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A new species of lizard in the genus *Caledoniscincus* (Reptilia: Scincidae) from far northwest New Caledonia

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Abstract

A new species of skink in the genus *Caledoniscincus* is described from the far north-west region of New Caledonia. It is known from a single location, the isolated ultramafic massif of Dôme de Tiébaghi, north of Koumac. The new species, *Caledoniscincus pelletieri* **sp. nov.**, has a bold, white mid-lateral stripe on the body, a feature which distinguishes it from most other species of *Caledoniscincus* except the regionally sympatric *Caledoniscincus haplorhinus* (Günther) and *Caledoniscincus austrocaledonicus* (Bavay), and the recently described *Caledoniscincus constellatus* Sadlier, Whitaker, Wood & Bauer just to the south. The new species can be distinguished from these taxa in features of scalation and colouration, most notably in lacking an extension of the pale midlateral stripe between the ear and forelimbs and in having more lamellae on the underside of the fourth toe. The differences in morphology between *C. pelletieri* **sp. nov.** and the other members of the genus are complemented by a high level of genetic differentiation, further supporting its distinctiveness as an independent evolutionary lineage warranting recognition as a distinct species. The DNA sequence data for the ND2 mitochondrial gene identifies the new species as the sister to *C. constellatus* and these two taxa as the sister to all *Caledoniscincus*. The species is of extremely high conservation concern given its restricted distribution in an area that is currently being heavily impacted by human activities, and it satisfies the IUCN criteria to be ranked as a Critically Endangered species.

Key words: Reptilia, Scincidae, New Caledonia, Endangered

Résumé

Nous décrivons ici un nouveau lézard Scincidae du genre *Caledoniscincus* de l'extrême Nord-Ouest de la Nouvelle-Calédonie. Il n'est connu que d'une unique localité, le massif ultra-basique du Dôme de Tiébaghi, au Nord de Koumac. La nouvelle espèce, *Caledoniscincus pelletieri* **sp. nov.**, possède une ligne blanche médio-latérale marquée sur le corps, une caractéristique qui la distingue de la majorité des autres espèces du genre *Caledoniscincus*, à l'exception de l'endémique régional sympatrique *Caledoniscincus haplorhinus* (Günther) et de *Caledoniscincus austrocaledonicus* (Bavay), mais aussi de l'espèce décrite récemment, *Caledoniscincus constellatus* Sadlier, Whitaker, Wood & Bauer qui se rencontre un peu plus au Sud. La nouvelle espèce peut se distinguer de ces taxa par ses caractéristiques d'écaillure et de colouration, surtout par l'absence d'une extension de la bande pâle médio-latérale entre l'oreille et les membres antérieurs et par son nombre accru de lamelles sous l'orteil IV. Les différences morphologiques entre *C. pelletieri* **sp. nov.** et les autres membres du genre sont confortées par de fortes divergences génétiques supportant ainsi sa distinction comme une lignée évolutive indépendante devant être reconnue comme une espèce séparée. La séquence d'ADN pour le gène mitochondrial ND2 permet d'identifier cette espèce nouvelle comme l'espèce sœur de C. constellatus. Ensemble, ces deux taxa constituent le groupe frère de tous les autres *Caledoniscincus*. Le statut de conservation de cette espèce est

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particulièrement préoccupant du fait de sa répartition limitée à une zone actuellement fortement dégradée par des activités humaines, ce qui nécessite de la ranger dans la catégorie de la Liste Rouge de l'UICN En Danger Critique d'Extinction .

Introduction

The island of New Caledonia is a French Overseas Territory lying just to the north of the Tropic of Capricorn in the southwest Pacific Ocean, approximately 2000 km to the east of the Australian east coast. The principal island, Grande Terre, is continental in origin, is approximately 390 km long and about 50 km wide on average. New Caledonia is internationally recognized as one of the world's biodiversity 'hotspots' (Mittermier *et al*. 1999). In terms of biodiversity, the island has an exceptionally rich and diverse flora and fauna characterized by a high level of regional endemism (Mittermier *et al*. 1996; Myers *et al*. 2000) and its status as a 'hotspot' stems from a suite of threats to this unique biota. One of the most significant of these threatening processes is activity associated with the rapidly expanding mining industry that is the backbone of the country's economy (Pascal *et al*. 2008). For fauna, no group better epitomizes the regional endemicity and richness of New Caledonia than its lizards. The inventory of 94 described lizard species (and ~40 undescribed taxa), of which >90% are endemic, is greater than islands of similar size, and comparable to islands over ten times its size (19,103 km^2). New Zealand with a total land area of 268,704 km^2 has a described native lizard fauna of ~60 species (and ~40 undescribed taxa bearing tag names), all endemic, and Fiji the next largest island group in the region with an area of 15,919 km^2 (main islands only) 14 species, with the skink and gecko fauna all within widespread Pacific genera. Further, new taxa are constantly being described in New Caledonia, even from within well-known and emblematic taxa such as the island's giant geckos formerly included in the genus *Rhacodactylus* Fitzinger (Bauer *et al*. 2012).

Recent studies indicate that historical processes have had a significant impact on the evolutionary history of the lizard fauna. In particular the extent of narrow range endemism found most likely reflects a scenario of vicariant events influenced by substrate, elevation and climate, particularly on the islands ultramafic surfaces (Bauer *et al*. 2006; Sadlier *et al*. 2009, 2014b). Ultramafic substrates (peridotites and serpentines) once covered nearly all of the main island and its associated islands but have since been reduced by erosion. They now occur on the island as an extensive and relatively unbroken block in the south, a series of ranges on the central-east coast, and as an extensive chain of often isolated massifs along the central-west and north-west coast (Mathieu-Daudé 1992). The ultramafic ranges in both the southern and north-west/central-west regions are now recognized as having a rich lizard fauna characterized by both broad-scale and localized endemism. Of the 94 described endemic lizard species within endemic genera (including the species described here and 7 taxa in press) approximately 45% are found only in habitats on ultramafic surfaces. However, this proportion will change with the formal description of a number of as-yet unnamed taxa in the diplodactylid genus *Bavayia* Roux across both metamorphic and ultramafic surfaces of Grande Terre. The extensive suite of endemic species in both the southern and the north-west/central-west ultramafic regions of New Caledonia identify these areas as distinctive phylogeographic zones for lizards (Sadlier 2010).

Furthermore, it is becoming clear that the chain of isolated ultramafic massifs found in the north-west and central-west regions of Grande Terre are areas of extreme, often massif-specific, microendemism. Genetic studies on the skink genus *Marmorosphax* Sadlier have identified a distinct evolutionary lineage of several narrow-range species from the north-west/central-west ultramafic ranges (Sadlier *et al*. 2009, unpublished), some of which are separated from each other by a level of genetic divergence which clearly indicates they are on independent evolutionary trajectories. Similarly, studies on the diplodactylid gecko genus *Dierogekko* Bauer, Jackman, Sadlier & Whitaker (Bauer *et al.* 2006) have revealed a comparable evolutionary history of narrow-range endemism with six of the eight species found in the north-west/central-west ultramafic ranges, and each being restricted to a single massif. The presence of a number of lizard species in the north-west/central-west ranges restricted to a single massif (including a number of undescribed *Bavayia* – A. Bauer unpublished; Sadlier *et al*. 2014a) highlights the conservation significance of each individual ultramafic massif to the diversity of the region. Further, some of these lizard species appear to be restricted to the higher elevations of these massifs (Sadlier *et al*. 2004, 2009, 2014a), the main area on each that has been, or could be, under considerable pressure from mining activities.

The extent of localized endemism in the lizard fauna on the island's north-west/central-west region ultramafic

surfaces was unsuspected (Whitaker *et al*. 2004), and not realised until recently. It has also created a predicament for the provincial conservation authorities given many of the localized endemic lizard species on these ultramafic surfaces are likely to lie within mining concessions. This situation is exacerbated by an increased demand for nickel ore (the primary mineral extracted) which has recently gone through an economic resurgence, and new technology now makes it viable to extract lower grade ore from areas previously considered uneconomic.

The new species described here is a member of New Caledonia's most diverse scincid lizard genus, *Caledoniscincus* Sadlier, 1986. It is the most diverse genus of New Caledonian skinks with 15 species recognized on morphological and genetic criteria (Sadlier *et al.* unpublished), including the species described here. Some species in the genus have widespread distributions across Grande Terre, *Caledoniscincus festivus* (Roux), and also extend onto the islands associated with the region, *C. atropunctatus* (Roux), *Caledoniscincus haplorhinus* (Günther) and *Caledoniscincus austrocaledonicus* (Bavay). Two species are entirely southern in distribution, one, *Caledoniscincus notialis* Sadlier Smith, Bauer & Wood, being restricted to ultramafic surfaces in the south of Grande Terre while the other, *Caledoniscincus bodoi* (Börner), is restricted to the Ile des Pin to the south of the main island and its offshore islets. The greatest diversity of species occurs in primarily forest habitats of the central-east and northern ranges. Here five species have been recorded from forest habitat across ultramafic and metamorphic surfaces, *Caledoniscincus aquilonius* Sadlier, Bauer & Colgan, *Caledoniscincus auratus* Sadlier, Bauer & Colgan, *Caledoniscincus chazeaui* Sadlier, Bauer & Colgan *Caledoniscincus renevieri* Sadlier, Bauer & Colgan and *Caledoniscincus terma* Sadlier, Bauer & Colgan and one, *Caledoniscincus orestes* Sadlier from higher elevation forest habitat only. Recent survey work in the north-west region of the main island has also resulted in the discovery of two species known only from a limited number of sites. One of these, *Caledoniscincus constellatus* Sadlier, Whitaker, Wood & Bauer is known from only five individuals from two coastal and near-coastal locations. The other is the species described here which has an extremely localized distribution, and is known only from the summit of the ultramafic massif of Dôme de Tiébaghi. This massif, like many in the region, is currently undergoing extensive development for the extraction of nickel ore. This factor, in combination with a range of other threats to its security, has identified this species as being at the highest level of conservation concern, and meeting the IUCN criteria to be ranked as 'Critically Endangered'.

Materials and methods

Acronyms: Registration numbers for specimens used in the morphological description and in the genetic study are prefixed as follows: AMS Australian Museum, Sydney; MNHN Museum National d'Histoire Naturelle, Paris; CAS California Academy of Sciences, San Francisco.

Measurements. The following characters were scored for each specimen (to the nearest 0.5 mm): snout–vent length (SVL)—measured from tip of snout to caudal edge of anal scales; axilla–groin distance—measured from middle of base of the forelimb to middle of base of hind limb; forelimb–snout length—measured from tip of snout to middle of base of forelimb; hind limb length—measured from middle of base of hind limb to tip of fourth toe including nail; tail length—measured from caudal edge of anal scales to tip of tail, on complete original tails only. Body measurements are expressed as percentages of snout to vent length (SVL) in the taxon account. Examination of X-rays of specimens showed only specimen as having a complete tail.

Scalation. Head scalation follows Sadlier (1986). Scalation characters of the body and toes are defined as follows, and the abbreviations used in Table 1 given in parentheses: midbody scale rows (MBR)—number of longitudinal scale rows around body counted midway between axilla and groin; dorsal scale rows (DSR)—number of scales in a row from first scale posterior to parietal scale to last scale at the level of vent opening; fourth finger (FFS) and toe (FTS) scales—number of dorsal scales on fourth digit of hand and foot, distal scale contains claw and basal scale broadly contacts adjacent basal scale of third finger or toe; fourth finger (FFL) and toe (FTL) lamellae—number of ventral scales on fourth digit of hand and foot, distal scale borders the claw and basal scale is last largely undivided scale at a point level with intersection of third and fourth digits. Bilaterally scoreable scalation characters were scored on both sides and the mean value used; in the holotype description these values are presented as left/right values.

Osteology. Specimens were X-rayed to determine the number of presacral and postsacral vertebrae (the latter only taken from individuals that could confidently be determined as having complete tails), and the phalangeal formulae for the hand and feet.

Genetic studies. We obtained sequence data from a 514 bp fragment of the mitochondrial NADH dehydrogenase subunit 2 (ND2) gene for two specimens from Dôme de Tiébaghi initially determined on morphological criteria as an undescribed species of *Caledoniscincus*. These were compared with 23 samples representing all described species of *Caledoniscincus* except *C. bodoi*. Outgroup taxa were selected on the basis of a broader phylogenetic analysis of New Caledonian skinks by Smith *et al*. (2007) and sequences for these were obtained from GenBank (Appendix 1). All sequences used in this study along with corresponding GenBank accession numbers can be found in Appendix 1.

Total Genomic DNA was isolated from liver or skeletal muscle specimens stored in 95% ethanol using the Qiagen DNeasy™ tissue kit (Valencia, CA, USA). The target gene was amplified using a double-stranded Polymerase Chain Reaction (PCR). Included in the reaction were 1.0 µl genomic DNA, 1.0 µl light strand primer MET F6 L4437 5'-AAGCTTTCGGGCCCATACC-3' (Macey *et al*. 1997), 1.0 µl heavy strand primer TRP R3 H5540 5'-TTTAGGGCTTTGAAGGC-3' (Macey *et al*. 1997), 1.0 µl dinucleotide pairs, 2.0 µl 5x buffer, 1.0 µl MgCl 10x buffer, 0.1 µl Taq polymerase, and 7.5 µl ultra-pure H_2O. All reactions were executed on an Eppendorf Mastercycler gradient thermocycler under the following conditions: initial denaturation at 95ºC for 2 min, followed by a second denaturation at 95ºC for 35 s, annealing at 50–54ºC for 35 s, followed by a cycle extension at 72ºC for 35 s, for 31 cycles. PCR products were visualized on 10% agarose gel electrophoresis.

PCR products were vacuum purified using MANU 30 PCR Millipore plates to remove any impurities in the PCR products and were then subsequently resuspended in ultra-pure water. Purified PCR products were then sequenced using ABI Big-Dye Terminator kit v3.1 Cycle Sequencing Kit (GE Healthcare, Piscataway, NJ, USA) in an ABI GeneAmp PCR 9700 thermal cycler. Products were purified with Sephadex G-50 Fine (GE Healthcare, Piscataway, NJ, USA). Purified sequence reactions were analysed using an ABI 3730XL automated sequencer at the Brigham Young University DNA Sequencing Center. Sequences were analyzed from both the 3' and the 5' ends independently. Both the contiguous and the complimentary strands were uploaded and edited in Genious™ version 5.4 (Drummond *et al*. 2011), ambiguous bases were corrected. After editing the sequences they were initially aligned by eye. MacClade v4.08 (Maddison & Maddison 2005) was used to check for premature stop codons and to ensure that the alignment was in the correct amino acid reading frame.

For our phylogenetic analyses we applied both partitioned Maximum Likelihood-ML and partitioned Bayesian Inference-BI) The Akaike Information Criterion (AIC) as implemented in ModelTest v3.7 (Posada & Crandall 1998) was used to calculate the best-fit model of evolution for both ML and BI. For both model-based approaches we partitioned our data set by codon position. The General Time Reversal (GTR) plus (I) for proportional sites plus (Γ) for gamma distribution among site variation was the most complex model selected and was applied for all codon positions in the Maximum Likelihood analysis do to computer programing limitations. A Maximum Likelihood analysis was performed using RAxML-HPC v7.2.3 (Stamatakis *et al.* 2008). The analysis was performed using the above model of evolution. Gaps were treated as missing data and for clade confidence we applied 1000 bootstrap pseudo-replicates via the rapid hill-climbing algorithm (Stamatakis *et al.* 2008).

The partitioned Bayesian analysis was carried out in MrBayes v3.1 (Huelsenbeck & Ronquist 2001; Ronquist & Huelsenbeck 2003) using default priors. The GTR+I+Γ model was applied for the first codon position, GTR+Γ for the second position, and GTR+I for the third following the models selected from AIC in ModelTest (Posada & Crandall 1998). Two simultaneous runs were performed with four chains per run, three hot and one cold following default settings. The analysis was run for five million generations and sampled every 500 generations from the Markov Chain Monte Carlo (MCMC). After five million generations the standard deviation split frequency was below 0.01 and we assume convergence. The program Are We There Yet? (AWTY) (Nylander *et al.* 2008) was used to plot the log likelihood scores against the number of generations to assess convergence and to determine the appropriate burn-in. A consensus tree from the two runs was built using TreeAnnotator v1.6.1 (Drummond & Rambaut 2006). Nodes that had posterior probabilities above 0.95 and ML bootstrap support values above 70 were considered significantly supported (Huelsenbeck & Ronquist 2001; Wilcox 2002).

Results

The species of *Caledoniscincus* described here was initially recognized as a potentially new taxon by virtue of significant differences in colouration compared to other members of the genus. A comparison of differences in

scalation between the new species and all members of the genus (Sadlier 1986; Sadlier *et al*. 1999; Sadlier *et al*. 2012; Sadlier *et al*. 2013) showed it to have more lamellae on the longest (4th) digit of the pes than other species. In particular, the new species showed near non-overlapping differences in the number of lamellae under the fourth toe (Table 1) when compared to *C*. *constellatus* and *C*. *haplorhinus*, the two species with which it is most likely to be confused. However, it is possible that with further samples the range of variation for this character in the new species could increase and the current level of discrimination with other taxa be reduced.

TABLE 1. Values for number of midbody scale rows (MBR), dorsal scale rows (DSR), fourth finger (FFS) and toe (FTS) scales, and fourth finger (FFL) and toe (FTL) lamellae between samples of *Caledoniscincus pelletieri* **sp. nov**., *Caledoniscincus constellatus*, *Caledoniscincus haplorhinus* (combined data for six separate populations) from the west coast of New Caledonia, and *Caledoniscincus austrocaledonicus* from the neotype population on Mt Aoupinié in the central ranges of New Caledonia.

.	*C*. *pelletieri* **sp. nov.** N = 4	*C*. *constellatus* Vavouto N = 4	*C*. *haplorhinus* west coast N.C. N = 51	*C. austrocal.* Mt. Aoupinié N = 28
MBR				
range (mean ± sd)	28–32 (30.0 ± 1.6)	28–30 (28.5 ± 1.0)	28–32 (29.9 ± 0.98)	30–32 (31.2 ± 0.99)
DSR				
range (mean ± sd)	63–65 (64.0 ± 0.8)	61–65 (63.0 ± 1.63)	59–66 (63.0 ± 1.49)	58–65 (61.2 ± 1.84)
FFS				
range (mean ± sd)	10–11 (10.75 ± 0.5)	10–12 (11.0 ± 0.82)	10–13 (10.95 ± 0.66)	11–12 (11.3 ± 0.40)
FFL				
range (mean ± sd)	16–18 (17.25 ± 0.65)	16–18 (16.5 ± 0.71)	14–20 (16.0 ± 0.92)	15–18 (16.5 ± 0.69)
FTS				
range (mean ± sd)	17–18 (17.75 ± 0.23)	17–19 (18.0 ± 0.82)	14–20 (16.7 ± 1.01)	16–19 (17.0 ± 0.56)
FTL				
range (mean ± sd)	35–37 (36.1 ± 0.85)	31–33 (31.9 ± 0.85)	25–35 (28.0 ± 1.64)	26–33 928.7 ± 1.74)

For the parsimony analysis of 514 bp of ND2, 45 sites were variable but uninformative and 225 were informative. The score of the best likelihood tree was - ln L 5966.829630. The level of genetic differentiation provided by the ND2 sequence data (Fig. 1) gave strong support for the individuals sampled as belonging to a distinct and highly divergent evolutionary lineage. The new species shows a high level of genetic differentiation from the three morphologically and genetically most similar species *C*. *constellatus* (12.4%), *C*. *haplorhinus* (15%) and *C*. *austrocaledonicus* (16.3%). The genetic data also strongly supports (PP 1.0; ML 96%) the new species as the sister to *C*. *constellatus*. This species pair is in turn the sister to a group comprising all other *Caledoniscincus*, although support for this latter group only receives modest support (PP 0.90; ML 49%).

The morphological and genetic differences in combination support recognition of the individuals studied from Dôme de Tiébaghi as belonging to a new species distinct from all other species of *Caledoniscincus* under a lineage-based species concept (Mayden 1997; de Queiroz 1998).

Systematics

The species of *Caledoniscincus* range from moderately small (*Caledoniscincus chazeaui*, maximum SVL 43 mm) to moderately large in size (*C. festivus*, maximum SVL 72 mm) with moderately well developed limbs and digits, and a moderately long tail (~ 150% +/- 10% of SVL across most species in the genus). In scalation and osteology they share the following suite of characters. Apomorphic character states for the genus within the context of the Eugongylus group of skinks are denoted by an asterisk*, and polarities for characters follows Sadlier (2010): *dorsal body scales with three strong keels; supranasal absent; *nasal scale with a postnasal crease; frontonasal broader than long; *prefrontals reduced in size and widely separated; frontal nearly as broad as long; supraoculars four; *frontoparietals fused; interparietal distinct; parietals in broad contact behind interparietal, and each bordered by a single nuchal and upper secondary temporal scale; primary temporal single; lower secondary temporal single;

tertiary temporals two; postlabials two; nasals moderately to widely separated; anterior loreal higher than wide; supraciliaries seven; upper labials seven, with the fifth subocular and contacting the lower eyelid; postmental contacting first and second lower labial; transversely enlarged chinshields three either side, first pair in broad contact, second pair separated by one scale, third pair separated by three scales; premaxillary teeth 11; atlantal arches of first cervical vertebrae fused to the *intercentrum; presacral vertebrae usually 29, rarely 30 (except in *Caledoniscincus orestes* where 29 or 30 presacral vertebrae are present in approximately equal proportions); phalangeal formula for the manus 2.3.4.5.3 and for the pes 2.3.4.5.4.; two pairs of mesosternal ribs ; *hemipenes distinctly bifurcated.

The condition of atlantal arches of first cervical vertebrae and the morphology of the hemipenes is not known for the new species described here, but the species otherwise agrees with the diagnosis for the genus for the remaining apomorphic states, and its placement in the genus is supported by the genetic data.

The species of *Caledoniscincus* are conservative in certain aspects of their morphology with minimal diagnostic differentiation in scalation and, to a lesser extent, body proportions (see Sadlier *et al*. 1999). The most notable differences between species are in colouration, particularly between adult males of different taxa. Adult female *Caledoniscincus* typically retain a colour and pattern similar to that of juveniles, whereas males change in pattern and at maturity often develop a different ventral colouration to the females.

Caledoniscincus is the most speciose of the endemic New Caledonian skink genera. The recent description of new taxa (Sadlier *et al*. 2012, 2013) including the species described here brings the number of taxa currently recognized in the genus to 14.

Caledoniscincus pelletieri **sp. nov. Sadlier, Whitaker, Wood & Bauer**

Figs. 1–5

Holotype. MNHN 2012.0225 (formerly AMS R.174984) Dôme de Tiébaghi (southwest end of plateau), Province Nord, New Caledonia 20°28'20"S 164°12'43"E (collected 23 November 2011, A.H. & V.A. Whitaker).

Paratypes. All Province Nord, New Caledonia: AMS R.174994 Dôme de Tiébaghi (southwest end of plateau) 20°28'30"S 164°12'47"E (collected 24 November 2011, A.H. & V.A. Whitaker); AMS R.177490 Dôme de Tiébaghi (northern end of plateau) 20°26'18"S 164°11'42"E (collected 2 November 2012, S. Astrongatt); AMS R.177491 Dôme de Tiébaghi (southern end of plateau) 20°28'26"S 164°13'44"E (collected 5 November 2012, S. Astrongatt).

Etymology. The species is named after Bernard Pelletier, formerly head of environment for Société le Nickel (SLN), Nouméa, in recognition of his exceptional support to herpetological surveys of mining areas commissioned by SLN and undertaken by Whitaker Consultants Limited (AHW).

Diagnosis. *Caledoniscincus pelletieri* **sp. nov.** can be distinguished from the other species of *Caledoniscincus* by the following combination of characters: (a) body size moderately large (largest of four adult females 58.5 mm SVL); (b) lamellae of fourth toe 35–37 ; (c) midlateral stripe broad, pale, extending between fore and hind limbs only; and (d) ventral colour bright yellow.

Only three other species of *Caledoniscincus*, *C. constellatus*, *C. haplorhinus* and *C. austrocaledonicus* (northern and central region populations, see Sadlier *et al*. 1999), have a pale lateral stripe along the lateral side of the body. However, in these taxa the pale mid-lateral stripe also extends along the neck between the forelimbs and ear opening (complete and unbroken in *C. constellatus* and *C. haplorhinus*, but broken in *C. austrocaledonicus*), whereas the mid-lateral stripe is absent from the neck of *C. pelletieri* **sp. nov.** The general colour pattern of the body of *Caledoniscincus pelletieri* **sp. nov.** is most similar to *C. constellatus* and *C. haplorhinus*. The females of all three taxa are distinctly two-toned with a light coloured dorsal surface that contrasts markedly with the adjacent darker upper lateral surface, which in turn, is bordered below by a pale midlateral stripe along the side of the body. The ventral colour of *Caledoniscincus pelletieri* **sp. nov.** is most similar to *C. constellatus* in that females of both species have a bold yellow ventral surface, whereas the ventral colour is paler in adult female *C. austrocaledonicus* (moderate yellow), and even more so in *C. haplorhinus* (pale yellow).

Caledoniscincus pelletieri **sp. nov.** is further distinguished from *C. constellatus*, *C. haplorhinus* and *C. austrocaledonicus* in having more lamellae (>35 *vs* <35) under the 4th toe of the foot (Table 1).

Description. The species is described from four adult females 45–58mm SVL.

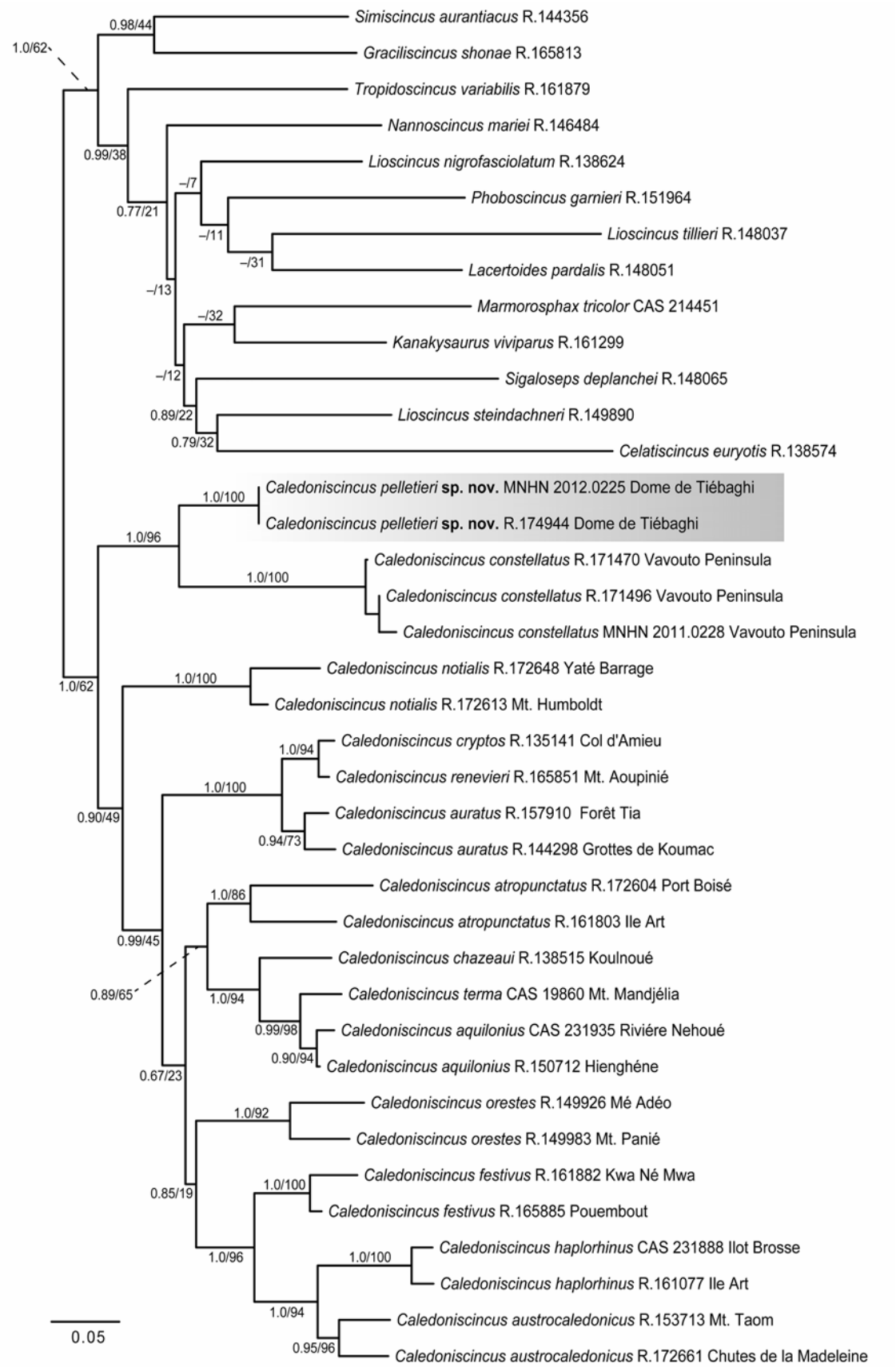

FIGURE 1. A Maximum Likelihood (-lnL 5966.829630) tree for the phylogenetic relationships of *Caledoniscincus pelletieri* relative to each species within the genus—Bayesian posterior probabilities and ML bootstrap support values are presented respectively. The new species is highlighted in grey for clarity. "R" numbers are associated with Australian Museum (AMS) specimens.

FIGURE 2. Holotype (MNHN 2012.0225) of *Caledoniscincus pelletieri* **sp. nov.** an adult female (A), paratype AMS R.174994 an adult female (B), and an adult male, no voucher (C).

Measurements: axilla–groin distance 55.6–63.2% SVL ($\bar{x}$ = 59.8%); forelimb–snout distance 32.5–37.8% SVL ($\bar{x}$ = 35.2%); hindlimb length 42.7–48.1% SVL ($\bar{x}$ = 44.8%); tail length of individual with original tail 195.8% SVL.

Scalation: Dorsal body scales with three strong keels; midbody scale rows 28–32 ($\bar{x}$ = 30.0, sd = 1.6); dorsal scale rows 63–65 ($\bar{x}$ = 64.0, sd = 0.8); scales on top of fourth finger 10–11 ($\bar{x}$ = 10.75 sd = 0.5); lamellae beneath fourth finger 16–18 ($\bar{x}$ = 17.25, sd = 0.65); scales on top of fourth toe 17–18 ($\bar{x}$ = 17.75, sd = 0.3); lamellae beneath fourth toe 35–37 ($\bar{x}$ = 36.1, sd = 0.85).

Osteology: Premaxillary teeth 11 (n = 2); presacral vertebrae 29 (n = 2) – 30 (n = 1); postsacral vertebrae 58 (n = 1) for the only individual with original tail; phalangeal formula for the manus 2.3.4.5.3 and pes 2.3.4.5.4.

Colour and pattern – in life (Fig. 2a & 2b): Dorsal surface of adult females pale grey-brown above with a series of small, dark brown blotches spaced along the vertebral line of the neck, body and base of tail, with the posterior edges of the dark markings tending to extend back into the intervening lighter grey-brown areas and to become progressively more continuous, joining around the level of the hindlimbs to form an uneven-sided dark streak along the tail. The top of head is uniformly pale grey-brown and without darker markings. Lateral surface of body between the fore and hind limbs very dark brown divided by a bold white mid-lateral stripe that extends along the side of the body between the limbs. White mid-lateral stripe terminates abruptly at the anterior end just above the insertion of the forelimb, but extends posteriorly beyond the hind limbs and onto the tail, and less distinctly down the leading edge of the front and hind limbs. Lateral surface progressively changes tone from dark to mid-brown on the neck and face, and lacks obvious white markings. Dorsal and lateral surfaces well differentiated and highly contrasting, with the dorsolateral edge irregular, and sometimes (paratype) defined by a pale (cream) narrow stripe between the eye and along the remainder of the body (half scale width). Lateral and ventral surfaces also highly contrasting (changing from dark brown to bright yellow) and well differentiated. The hind limbs of smaller individuals have a russet suffusion above and at the sides. Tail grey-brown above, with the darker vertebral markings on the body, continuing along the tail as a series of interconnected mid-brown blotches. Lateral surface of tail dark over the remainder of its length. Under-surface of the head and neck predominately white but with fine dark brown markings at the side that extend diffusely and irregularly onto the lower surface of head and neck, remainder of body posterior of the forelimbs bold yellow which also extends along the underside of the limbs to the soles and along the proximal third of the tail. Soles of feet grey.

Details of Holotype: Adult female (MNHN 2012.0225); size 58.5 mm SVL; tail incomplete, length 103 mm (19.5 mm of tip reproduced).

Comments. The colouration of female *Caledoniscincus pelletieri* **sp. nov.** is similar to that of the single known adult female of its' sister taxon *C. constellatus* in having a highly contrasting grey-brown dorsal surface and very dark brown lateral surface to the body, a pattern of dark blotches along the vertebral line of dorsal surface, a bold white mid-lateral stripe to the body, a bold yellow flush to the underside of the body and tail, and to a lesser extent a russet flush to the upper surfaces of the limbs.

The colouration of a single male *Caledoniscincus pelletieri* **sp. nov.** photographed on Dôme de Tiébaghi (Fig. 2c) is similar to that of adult males of its' sister taxon *C. constellatus* in having a reticulate pattern of narrow , bicoloured transverse bars on the dorsal surface of the body, the individual scales of which are black with one to several small white spots within the scale, on a predominately mid-brown background.

The most obvious difference in colouration between the two species (both males and females) is in the absence of a white mid-lateral stripe anterior to the forelimb in *C. pelletieri* **sp. nov.** Other differences in colouration between the available specimens of these two taxa include a progressive gradation in tone on the side of the head and neck from mid-brown anteriorly to dark brown approaching the forelimb in adults of both sexes in *C. pelletieri* **sp. nov.**, whereas the neck is uniformly black on either side of the white mid-lateral stripe in adults of both sexes in *C. constellatus*. Also, the pale narrow dorsolateral edge is poorly defined or absent in adult female *C. pelletieri* **sp. nov.**, whereas this marking is clearly defined and 1/2 scale wide in the female *C. constellatus*.

Distribution and biology. *Caledoniscincus pelletieri* **sp. nov**. is known only from the ultramafic massif of Dôme de Tiébaghi in the far northwest of the Grande Terre (Fig. 3). Three individuals were captured at the southern end of the summit plateau and one approximately five kilometres distant at the northern end of the plateau (Fig. 5). All sites were at or just below the plateau rim at elevations between 420–500 m.

All specimens were captured during the day in glue traps set on the ground in stick litter. No other individuals were observed. The habitat at three sites comprises small remnants of low, closed forest that are surrounded by fire-induced maquis shrubland; at the fourth site the lizard was captured in woody maquis in sparse *Araucaria rulei*

forest. The holotype was captured on the margin of a vehicle track through low forest (6–8 m canopy height) on cuirasse, similar to that illustrated in figure 4a; one paratype (AMS R.174944) was in a steep-sided gully within dense forest (canopy c.15 m, trunks to 0.5 m dbh) with a thick understorey of palms as illustrated in figure 4b.

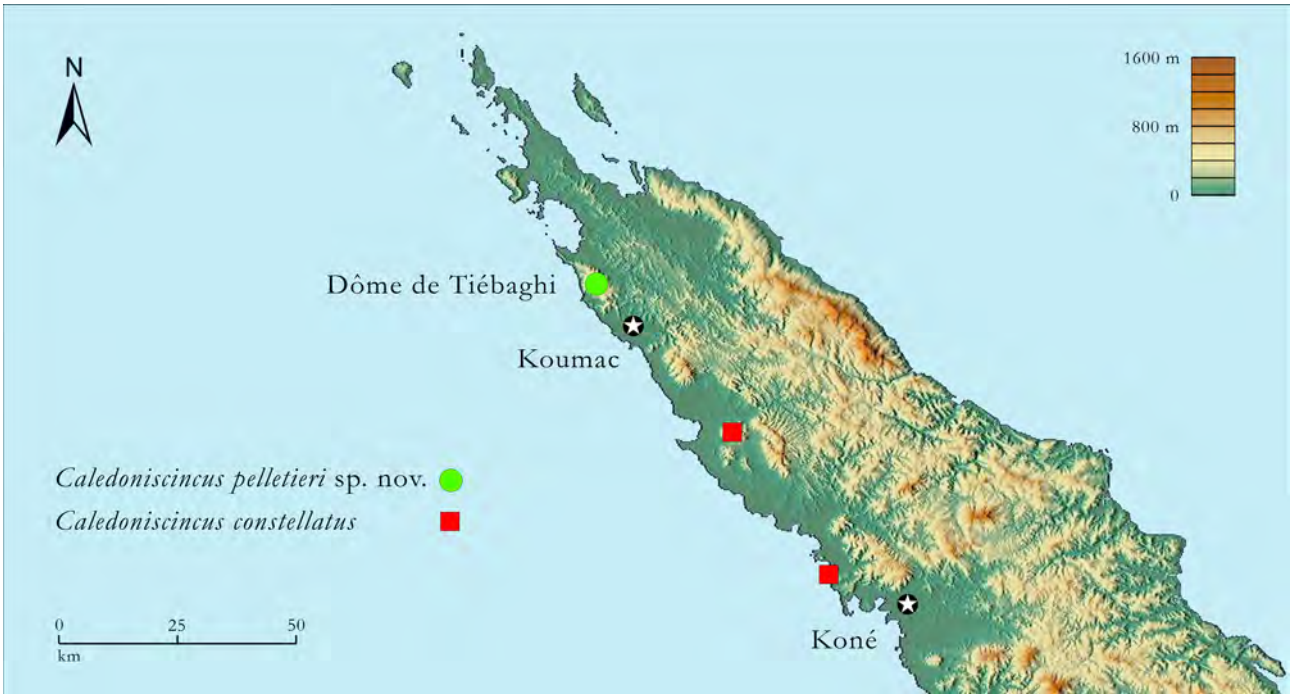

FIGURE 3. Distribution of *Caledoniscincus pelletieri* **sp. nov.** (green dot) and its sister species *Caledoniscincus constellatus* (red square) in north-west New Caledonia.

Between 2001–2012 six detailed surveys of the lizard fauna were conducted on and around the Dôme de Tiébaghi, using a variety of methods and at a large number of locations that covered the full range of habitats and elevation. Despite this level of survey effort the only specimens of *Caledoniscincus pelletieri* **sp. nov**. are those from two separate surveys in 2011 and 2012, and two recent specimens collected (and released) in 2013, it would appear that the species could be both uncommon and localized in distribution in comparison to other members of the genus.

The two female specimens collected in November 2011 both showed evidence of reproductive activity. The larger individual (holotype—58.5 mm) contained two large shelled eggs and the smaller (AMS R.174994—52.0 mm) had three enlarged ovarian follicles (1 left and 2 right) and an enlarged and convoluted oviduct indicating it was reproductively mature. The two female specimens collected in November 2012 were smaller; one (AMS R.177491—47.5 mm) had 2 enlarged ovarian follicles (1 left and 1 right) and in the other (AMS R.177490—45.0 mm) the follicles were not enlarged.

Other *Caledoniscincus* species syntopic with *Caledoniscincus pelletieri* **sp. nov**. on the Dôme de Tiébaghi plateau are *C. aquilonius, C. atropunctatus, C. austrocaledonicus, C. haplorhinus* and *C. festivus*.

Conservation status. *Caledoniscincus pelletieri* **sp. nov.** is exposed to range of human-mediated impacts of which the greatest threat comes from the expansion of the nickel mine on the Dôme de Tiébaghi plateau. Open-cast mining already occurs in very close proximity to all four sites at which this species has been found (Fig. 5), abutting the forest remnants on the southwest end of the plateau and to within 100 m of the collection sites at which the species was discovered in 2011, to within 200 m of the site at the southeast end of the plateau, and to within 250 m of the site at the northern end of the plateau. Even beyond the present area of active mining, the forest and adjacent maquis is extensively tracked. Any expansion of the mine beyond the present mine footprint, or the construction of infrastructural facilities such as tracks or silt-traps within forest and shrubland areas, will result in the destruction and further fragmentation of habitat of *Caledoniscincus pelletieri* **sp. nov**.

However, even without further expansion of the mine the species' habitat is at continued risk of degradation from mining activities. The strong winds that sweep over the plateau carry large volumes of wind-borne dust for considerable distances into the forest where it blankets the foliage and forest floor, and forest within gullies is at

considerable risk to erosion and slips from accelerated water run-off redirected from the mine. The extent and quality of forest habitat on the upper part of the massif are also at risk from the wildfires that are commonplace on the slopes of Dôme de Tiébaghi in the dry season. Introduced deer and pigs, both of which are common on the massif, cause damage to forest through browsing and soil and litter disturbance, thus limiting regeneration and opening the forest to increased drying.

FIGURE 4. Habitat of *Caledoniscincus pelletieri* **sp. nov.** on Dôme de Tiébaghi—closed forest remnant bisected by old mining track (A) on southwest rim of plateau, and closed-canopy forest to c.15 m with dense understorey of palms (B) where paratype AMS R.174994 was collected.

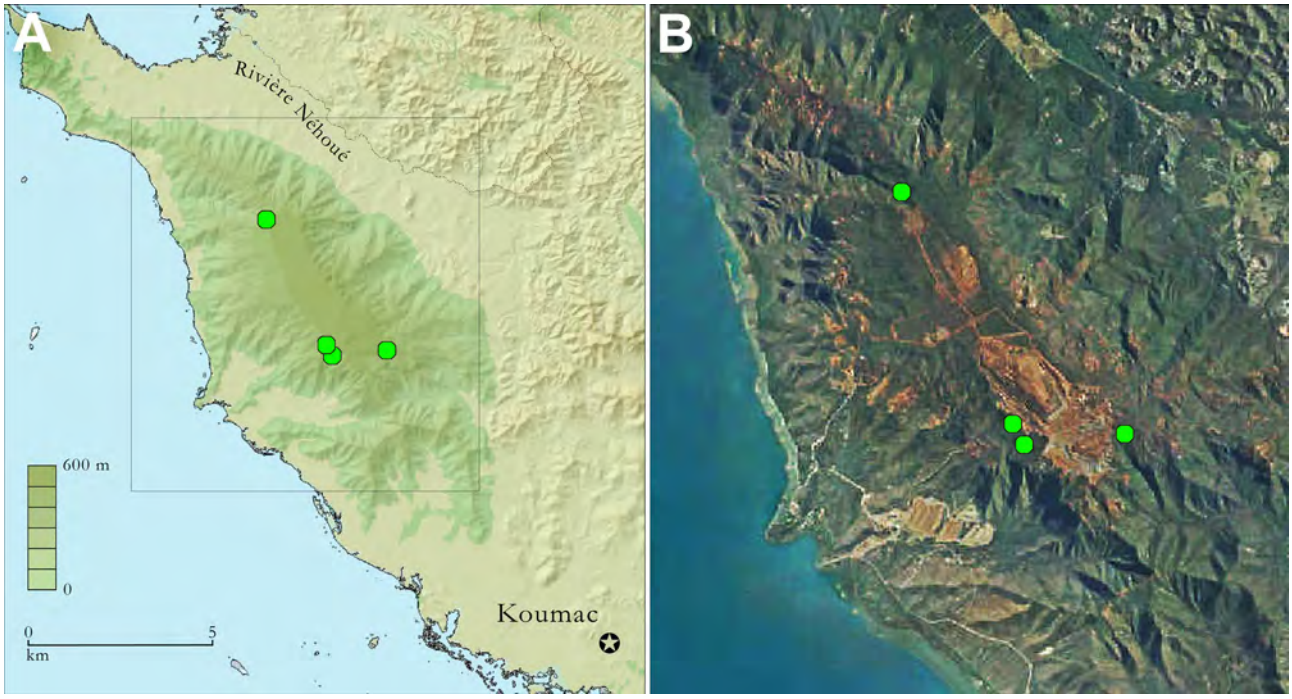

FIGURE 5. Hypsometric relief map of Dôme de Tiébaghi (A), with sites of known occurrence of *Caledoniscincus pelletieri* **sp. nov.** (green dots). Note the isolation of massif by virtue of the low elevation terrain to the north, east and south, the extent of the peridotite (green overlay—note elevational shading applies only within this area); and satellite image of the massif (B) showing the known sites of occurrence (green dots) in relation to the proximity of active mining activity as indicated by the presence of roads and areas of exposed red laterite soils.

Other introduced species present in the forests on the Tiébaghi massif that are a threat to *Caledoniscincus pelletieri* **sp. nov.** include rodents, feral cats and invasive ants (*Wasmannia auropunctata* and *Anoplolepis gracilipes*). Rodents and cats are known to be important predators of lizards (Whitaker 1978; Towns *et al*. 2006; Bonnaud *et al*. 2011; Medina *et al*. 2011) but distinguishing their relative impacts is difficult because of interactions between them and data on the degree to which they affect New Caledonian skink populations are lacking. However, the impacts of *Wasmannia* on lizards are better understood and reported as having a severe deleterious effect on the abundance and diversity within lizard communities, including the species of *Caledoniscincus* (Jourdan *et al*. 2001).

The population size and dynamics of *Caledoniscincus pelletieri* **sp. nov.** are not known and cannot be estimated from the data available, and as such its conservation status is derived from its extremely restricted range and the immediate threats to the species identified above. On this basis, *C. pelletieri* **sp. nov.** would satisfy the criteria to be ranked as Critically Endangered on IUCN Red List criteria (IUCN 2001).

Dôme de Tiébaghi is a highly significant site for lizard conservation. At least 21 species are known from the area including a number of Critically Endangered taxa, the majority of which are endemic to the massif. In addition to *Caledoniscincus pelletieri* **sp. nov.,** these Critically Endangered taxa are: *Dierogekko nehoueensis* Bauer, Jackman, Sadlier & Whitaker, *Oedodera marmorata* Bauer, Jackman, Sadlier & Whitaker, an undescribed taxon in *Bavayia*, and the skink *Marmorosphax taom* Sadlier, Smith, Bauer & Whitaker. Two Endangered taxa with restricted distributions in northern Grande Terre and the Iles Belep, *Mniarogekko jalu* Bauer, Whitaker Sadlier & Jackman, and *Kanakysaurus viviparus* Sadlier, Whitaker, Bauer & Smith, also occur on the massif. Further, the Tiébaghi massif is the northernmost limit of range of four other lizard species, *Rhacodactylus auriculatus* (Bavay), *Caledoniscincus aquilonius*, *Lioscincus novaecaledoniae* (Parker), and *Tropidoscincus boreus* Sadlier & Bauer.

The establishment and management of appropriate reserves on Dôme de Tiébaghi is crucial to the long-term conservation of this diverse lizard fauna. Areas of habitat that include one of the sites from which *C. pelletieri* **sp. nov.** is known have been identified as potential conservation areas by Société le Nickel, but management of these areas should also include strategies to combat the threats to habitat identified above.

Comparative material examined. The following specimens were used in the morphological comparisons presented in Table 1. We take here the opportunity to correct site co-ordinates for the types of *Caledoniscincus*

constellatus presented in the original description (Sadlier *et al*. 2012) due to incorrect conversion from UTM coordinates to latitude and longitude.

Caledoniscincus haplorhinus: AMS R.144257–58, R.144284–86, 144288 Grottes de Koumac, 9km E of Koumac 20°33'18"S 164°21'49"E; AMS R.171480–81 Pointe de Vavouto 21°00'40.3"S 164°41'07.9"E; AMS R.171483 Pointe de Vavouto 21°00'36.4"S 164°41'8.6"E; AMS R.171491 Pointe de Vavouto 21°00'17.8S 164°46'7.5E; AMS R.146459–68, Pindaï, Plage de Pindaï 21°21'26"S 164°57'11"E; AMS R.146433–4, CAS 198763–69, 198770–71 Plage de Ouano 21°50'43"S 165°48'33"E; AMS R.77409, R.77427, R.77429, R.77437, R.77451–52, R.78319–20, R.78322, R.78326, Nouméa, Fambourg Blanchot 22°18'S 166°27'E; AMS R.135119–23 Nouville, Isle Nou 22°16'S 166°24'E.

Caledoniscincus constellatus: MNHN 2011.0228 Pointe de Vavouto 21°00'29.9"S 164°41'16.1"E; AMS R.171471 & 171496 Pointe de Vavouto 21°00'24.6"S 164°41'13.8"E; AMS R.171470 Pointe de Vavouto 21°00'30.4"S 164°41'19.7"E.

Caledoniscincus austrocaledonicus: 28 specimens as listed by Sadlier *et al*. (1999) from the neotype locality of Mt. Aoupinié.

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APPENDIX 1. List of specimens used in the genetic study and associated GenBank accession numbers for ND2 gene fragment. For museum acronyms see materials and methods.

Genus	Species	Voucher	Locality	GenBank Accession No.
Outgroup				
Celatiscincus	*euryotis*	AMS R.138574	Île des Pins	DQ675204
Graciliscincus	*shonae*	AMS R. 165813	Mt. Ouin	DQ675207
Kanakysaurus	*viviparus*	AMS R.161299	Île Pott	DQ675209
Lacertoides	*pardalis*	AMS R.148051	Kwa Néie	DQ675211
Lioscincus	*nigrofasciolatus*	AMS R.138624	Île des Pins	DQ675216
Lioscincus	*steindachneri*	AMS R.149890	Mé Adéo	DQ675218
Lioscincus	*tillieri*	AMS R.148037	Mt. Vulcain	DQ675220
Marmorosphax	*tricolour*	CAS 214451	Mt. Koghis	DQ675227
Nannoscincus	*mariei*	AMS R.146484	Mt. Mou	DQ675232
Phoboscincus	*garnieri*	AMS R.151964	Mt. Dore	DQ675237
Sigaloseps	*deplanchei*	AMS R.148065	Plaine des Lacs	DQ675238
Simiscincus	*aurantiacus*	AMS R.144356	Mt. Koghis	DQ675250
Tropidoscincus	*variabilis*	AMS R.161879	Kwa Né Mwâ	DQ675242
Ingroup				
Caledoniscincus	*constellatus*	MNHN 2011.0228	Pointe de Vavouto	JQ743847
Caledoniscincus	*constellatus*	AMS R.171496	Pointe de Vavouto	JQ743846
Caledoniscincus	*constellatus*	AMS R.171470	Pointe de Vavouto	JQ743845
Caledoniscincus	*pelletieri* **sp. nov.**	MNHN 2012.0225	Dôme de Tiébaghi	JX988521
Caledoniscincus	*pelletieri* **sp. nov.**	AMS R.174944	Dôme de Tiébaghi	JX988522
Caledoniscincus	*notialis*	AMS R.172613	Mt. Humbolt	JQ743848
Caledoniscincus	*notialis*	AMS R.172648	Yaté Barrage	JQ743849
Caledoniscincus	*auratus*	AMS R157910	Forêt Tia	JQ743850
Caledoniscincus	*auratus*	AMS R144298	Grottes de Koumac	JQ743851
Caledoniscincus	*atropunctatus*	AMS R172604	Port Boisé	JQ743853
Caledoniscincus	*atropunctatus*	AMS R161803	Île Art	DQ675196
Caledoniscincus	*cryptos*	AMS R.135141	Col d'Amieu	JQ743852
Caledoniscincus	*chazeaui*	AMS R.138515	Koulnoué	DQ675272
Caledoniscincus	*renevieri*	AMS R.165851	Mt. Aoupinié	DQ675268

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APPENDIX 1. (Continued)

Genus	Species	Voucher	Locality	GenBank Accession No.
Caledoniscincus	*terma*	CAS 198680	Mt. Mandjélia	DQ675271
Caledoniscincus	*aquilonius*	CAS 231935	Riviére Néhoué	JQ743854
Caledoniscincus	*aquilonius*	AMS R.150712	Hienghène	JQ743855
Caledoniscincus	*orestes*	AMS R.149926	Mé Adéo	DQ675202
Caledoniscincus	*orestes*	AMS R.149983	Mt. Panié	JQ743856
Caledoniscincus	*festivus*	AMS R.161882	Kwa Né Mwâ	DQ675200
Caledoniscincus	*festivus*	AMS R.165885	Pouembout	JQ743857
Caledoniscincus	*haplorhinus*	AMS R.161077	Île Art	JQ743858
Caledoniscincus	*haplorhinus*	CAS 231888	Îlot Brosse	JQ743859
Caledoniscincus	*austrocaledonicus*	AMS R.153713	Mt. Taom	JQ743860
Caledoniscincus	*austrocaledonicus*	AMS R.172661	Chutes de la Madeleine	JQ743861

Addendum: At the time proofs of this manuscript were being prepared the senior author (RAS) received an image of a live specimen of *Caledoniscincus* from the Massif de Koniambo, approximately 80km to the south of Dôme de Tiébaghi.This specimen was similar in coloration to adult female *Caledoniscincus pelletieri*. Should future examination of this specimen confirm its identity as *C. pelletieri* the conservation status of the species would require reassessment.