'31"E)
R.185771.001	frozen tissue			
R.185772	wet specimen	Scincidae	<i>Saproscincus mustelinus</i>	Forest Road (31°47'50"S 150°10'31"E)
R.185772.001	frozen tissue			
R.185773	wet specimen	Scincidae	<i>Saproscincus mustelinus</i>	Shepherds Peak Trail (31°49'26"S 150°12'08"E)
R.185773.001	frozen tissue			

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Appendix 2 (continued). Reptiles sampled during May and November 2018, Coolah Tops National Park, NSW and environs.

reg. no.	sample type	family	species	location
R.185776*	wet specimen	Scincidae	<i>Cryptoblepharus pulcher</i>	Pinnacles Lookout, (31°41'39"S 150°00'44"E)
R.185776.001*	frozen tissue			
R.185777	wet specimen	Scincidae	<i>Cryptoblepharus pulcher</i>	Pinnacle Lookout (31°41'39"S 150°00'44"E)
R.185777.001	frozen tissue			
R.185778	wet specimen	Scincidae	<i>Cryptoblepharus pulcher</i>	Pinnacle Lookout (31°41'39"S 150°00'44"E)
R.185778.001	frozen tissue			
R.185779	wet specimen	Scincidae	<i>Cryptoblepharus pulcher</i>	Pinnacle Lookout (31°41'39"S 150°00'44"E)
R.185779.001	frozen tissue			
R.185780	wet specimen	Scincidae	<i>Cryptoblepharus pulcher</i>	Pinnacle Lookout (31°41'39"S 150°00'44"E)
R.185780.001	frozen tissue			
R.185781	wet specimen	Scincidae	<i>Cryptoblepharus pulcher</i>	Pinnacle Lookout (31°41'39"S 150°00'44"E)
R.185781.001	frozen tissue			
R.185782	wet specimen	Scincidae	<i>Cryptoblepharus pulcher</i>	Pinnacle Lookout (31°41'39"S 150°00'44"E)
R.185782.001	frozen tissue			
R.185783	wet specimen	Scincidae	<i>Cryptoblepharus pulcher</i>	Pinnacle Lookout (31°41'39"S 150°00'44"E)
R.185783.001	frozen tissue			
R.185784	wet specimen	Scincidae	<i>Cryptoblepharus pulcher</i>	Pinnacle Lookout (31°41'39"S 150°00'44"E)
R.185784.001	frozen tissue			
R.185785	wet specimen	Scincidae	<i>Ctenotus taeniolatus</i>	Pinnacle Lookout (31°41'39"S 150°00'44"E)
R.185785.001	frozen tissue			
R.185786	wet specimen	Scincidae	<i>Ctenotus taeniolatus</i>	Pinnacle Lookout (31°41'39"S 150°00'44"E)
R.185786.001	frozen tissue			
R.185854	wet specimen	Scincidae	<i>Ctenotus taeniolatus</i>	Shepherds Peak (31°49'18"S 150°12'19"E)
R.185854.001	frozen tissue			
R.185856	wet specimen	Scincidae	<i>Ctenotus taeniolatus</i>	Brackens Hut (31°45'06"S 150°01'46"E)
R.185856.001	frozen tissue			
R.190835.001	frozen tissue	Scincidae	<i>Hemiernis talbingoensis</i>	Shepherds Peak Trail (31°49'28"S 150°12'05"E)
R.185789	wet specimen	Scincidae	<i>Egernia striolata</i>	Shepherds Peak (31°49'14"S 150°12'18"E)
R.185789.001–2	frozen tissues			
R.185790	wet specimen	Scincidae	<i>Egernia striolata</i>	Shepherds Peak (31°49'17"S 150°12'19"E)
R.185790.001–2	frozen tissues			
R.185791	wet specimen	Scincidae	<i>Egernia striolata</i>	Shepherds Peak (31°49'17"S 150°12'19"E)
R.185791.001–2	frozen tissues			
R.185874	wet specimen	Scincidae	<i>Egernia striolata</i>	Pinnacle Lookout (31°41'40"S 150°00'45"E)
R.185874.001–2	frozen tissues			
R.185792	wet specimen	Scincidae	<i>Egernia cunninghami</i>	Shepherds Peak (31°49'15"S 150°12'19"E)
R.185792.001–2	frozen tissues			
R.185793	wet specimen	Scincidae	<i>Egernia cunninghami</i>	Shepherds Peak (31°49'15"S 150°12'19"E)
R.185793.001–3	frozen tissues			
R.185873	wet specimen	Scincidae	<i>Egernia cunninghami</i>	Pinnacle Lookout (31°41'40"S 150°00'44"E)
R.185873.001–3	frozen tissues			
R.186649	wet specimen	Scincidae	<i>Egernia cunninghami</i>	Pinnacle Lookout (31°41'40"S 150°00'44"E)
R.186649.001	frozen tissue			
R.186650	wet specimen	Scincidae	<i>Egernia cunninghami</i>	Pinnacle Lookout (31°41'40"S 150°00'44"E)
R.186650.001	frozen tissue			
R.185855	wet specimen	Scincidae	<i>Acritoscincus platynotus</i>	Brackens Hut (31°44'60"S 150°01'37"E)
R.185855.001	frozen tissue			
R.185858	wet specimen	Scincidae	<i>Liopholis whitii</i>	Bundella Lookout (31°41'48"S 150°01'04"E)
R.185858.001	frozen tissue			
R.185867	wet specimen	Scincidae	<i>Liopholis whitii</i>	Shepherds Peak (31°49'14"S 150°12'19"E)
R.185867.001–2	frozen tissues			
R.185868	wet specimen	Scincidae	<i>Liopholis whitii</i>	Shepherds Peak (31°49'14"S 150°12'19"E)
R.185868.001	frozen tissue			
R.185866	wet specimen	Diplodactylidae	<i>Underwoodisaurus milii</i>	Pinnacle Lookout (31°41'41"S 150°00'45"E)
R.185866.001–2	frozen tissues			
R.185871	wet specimen	Diplodactylidae	<i>Nebulifera robusta</i>	Pinnacle Lookout (31°41'40"S 150°00'44"E)
R.185871.001	frozen tissue			
R.185872	wet specimen	Agamidae	<i>Amphibolurus muricatus</i>	Bundella Lookout (31°41'48"S 150°01'04"E)
R.185872.001	frozen tissue			

* donated to the Australian Museum by Michael Murphy, NPWS.

Registration numbers R.185768–R.185793 were sampled in May; R.185852–R.190835 were sampled in November 2018.

Appendix 3. Anurans sampled during May and November 2018, Coolah Tops National Park, New South Wales.

reg. no.	sample type	family	species	location
R.185775*	wet specimen	Myobatrachidae	<i>Crinia signifera</i>	Rocky Creek Falls (31°42'20"S 150°00'44"E)
R.185775.001*	frozen tissue			
R.185863	wet specimen	Myobatrachidae	<i>Crinia signifera</i>	Dam, south of Forest Rd (31°43'42"S 150°02'52"E)
R.185863.001	frozen tissue			
R.185864	wet specimen	Myobatrachidae	<i>Crinia signifera</i>	top of falls, Norfolk Island Ck (31°44'51"S 150°00'43"E)
R.185864.001	frozen tissue			
R.185862	wet specimen	Hylidae	<i>Litoria peronii</i>	Dam, south of Forest Rd (31°43'42"S 150°02'52"E)
R.185862.001	frozen tissue			
R.185865	wet specimen	Hylidae	<i>Litoria peronii</i>	above falls, Norfolk Island Ck (31°44'48"S 150°00'53"E)
R.185865.001	frozen tissue			

* donated to the Australian Museum by Michael Murphy, NPWS.

Registration number R.185775 was sampled in May; R.185862–R.185865 were sampled in November 2018.

Appendix 4. Birds sampled during May 2018, Coolah Tops National Park, New South Wales.

reg. no.	sample type	family	species	location
O.76914	study skin	Psittacidae	<i>Platycercus elegans</i>	Swamp, Brackens Hut (31°45'04"S 150°01'57"E)
O.76914.001-4	frozen tissues*			
O.76941	skeleton, wing	Psittacidae	<i>Platycercus elegans</i>	Swamp, Brackens Hut (31°45'04"S 150°01'57"E)
O.76941.001	frozen tissue			
O.76915.001	blood	Halcyonidae	<i>Dacelo novaeguineae</i>	Forest, Brackens Hut (31°45'01"S 150°01'54"E)
O.76930.001	blood	Halcyonidae	<i>Dacelo novaeguineae</i>	Forest, Brackens Hut (31°45'09"S 150°01'56"E)
O.76931.001	blood	Halcyonidae	<i>Dacelo novaeguineae</i>	Forest, Brackens Hut (31°45'09"S 150°01'56"E)
O.76911	study skin	Climacteridae	<i>Corombates leucophaea</i>	Forest, Brackens Hut (31°45'01"S 150°01'54"E)
O.76911.001-3	frozen tissues			
O.76900.001	feather	Maluridae	<i>Malurus cyaneus</i>	Swamp, Brackens Hut (31°45'04"S 150°01'57"E)
O.76901.001	feather	Maluridae	<i>Malurus cyaneus</i>	Swamp, Brackens Hut (31°45'04"S 150°01'57"E)
O.76902.001	feather	Maluridae	<i>Malurus cyaneus</i>	Swamp, Brackens Hut (31°45'04"S 150°01'57"E)
O.76903.001	feather	Maluridae	<i>Malurus cyaneus</i>	Swamp, Brackens Hut (31°45'04"S 150°01'57"E)
O.76904	study skin	Maluridae	<i>Malurus cyaneus</i>	Swamp, Brackens Hut (31°45'04"S 150°01'57"E)
O.76904.001-3	frozen tissues			
O.76905	study skin	Maluridae	<i>Malurus cyaneus</i>	Swamp, Brackens Hut (31°45'04"S 150°01'57"E)
O.76905.001-3	frozen tissues			
O.76907.001	blood	Maluridae	<i>Malurus cyaneus</i>	Swamp, Brackens Hut (31°45'04"S 150°01'57"E)
O.76908.001	blood	Maluridae	<i>Malurus cyaneus</i>	Swamp, Brackens Hut (31°45'04"S 150°01'57"E)
O.76909.001	blood	Maluridae	<i>Malurus cyaneus</i>	Swamp, Brackens Hut (31°45'04"S 150°01'57"E)
O.76918	study skin	Maluridae	<i>Malurus cyaneus</i>	Swamp, Brackens Hut (31°45'04"S 150°01'57"E)
O.76918.001-3	frozen tissues			
O.76940	study skin	Maluridae	<i>Malurus cyaneus</i>	Swamp, Brackens Hut (31°45'04"S 150°01'57"E)
O.76940.001	frozen tissue			
O.76906	study skin	Pardalotidae	<i>Sericornis frontalis</i>	Swamp, Brackens Hut (31°45'04"S 150°01'57"E)
O.76906.001-3	frozen tissues			
O.76910	study skin	Pardalotidae	<i>Sericornis frontalis</i>	Forest, Brackens Hut (31°45'01"S 150°01'54"E)
O.76910.001-3	frozen tissues			
O.76916	skeleton	Pardalotidae	<i>Sericornis frontalis</i>	Forest, Brackens Hut (31°45'01"S 150°01'54"E)
O.76916.001	frozen tissue			
O.76912	study skin	Pardalotidae	<i>Acanthiza pusilla</i>	Forest, Brackens Hut (31°45'01"S 150°01'54"E)
O.76912.001-3	frozen tissues			
O.76927	study skin	Pardalotidae	<i>Acanthiza pusilla</i>	Forest, Brackens Hut (31°45'01"S 150°01'54"E)
O.76927.001-3	frozen tissues			
O.76937	study skin	Pardalotidae	<i>Acanthiza pusilla</i>	Forest, Brackens Hut (31°45'01"S 150°01'54"E)
O.76937.001	frozen tissue			
O.76938	study skin	Pardalotidae	<i>Acanthiza pusilla</i>	Forest, Brackens Hut (31°45'01"S 150°01'54"E)
O.76938.001	frozen tissue			
O.76919	study skin	Pardalotidae	<i>Acanthiza lineata</i>	Swamp, Brackens Hut (31°45'04"S 150°01'57"E)
O.76919.001-3	frozen tissues			
O.76920	study skin	Pardalotidae	<i>Acanthiza lineata</i>	Swamp, Brackens Hut (31°45'04"S 150°01'57"E)
O.76920.001-3	frozen tissues			
O.76921.001	feathers	Pardalotidae	<i>Acanthiza lineata</i>	Swamp, Brackens Hut (31°45'04"S 150°01'57"E)
O.76922.001	feathers	Pardalotidae	<i>Acanthiza lineata</i>	Swamp, Brackens Hut (31°45'04"S 150°01'57"E)
O.76923.001	feathers	Pardalotidae	<i>Acanthiza lineata</i>	Swamp, Brackens Hut (31°45'04"S 150°01'57"E)
O.76925.001	feathers	Pardalotidae	<i>Acanthiza lineata</i>	Swamp, Brackens Hut (31°45'04"S 150°01'57"E)
O.76926.001	feathers	Pardalotidae	<i>Acanthiza lineata</i>	Swamp, Brackens Hut (31°45'04"S 150°01'57"E)
O.76935	study skin	Pardalotidae	<i>Acanthiza lineata</i>	Forest, Brackens Hut (31°45'01"S 150°01'54"E)
O.76935.001	frozen tissue			
O.76936	study skin	Pardalotidae	<i>Acanthiza lineata</i>	Forest, Brackens Hut (31°45'01"S 150°01'54"E)
O.76936.001	frozen tissue			
O.76932	study skin	Pardalotidae	<i>Acanthiza reguloides</i>	Forest, Brackens Hut (31°45'01"S 150°01'54"E)
O.76932.001	frozen tissue			
O.76933	study skin	Pardalotidae	<i>Acanthiza reguloides</i>	Forest, Brackens Hut (31°45'01"S 150°01'54"E)
O.76933.001	frozen tissue			
O.76934	study skin	Pardalotidae	<i>Acanthiza reguloides</i>	Forest, Brackens Hut (31°45'01"S 150°01'54"E)
O.76934.001	frozen tissue			
O.76913	study skin	Meliphagidae	<i>Acanthorhynchus tenuirostris</i>	Swamp, Brackens Hut (31°45'04"S 150°01'57"E)
O.76913.001-3	frozen tissues			
O.76924	study skin	Meliphagidae	<i>Lichenostomus chrysops</i>	Swamp, Brackens Hut (31°45'04"S 150°01'57"E)
O.76924.001-3	frozen tissues			
O.76929	study skin	Meliphagidae	<i>Lichenostomus chrysops</i>	Swamp, Brackens Hut (31°45'04"S 150°01'57"E)
O.76929.001-3	frozen tissues			
O.76928	study skin	Petroicidae	<i>Eopsaltria australis</i>	Forest, Brackens Hut (31°45'01"S 150°01'54"E)
O.76928.001-3	frozen tissues			
O.76917	study skin	Pachycephalidae	<i>Pachycephala pectoralis</i>	Swamp, Brackens Hut (31°45'04"S 150°01'57"E)
O.76917.001-3	frozen tissues			
O.76939	study skin	Pachycephalidae	<i>Pachycephala pectoralis</i>	Forest, Brackens Hut (31°45'01"S 150°01'54"E)
O.76939.001	frozen tissue			

* All bird tissues were collected and snap-frozen using specifications for RNA sampling.

Appendix 5. Mammals sampled during May and November 2018, Coolah Tops National Park, New South Wales and environs. Abbreviations: *skel. frag.* = skeletal fragments.

reg. no.	sample type	family	species	location
M.49344	wet specimen	Dasyuridae	<i>Antechinus stuartii</i>	Pinnacle Lookout (31°41'49"S 150°01'06"E)
M.49344.001–2	frozen tissues			
M.49345	wet specimen	Dasyuridae	<i>Antechinus stuartii</i>	Pinnacle Lookout (31°41'49"S 150°01'06"E)
M.49345.001–2	frozen tissues			
M.49361	wet specimen	Dasyuridae	<i>Antechinus stuartii</i>	Hildegard Rd (31°45'06"S 150°01'25"E)
M.49361.001–2	frozen tissues			
M.49362	wet specimen	Dasyuridae	<i>Antechinus stuartii</i>	Creek, Bald Hill Rd (31°45'25"S 150°01'09"E)
M.49362.001–2	frozen tissues			
M.49371	wet specimen	Dasyuridae	<i>Antechinus stuartii</i>	Hildegard Rd (31°45'05"S 150°01'24"E)
M.49371.001–2	frozen tissues			
M.49372	wet specimen	Dasyuridae	<i>Antechinus stuartii</i>	Creek, Bald Hill Rd (31°45'05"S 150°01'24"E)
M.49372.001–2	frozen tissues			
M.49387.001	frozen tissue	Dasyuridae	<i>Antechinus stuartii</i>	Creek, Bald Hill Rd (31°45'25"S 150°01'10"E)
M.49331	skull, skeleton	Macropodidae	<i>Macropus giganteus</i>	Brackens Hut (31°45'07"S 150°01'53"E)
M.49380	skull, skeleton	Macropodidae	<i>Macropus giganteus</i>	Brackens Hut (31°45'05"S 150°01'57"E)
M.49987	skull, skeleton	Macropodidae	<i>Macropus giganteus</i>	Brackens Hut (31°45'06"S 150°01'54"E)
M.49988	skull, skeleton	Macropodidae	<i>Macropus giganteus</i>	Brackens Hut (31°45'03"S 150°01'56"E)
M.49357	skull, skeleton	Macropodidae	<i>Notamacropus rufogriseus</i>	Pinnacle Lookout (31°41'48"S 150°01'04"E)
M.49357.001	frozen tissue			
M.49358	skull, skeleton	Macropodidae	<i>Wallabia bicolor</i>	Creek, Bald Hill Rd (31°45'24"S 150°01'03"E)
M.49527	tails, skel. frag.	Pseudocheiridae	<i>Petauroides volans</i>	The Barracks (31°43'52"S 150°00'55"E)
M.49536	skel. fragments	Pseudocheiridae	<i>Petauroides volans</i>	The Barracks (31°43'52"S 150°00'55"E)
M.49332	skull, skeleton	Vombatidae	<i>Vombatus ursinus</i>	Brackens Hut (31°45'01"S 150°01'45"E)
M.49370	wet specimen	Vombatidae	<i>Vombatus ursinus</i>	Forest Rd (31°43'55"S 150°02'19"E)
M.49370.002–6	frozen tissues			
M.49389	skull	Vombatidae	<i>Vombatus ursinus</i>	Shepherds Peak Trail (31°49'25"S 150°12'10"E)
M.49390	skull	Vombatidae	<i>Vombatus ursinus</i>	Shepherds Peak Trail (31°49'25"S 150°12'10"E)
M.49986	skull, skeleton	Vombatidae	<i>Vombatus ursinus</i>	Brackens Hut (31°45'06"S 150°02'04"E)
M.49359*	wet specimen	Vespertilionidae	<i>Chalinolobus dwyeri</i>	Bundella Track (31°43'49"S 150°03'35"E)
M.49359.001–2*	frozen tissues			
M.49340	wet specimen	Vespertilionidae	<i>Chalinolobus morio</i>	Brackens Hut (31°45'08"S 150°01'57"E)
M.49340.001–2	frozen tissues			
M.49341	wet specimen	Vespertilionidae	<i>Chalinolobus morio</i>	Bundah Trail (31°45'03"S 150°01'22"E)
M.49341.001–2	frozen tissues			
M.49343	wet specimen	Vespertilionidae	<i>Chalinolobus morio</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49343.001–2	frozen tissues			
M.49346	wet specimen	Vespertilionidae	<i>Chalinolobus morio</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49346.001–2	frozen tissues			
M.49348.001	frozen tissue	Vespertilionidae	<i>Chalinolobus morio</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49349.001	frozen tissue	Vespertilionidae	<i>Chalinolobus morio</i>	Creek line, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49354.001	frozen tissue	Vespertilionidae	<i>Chalinolobus morio</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49374.001	frozen tissue	Vespertilionidae	<i>Chalinolobus morio</i>	Dam, Forest Rd (31°43'43"S 150°02'54"E)
M.49376.001	frozen tissue	Vespertilionidae	<i>Chalinolobus morio</i>	Dam, Forest Rd (31°43'43"S 150°02'54"E)
M.49385.001	frozen tissue	Vespertilionidae	<i>Chalinolobus morio</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.51064.001	frozen tissue	Vespertilionidae	<i>Chalinolobus morio</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.51065.001	frozen tissue	Vespertilionidae	<i>Chalinolobus morio</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.51066.001	frozen tissue	Vespertilionidae	<i>Chalinolobus morio</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.51067.001	frozen tissue	Vespertilionidae	<i>Chalinolobus morio</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.51071.001	frozen tissue	Vespertilionidae	<i>Chalinolobus morio</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49992	wet specimen	Vespertilionidae	<i>Chalinolobus morio</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49992.001–2	frozen tissues			
M.51073.001	frozen tissue	Vespertilionidae	<i>Chalinolobus morio</i>	Hildegard Road junction with Forest Road (31°43'15"S 150°05'24"E)
M.50038	wet specimen	Vespertilionidae	<i>Chalinolobus morio</i>	Hildegard Rd (31°44'54"S 150°01'25"E)
M.50038.001–2	frozen tissues			
M.49991	wet specimen	Vespertilionidae	<i>Chalinolobus gouldii</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49991.001–2	frozen tissues			
M.50040	wet specimen	Vespertilionidae	<i>Chalinolobus gouldii</i>	Dam, Forest Rd (31°43'43"S 150°02'54"E)
M.50040.001–2	frozen tissues			
M.50033	wet specimen	Vespertilionidae	<i>Falsistrellus tasmaniensis</i>	Dam, Forest Rd (31°43'43"S 150°02'54"E)
M.50033.001–3	frozen tissues			
M.50041	wet specimen	Vespertilionidae	<i>Falsistrellus tasmaniensis</i>	Dam, Forest Rd (31°43'43"S 150°02'54"E)
M.50041.001–2	frozen tissues			
M.49337	wet specimen	Vespertilionidae	<i>Nyctophilus geoffroyi</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49337.001–2	frozen tissues			
M.49338	wet specimen	Vespertilionidae	<i>Nyctophilus geoffroyi</i>	Bundella Track (31°43'49"S 150°03'35"E)
M.49338.001–2	frozen tissues			

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Appendix 5 (continued). Mammals sampled during May and November 2018, Coolah Tops National Park, New South Wales and environs.

reg. no.	sample type	family	species	location
M.49342	wet specimen	Vespertilionidae	<i>Nyctophilus geoffroyi</i>	Hildegard Rd, (31°44'54"S 150°01'25"E)
M.49342.001–2	frozen tissues			
M.49363	wet specimen	Vespertilionidae	<i>Nyctophilus geoffroyi</i>	Bundah Trail (31°45'03"S 150°01'22"E)
M.49363.001–2	frozen tissues			
M.49382.001	frozen tissue	Vespertilionidae	<i>Nyctophilus geoffroyi</i>	Racecourse Track (31°42'14"S 150°01'15"E)
M.49383.001	frozen tissue	Vespertilionidae	<i>Nyctophilus geoffroyi</i>	Racecourse Track (31°42'14"S 150°01'15"E)
M.50036	wet specimen	Vespertilionidae	<i>Nyctophilus geoffroyi</i>	Hildegard Rd, (31°44'54"S 150°01'25"E)
M.50036.001–2	frozen tissues			
M.49333	wet specimen	Vespertilionidae	<i>Nyctophilus gouldi</i>	Bundah Trail (31°45'03"S 150°01'22"E)
M.49333.001–2	frozen tissues			
M.49334	wet specimen	Vespertilionidae	<i>Nyctophilus gouldi</i>	Bundah Trail (31°45'03"S 150°01'22"E)
M.49334.001–2	frozen tissues			
M.49360	wet specimen	Vespertilionidae	<i>Nyctophilus gouldi</i>	Bundella Track (31°43'49"S 150°03'35"E)
M.49360.001–2	frozen tissues			
M.49369.001	frozen	Vespertilionidae	<i>Nyctophilus gouldi</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49377.001	frozen tissue	Vespertilionidae	<i>Nyctophilus gouldi</i>	Dam, Forest Rd (31°43'43"S 150°02'54"E)
M.49378	wet specimen	Vespertilionidae	<i>Nyctophilus gouldi</i>	Dam, Forest Rd (31°43'43"S 150°02'54"E)
M.49378.001–2	frozen tissues			
M.49381.001	frozen tissue	Vespertilionidae	<i>Nyctophilus gouldi</i>	Racecourse Track (31°42'14"S 150°01'15"E)
M.51070.001	frozen tissue	Vespertilionidae	<i>Nyctophilus gouldi</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.50037	wet specimen	Vespertilionidae	<i>Nyctophilus gouldi</i>	Hildegard Rd, (31°44'54"S 150°01'25"E)
M.50037.001–2	frozen tissues			
M.49335	wet specimen	Vespertilionidae	<i>Vespadelus darlingtoni</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49335.001–2	frozen tissues			
M.49336	wet specimen	Vespertilionidae	<i>Vespadelus darlingtoni</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49336.001–2	frozen tissues			
M.49339	wet specimen	Vespertilionidae	<i>Vespadelus darlingtoni</i>	Bundella Track (31°43'49"S 150°03'35"E)
M.49339.001–2	frozen tissues			
M.49347.001	frozen tissue	Vespertilionidae	<i>Vespadelus darlingtoni</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49350.001	frozen tissue	Vespertilionidae	<i>Vespadelus darlingtoni</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49351.001	frozen tissue	Vespertilionidae	<i>Vespadelus darlingtoni</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49352.001	frozen tissue	Vespertilionidae	<i>Vespadelus darlingtoni</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49353.001	frozen tissue	Vespertilionidae	<i>Vespadelus darlingtoni</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49355.001	frozen tissue	Vespertilionidae	<i>Vespadelus darlingtoni</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49356.001	frozen tissue	Vespertilionidae	<i>Vespadelus darlingtoni</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49365.001	frozen tissue	Vespertilionidae	<i>Vespadelus darlingtoni</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49366.001	frozen tissue	Vespertilionidae	<i>Vespadelus darlingtoni</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49367.001	frozen tissue	Vespertilionidae	<i>Vespadelus darlingtoni</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49368.001	frozen tissue	Vespertilionidae	<i>Vespadelus darlingtoni</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49373	wet specimen	Vespertilionidae	<i>Vespadelus darlingtoni</i>	Dam, Forest Rd (31°43'43"S 150°02'54"E)
M.49373.001–2	frozen tissues			
M.49375	wet specimen	Vespertilionidae	<i>Vespadelus darlingtoni</i>	Dam, Forest Rd (31°43'43"S 150°02'54"E)
M.49375.001–2	frozen tissues			
M.49379	wet specimen	Vespertilionidae	<i>Vespadelus darlingtoni</i>	Dam, Forest Rd (31°43'43"S 150°02'54"E)
M.49379.001–2	frozen tissues			
M.50031	wet specimen	Vespertilionidae	<i>Vespadelus darlingtoni</i>	Hildegard Rd junction with Forest Rd (31°43'15"S 150°05'24"E)
M.50031.001–2	frozen tissues			
M.50032	wet specimen	Vespertilionidae	<i>Vespadelus darlingtoni</i>	Hildegard Rd junction with Forest Rd (31°43'15"S 150°05'24"E)
M.50032.001–2	frozen tissues			
M.50039	wet specimen	Vespertilionidae	<i>Vespadelus darlingtoni</i>	Hildegard Rd, (31°44'54"S 150°01'25"E)
M.50039.001–2	frozen tissues			
M.49364	wet specimen	Vespertilionidae	<i>Vespadelus vulturinus</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49364.001–2	frozen tissues			
M.49384	wet specimen	Vespertilionidae	<i>Vespadelus vulturinus</i>	Racecourse Track (31°42'14"S 150°01'15"E)
M.49384.001–2	frozen tissues			
M.49386	wet specimen	Vespertilionidae	<i>Vespadelus vulturinus</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49386.001–2	frozen tissues			
M.51068.001	frozen tissue	Vespertilionidae	<i>Vespadelus vulturinus</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.51069.001	frozen tissue	Vespertilionidae	<i>Vespadelus vulturinus</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49993	wet specimen	Vespertilionidae	<i>Vespadelus vulturinus</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49993.001–2	frozen tissues			
M.49994	wet specimen	Vespertilionidae	<i>Vespadelus vulturinus</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.49994.001–2	frozen tissues			
M.50030	wet specimen	Vespertilionidae	<i>Vespadelus vulturinus</i>	Creek, Bald Hills Rd (31°45'23"S 150°00'59"E)
M.50030.001–2	frozen tissues			

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Appendix 5 (continued). Mammals sampled during May and November 2018, Coolah Tops National Park, New South Wales and environs.

reg. no.	sample type	family	species	location
M.51074.001	frozen tissue	Vespertilionidae	<i>Vespadelus vulturnus</i>	Hildegard Rd junction with Forest Rd (31°43'15"S 150°05'24"E)
M.51075.001	frozen tissue	Vespertilionidae	<i>Vespadelus vulturnus</i>	Hildegard Rd junction with Forest Rd (31°43'15"S 150°05'24"E)
M.51076.001	frozen tissue	Vespertilionidae	<i>Vespadelus vulturnus</i>	Hildegard Rd junction with Forest Rd (31°43'15"S 150°05'24"E)
M.50035	wet specimen	Vespertilionidae	<i>Vespadelus vulturnus</i>	Hildegard Rd junction with Forest Rd (31°43'15"S 150°05'24"E)
M.50035.001–2	frozen tissues			
M.50034	wet specimen	Vespertilionidae	<i>Vespadelus vulturnus</i>	Hildegard Rd, (31°44'54"S 150°01'25"E)
M.50034.001–2	frozen tissues			
M.49388	wet specimen	Muridae	<i>Mus musculus</i>	State Forest Rd (31°45'10"S 149°54'03"E)
M.49388.001	frozen tissue			
M.49391–6	wet specimens	Muridae	<i>Mus musculus</i>	State Forest Rd (31°45'10"S 149°54'03"E)
M.50042	wet specimen	Muridae	<i>Mus musculus</i>	Brackens Hut (31°45'05"S 150°01'54"E)
M.50042.001–2	frozen tissues			
M.51187	skeleton, partial	Cervidae	<i>Dama dama</i>	Brackens Hut (31°45'11"S 150°02'E)

* donated to the Australian Museum by Michael Murphy, NPWS.

Registration numbers M.49344–M.49536 were sampled in May; M.49986–M.51187 were sampled in November 2018.

Appendix 6. Details of mammal and reptile samples used in genetic comparisons.

reg. no.	EBU (tissue)	species	location
AM R.142816	4559	<i>Lampropholis amacula</i>	Ellenborough, NSW
AM R.146156	5773	<i>Lampropholis amacula</i>	Newfoundland State Forest, NSW
AM R.152165	31681	<i>Lampropholis caligula</i>	Coolah Tops, NSW
AM R.185861	81547	<i>Lampropholis caligula</i>	Coolah Tops, NSW
AM R.148270	6214	<i>Lampropholis elongata</i>	Riamukka State Forest, NSW
AM R.167386	45334	<i>Lampropholis elongata</i>	Riamukka State Forest, NSW
AM M.32904	11960	<i>Antechinus agilis</i>	Kioloa, NSW
AM M.33317	13207	<i>Antechinus agilis</i>	Brindabella, ACT
AM M.37246	39817	<i>Antechinus agilis</i>	Mt Canobolas, NSW
AM M.42320	56685	<i>Antechinus agilis</i>	Bees Nest Nature Reserve, NSW
AM M.43616	35565	<i>Antechinus agilis</i>	Jenolan Caves, NSW
AM M.50091	72967	<i>Antechinus agilis</i>	Mt Canobolas, NSW
AM M.34305	8337	<i>Antechinus stuartii</i>	Mittagong, NSW
AM M.43369	35555	<i>Antechinus stuartii</i>	Wedderburn, NSW
AM M.49344	85782	<i>Antechinus stuartii</i>	Coolah Tops, NSW
AM M.49345	85783	<i>Antechinus stuartii</i>	Coolah Tops, NSW
AM M.49361	85778	<i>Antechinus stuartii</i>	Coolah Tops, NSW
AM M.49362	85779	<i>Antechinus stuartii</i>	Coolah Tops, NSW
AM M.49371	85769	<i>Antechinus stuartii</i>	Coolah Tops, NSW
AM M.49372	85770	<i>Antechinus stuartii</i>	Coolah Tops, NSW
AM M.51080	111262	<i>Antechinus stuartii</i>	Newnes Plateau, NSW
AM M.51081	111263	<i>Antechinus stuartii</i>	Newnes Plateau, NSW
AM M.49359	85776	<i>Chalinolobus dwyeri</i>	Coolah Tops, NSW
AM M.22089	25958	<i>Chalinolobus gouldii</i>	Corktree Bore, Pilbara, WA
AM M.34595	26335	<i>Chalinolobus gouldii</i>	Empire Bay, NSW
AM M.36162	35228	<i>Chalinolobus gouldii</i>	White Cliffs, NSW
AM M.47820	71046	<i>Chalinolobus gouldii</i>	Cattai, NSW
AM M.47821	71044	<i>Chalinolobus gouldii</i>	Somersby, NSW
AM M.23971	26276	<i>Chalinolobus morio</i>	Berry Rd, Billilimbra State Forest, NSW
AM M.34005	9836	<i>Chalinolobus morio</i>	Coleambally, NSW
AM M.39844	48157	<i>Chalinolobus morio</i>	Eagle Rock, WA
AM M.45571	48271	<i>Chalinolobus morio</i>	Scratch Rd, Pilliga Sate Forest, NSW
AM M.49346	85784	<i>Chalinolobus morio</i>	Coolah Tops, NSW
AM M.49340	85798	<i>Chalinolobus morio</i>	Coolah Tops, NSW
AM M.49341	85799	<i>Chalinolobus morio</i>	Coolah Tops, NSW
AM M.25363	26005	<i>Chalinolobus picatus</i>	Dunsandle, NSW
AM M.22087	25893	<i>Chalinolobus nigrogriseus</i>	Napier Downs, WA
AM M.49709	99876	<i>Chalinolobus nigrogriseus</i>	TransFly, PNG

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Appendix 6 (continued). Details of mammal and reptile samples used in genetic comparisons.

reg. no.	EBU (tissue)	species	location
WAM M.60490		<i>Nyctophilus arnhemensis</i>	Cape Keraudren, WA
WAM M.60491		<i>Nyctophilus arnhemensis</i>	Cape Keraudren, WA
AM M.23448	28526	<i>Nyctophilus bifax</i>	Lockerbie Scrub, Cape York, Qld
AM M.25355	25997	<i>Nyctophilus corbeni</i>	Dunsandle, NSW
AM M.25356	26000	<i>Nyctophilus corbeni</i>	Dunsandle, NSW
AM M.22127	25817	<i>Nyctophilus daedalus</i>	Corktree Bore, Pilbara, WA
AM M.22128	25818	<i>Nyctophilus daedalus</i>	Corktree Bore, Pilbara, WA
AM M.22130	25820	<i>Nyctophilus geoffroyi</i>	Corktree Bore, Pilbara, WA
AM M.39795	48177	<i>Nyctophilus geoffroyi</i>	Northcliff, WA
AM M.47969	73384	<i>Nyctophilus geoffroyi</i>	Dubbo, NSW
AM M.49337	85796	<i>Nyctophilus geoffroyi</i>	Coolah Tops, NSW
AM M.49338	85797	<i>Nyctophilus geoffroyi</i>	Coolah Tops, NSW
AM M.49363	85780	<i>Nyctophilus geoffroyi</i>	Coolah Tops, NSW
AM M.49342	85700	<i>Nyctophilus geoffroyi</i>	Coolah Tops, NSW
AM M.23968	26270	<i>Nyctophilus gouldi</i>	Berry Rd, Billilimbra State Forest, NSW
AM M.23966	26268	<i>Nyctophilus gouldi</i>	Crabapple Rd, Billilimbra State Forest, NSW
AM M.39799	48138	<i>Nyctophilus gouldi</i>	Waroona, WA
AM M.39807	48148	<i>Nyctophilus gouldi</i>	Northcliffe, WA
AM M.39811	48102	<i>Nyctophilus gouldi</i>	Windy Harbour, WA
AM M.39812	48147	<i>Nyctophilus gouldi</i>	Windy Harbour, WA
AM M.47801	71025	<i>Nyctophilus gouldi</i>	South West Rocks area, NSW
AM M.47891	73303	<i>Nyctophilus gouldi</i>	Armidale area, NSW
AM M.49378	85756	<i>Nyctophilus gouldi</i>	Coolah Tops, NSW
AM M.49360	85777	<i>Nyctophilus gouldi</i>	Coolah Tops, NSW
AM M.49334	85781	<i>Nyctophilus gouldi</i>	Coolah Tops, NSW
AM M.49333	85791	<i>Nyctophilus gouldi</i>	Coolah Tops, NSW
AM M.23963	26263	<i>Vespadelus darlingtoni</i>	Berry Rd, Billilimbra State Forest, NSW
AM M.23965	26266	<i>Vespadelus darlingtoni</i>	Crabapple Rd, Billilimbra State Forest, NSW
AM M.35347	12109	<i>Vespadelus darlingtoni</i>	Mitchell Park Rd, Cattai, NSW
AM M.36555	36428	<i>Vespadelus darlingtoni</i>	Banksia Rd, East Boyd State Forest, NSW
AM M.39876	46109	<i>Vespadelus darlingtoni</i>	Mobong Road, Cascade, NSW
AM M.39884	46105	<i>Vespadelus darlingtoni</i>	Mobong Road, Cascade, NSW
AM M.47831	71053	<i>Vespadelus darlingtoni</i>	Jenolan Caves, NSW
AM M.47890	48188	<i>Vespadelus darlingtoni</i>	Kearl Road, Springside, NSW
AM M.48731	83445	<i>Vespadelus darlingtoni</i>	Lord Howe Island, NSW
AM M.48733	83449	<i>Vespadelus darlingtoni</i>	Lord Howe Island, NSW
AM M.49373	85751	<i>Vespadelus darlingtoni</i>	Coolah Tops, NSW
AM M.49335	85794	<i>Vespadelus darlingtoni</i>	Coolah Tops, NSW
AM M.49366	85763	<i>Vespadelus darlingtoni</i>	Coolah Tops, NSW
AM M.49336	85795	<i>Vespadelus darlingtoni</i>	Coolah Tops, NSW
AM M.50031	85718	<i>Vespadelus darlingtoni</i>	Coolah Tops, NSW
AM M.50032	85719	<i>Vespadelus darlingtoni</i>	Coolah Tops, NSW
AM M.50039	85724	<i>Vespadelus darlingtoni</i>	Coolah Tops, NSW
AM M.21408	25830	<i>Vespadelus finlaysoni</i>	Corktree Bore, Pilbara, WA
AM M.23964	46104	<i>Vespadelus pumilus</i>	Crabapple Rd, Billilimbra State Forest, NSW
AM M.39879	26265	<i>Vespadelus pumilus</i>	Mobong Rd, Cascade, NSW
AM M.34585	26331	<i>Vespadelus pumilus</i>	Gerringong, NSW
AM M.37389	39818	<i>Vespadelus regulus</i>	Genoa National Park, NSW
AM M.39872	46108	<i>Vespadelus regulus</i>	Woomargama National Park, NSW
AM M.39883	46178	<i>Vespadelus regulus</i>	Mobong Rd, Cascade, NSW
AM M.36552	36423	<i>Vespadelus regulus</i>	Banksia Rd, East Boyd State Forest, NSW
AM M.40189	46160	<i>Vespadelusroughtoni</i>	Bonalbo, NSW
AM M.34009	9840	<i>Vespadelus vulturinus</i>	Coleambally, NSW
AM M.36562	36436	<i>Vespadelus vulturinus</i>	Bodalla Sate Forest, Narooma, NSW
AM M.39866	46103	<i>Vespadelus vulturinus</i>	Pilliga West State Forest, NSW
AM M.39869	46131	<i>Vespadelus vulturinus</i>	Pilliga West State Forest, NSW
AM M.49384	85741	<i>Vespadelus vulturinus</i>	Coolah Tops, NSW
AM M.49386	85743	<i>Vespadelus vulturinus</i>	Coolah Tops, NSW
AM M.49364	85761	<i>Vespadelus vulturinus</i>	Coolah Tops, NSW
AM M.50995	48209	<i>Vespadelus vulturinus</i>	Namoi River, NW Pilliga, NSW