Zootaxa 3717 (4): 543–558
www.mapress.com/zootaxa/

Article

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

http://dx.doi.org/10.11646/zootaxa.3717.4.6
http://zoobank.org/urn:lsid:zoobank.org:pub:1E052509-825D-4527-8F24-1F1C7781C47B

A spectacular new leaf-tailed gecko (Carphodactylidae: *Saltuarius*) from the Melville Range, north-east Australia

CONRAD J. HOSKIN[1,3] & PATRICK COUPER[2]

[1]*School of Marine & Tropical Biology, James Cook University, Townsville, Queensland 4811, Australia*
[2]*Queensland Museum, PO Box 3300, South Bank, Brisbane, Queensland 4101, Australia*
[3]*Corresponding author. E-mail: conrad.hoskin@jcu.edu.au*

Abstract

Leaf-tailed geckos are a distinctive group of carphodactyline geckos of rainforests and rocky habitats of eastern Australia. Three genera are recognized: *Phyllurus* (9 species), *Saltuarius* (6 species) and *Orraya* (1 species). Leaf-tailed geckos have been the subject of much survey and taxonomic work because they are large, impressive geckos and generally have highly localized distributions. The six species comprising *Saltuarius* are distributed in rock outcrops and rainforests along the ranges from northern New South Wales to the Wet Tropics region of north-east Queensland. Here we report the discovery of a new *Saltuarius* species at Cape Melville, a rainforest outlier on Cape York Peninsula in north-east Queensland. The new species is assigned to *Saltuarius* based on morphological and genetic data. *Saltuarius eximius* **sp. nov.** is highly distinct from all congeners in many aspects of morphology. It has a very long slender form, with relatively longer limbs, longer body, narrower body and narrower neck than all congeners. It also has a highly distinct head that is relatively smaller than that of all other *Saltuarius*, with very large eyes that are grey rather than patterned. The tail is large but with a relatively short attenuated tip. *Saltuarius eximius* **sp. nov.** appears to be highly localized to upland rainforest associated with boulder habitat in the Cape Melville Range. The unusual elongate form and large eyes of *S. eximius* **sp. nov.** likely reflect adaptation to deep boulder habitat. Two other new vertebrate species (a skink and a frog) were discovered in the rainforest and boulder-fields of Cape Melville during recent surveys, bringing the number of vertebrates known to be endemic to the Cape Melville Range to six (three frogs, two skinks and one gecko).

Key words: *Saltuarius eximius*, *Orraya*, Cape York, boulder-field, rainforest, lithorefugia

Introduction

The Australian leaf-tailed geckos fall within the family Carphodactylidae and consist of three genera: *Phyllurus* Goldfuss 1820, *Saltuarius* Couper *et al.* 1993 and *Orraya* Couper *et al.* 2000. Leaf-tailed geckos are large, impressive geckos that are highly camouflaged against rocks and tree trunks. Most species are rainforest dependent but some occur in drier (sclerophyll forest) habitats in association with rock. Leaf-tailed geckos are restricted to eastern Australia, with species generally having highly localized distributions, including some found on a single mountain or range (e.g., *Orraya occultus* (Couper *et al.* 1993), *Phyllurus amnicola* Hoskin *et al.* 2000 [in Couper *et al.* 2000], *Phyllurus gulbaru* Hoskin *et al.* 2003). The distribution of leaf-tailed geckos is interesting in that each species is generally localized to an isolated rainforest or rocky region, but in total the species cover much of the coastal ranges of eastern Australia. Only two sites have more than one leaf-tailed gecko species (Many Peaks Range: *P. caudiannulatus* Covacevich 1975, *S. salebrosus* (Covacevich 1975); Pattersons Gorge: *P. gulbaru*, *S. cornutus* (Ogilby 1892)). The habitat restriction, persistence and low vagility of leaf-tailed geckos has made them a key group in biogeographic analyses of the mesic forests of north-eastern Australia (e.g. Mortiz *et al.* 2005).

There are six *Saltuarius* species described, ranging from north-east Queensland to north-east New South Wales (Couper *et al.* 2008). The genus *Saltuarius* was erected to accommodate a monophyletic group of larger species with unique internal and external morphological characteristics and different chromosome number compared to *Phyllurus* (Couper *et al.* 1993). At this time four species were included: *S. cornutus*, *S. salebrosus* (Covacevich

Accepted by A. Bauer: 5 Sept. 2013; published: 1 Oct. 2013

1975), *S. swaini* (Wells & Wellington 1985) and *S. occultus* Couper *et al.* 1993. *Saltuarius wyberba* Couper *et al.* 1997 was subsequently described and *S. occultus* was reassigned to a new genus, *Orraya* Couper *et al.* 2000, based on unique morphological traits and an mtDNA lineage highly divergent to all other leaf-tailed geckos (Couper *et al.* 2000). Recently the *S. swaini* group of north-east New South Wales (NSW) and south-east Queensland (Qld) was revised and two new species were recognized, *S. kateae* Couper *et al.* 2008 and *S. moritzi* Couper *et al.* 2008. Thus the following species are currently recognized in *Saltuarius* (from north to south): *S. cornutus* (rainforest of the Wet Tropics, north-east Qld), *S. salebrosus* (rainforests and rocky habitats of mid-east Qld), *S. swaini* (rainforest of south-east Qld and north-east NSW), *S. wyberba* (rocky habitats of south-east Qld and north-east NSW), *S. kateae* (rocky habitats of the Richmond Ra, north-east NSW) and *S. moritzi* (rainforest, sclerophyll forests and rocky habitats of north-east NSW).

A number of highly localized leaf-tailed geckos have been described as a result of field discoveries over the last two decades (*P. ossa* Couper *et al.* 1993, *P. isis* Couper *et al.* 1993, *P. championae* Schneider *et al.* 2000 [in Couper *et al.* 2000], *P. amnicola* Hoskin *et al.* 2000 [in Couper *et al.* 2000], *P. gulbaru* Hoskin *et al.* 2003). These have all been *Phyllurus* geckos, which reflects the generally smaller distributions and more specific habitat requirements of these species versus *Saltuarius* geckos. Here we describe a new species of *Saltuarius* discovered during targeted herpetofauna surveys of the rainforests of the Melville Range, on Cape Melville, north-east Queensland. Two other new species were also discovered during these surveys, a *Saproscincus* skink (Hoskin, submitted) and a *Cophixalus* frog (Hoskin, submitted). Cape Melville is dominated by the Melville Range, a low range (generally < 500 m elevation) of granite boulder-fields, with patches of rainforest on the slopes and an elevated rainforest plateau. The Melville Range is highly isolated from other elevated rainforest areas of north-east Queensland and is already recognized for having three endemic, rock-associated vertebrates. The new *Saltuarius* species is described herein.

Methods

Morphometrics: Specimens examined are held in the Queensland Museum (QMJ codes). All measurements of preserved specimens were taken using Mitutoyo electronic callipers and rounded to the nearest 0.1 mm. Field measurements of snout to vent length (SVL) and weight (WT) were taken using Mitutoyo vernier callipers and a spring-loaded Pezola, respectively. All measurements (except SVL) and bilateral counts were recorded for the left side only. The following characters were measured: snout to vent length (SVL), tip of snout to anterior margin of cloaca with body straightened; original tail length (Tail), from posterior margin of cloaca to tip of tail; original tail tip length (Tip), length of attenuated tail tip; original or regenerated tail length (TailL), from posterior margin of cloaca to tip of tail; original or regenerated tail width (TailW), measured across widest part of the tail; head length (HL), mid anterior margin of ear to tip of snout; head width (HW), widest point across back of skull, corresponding with anterior upper margin of ear openings; head depth (HD), vertical measurement of head from top of head between eyes to ventral edge of lower jaw (measured parallel to the sagittal plane); snout length (snout), tip of snout to anterior margin of orbit; eye to ear (EE), posterior margin of orbit to mid anterior margin of ear; eye diameter (ED), measured across horizontal axis; neck length (NL), axilla to mid posterior margin of ear; neck width (NW), taken mid neck; length of forelimb (L1) and hindlimb (L2), in both cases measured from insertion to tip of longest digit (claw included), with limb stretched straight perpendicular to body; forearm length (FL), from elbow to 'heel'of the palm (i.e. radioulna length); lower hindlimb length (HLL), from knee to heel (i.e. tibiofibula length); axilla to groin length (AG), measured from armpit to groin with body straightened; mid-body width (midBW), measured across body at point equidistant from axilla and groin; subdigital lamellae, count of enlarged series beneath 4th finger and 4th toe and including claw sheath; subdigital scales, count from tip of 4th finger and 4th toe to basal junction of 3rd and 4th digits, respectively (series may include small scales proximal to the enlarged lamellae); supralabials, count of the series beginning immediately behind rostral and terminating a little past mid orbit where scales abruptly diminish in size; infralabials, count of the series beginning immediately behind mental and terminating a little past the mid orbit where scales abruptly diminish in size. Additionally, the distribution of enlarged tubercles was examined on digits and ventral surfaces.

Internal morphology: An X-ray was made by Mike Jeffery at the James Cook University Veterinary and Emergency Centre. The equipment used was a Shimadzu RAD speed and a Cannon (DR) Detector, using a kVp of 40 and an mAs of 8. The traits scored from the X-ray were: the shape of the cervical vertebrae (degree of

elongation), and number of lumbar vertebrae (defined as non rib-bearing vertebrae immediately anterior to the sacrum) (as defined in Couper *et al.* 1993).

Genetics. Two individuals of *Saltuarius eximius* **sp. nov.** were sequenced for 729 base pairs (bp) of mitochondrial DNA, consisting of sections of the 12S (421 bp) and cytochrome-*b* (308 bp) gene. 12S mtDNA was amplified using the primers 12SA and 12SB (Kocher *et al.* 1989), with an annealing temperature of 50°C. Primer sequences were: 12SA, 5'-AAACTGGGATTAGATACCCCACTAT-3'; 12SB, 5'-GAGGGTGACGGGCGGTGTGT-3'. Cytochrome-*b* was amplified using modified versions of the primers Ph1 (Schneider & Moritz 1999) and MVZ04 (Smith & Patton 1991), and an annealing temperature of 45°C. The primer sequences used were: Ph1, 5'-GACCCCAATACGAAAAA CCACCC-3'; MVZ04, 5'-GCAGCCCCTCAGAATGATATTTG-3'. Sequences have been deposited in GenBank (12S: QMJ92378 = KF553907, QMJ92379 = KF553908; cyt*b*: QMJ92378 = KF553909, QMJ92379 = KF553910). The sequences were concatenated for each individual and aligned with sequences for all other leaf-tailed gecko species (Hoskin & Schneider, unpub. data). Genetic divergence stated is uncorrected pairwise distance.

Systematics

The new species is assigned to *Saltuarius* by the following traits: two lumbar vertebrae, rostral contacting nostril, rostral shield fully divided, original tail large and broad with an elaborate outer flange and attenuated tip, and the presence of preanal pores (in males). Also assigned to *Saltuarius* based on genetics, falling with strong support within the *Saltuarius* clade based on mtDNA data (Hoskin, unpub. data).

Saltuarius eximius **sp. nov.**

Cape Melville Leaf-tailed Gecko
(Figs 1, 2, 3, 4A, 5A, 6, 7)

Material examined. Holotype: QMJ92377, female, Melville Range (14°16'38" S, 144°29'28" E, elevation 500 m), Cape Melville National Park, north-east Queensland, C. J. Hoskin, 20 March 2013. **Paratypes:** QMJ92378 (male), QMJ92379 (female), collection details as for holotype.

Diagnosis. *Saltuarius eximius* **sp. nov.** is highly distinct in its long and slender form, short head and very large eyes (Figs. 1–5). *Saltuarius eximius* **sp. nov.** is readily distinguished from all its congeners by the following non-overlapping (or largely non-overlapping) body measurements (as % SVL): its more elongate and narrow body form (AG = 49–50% *vs* 40–51% combined range for all other *Saltuarius* species; midBW = 11–12% *vs* 13–21%); longer limbs (L1 = 55–57% *vs* 42–52%, L2 = 63–64% *vs* 52–63%); narrower neck (NW = 6.3–6.5% *vs* 7.5–10.7%); narrower head (HW = 18–19% *vs* 19–24%); shorter head (HL = 24–25% *vs* 25–30%); shorter temporal region (EE = 6.0–7.8% *vs* 7.4–10.3%); and larger eye diameter (ED = 7.8–8.6% *vs* 5.2–7.3%) (Table 1). *Saltuarius eximius* **sp. nov.** also has an unpatterned grey eye versus the patterned eyes of all congeners. *Saltuarius eximius* **sp. nov.** also has a distinct tail that is elaborately frilled along the margin with a short, fine attenuated tip.

Etymology. Eximius; from the Latin meaning exceptional, extraordinary, exquisite. In recognition of the particularly fine form and distinctiveness of this species. The species epithet is treated as a noun in apposition.

Measurements and scale counts of holotype. SVL = 106.4 mm, AG = 53.5 mm, midBW = 11.5 mm, Tail (original) = 68.3 mm, Tip = 17.2 mm, TailW = 33.9, L1 = 60.7 mm, L2 = 68.6 mm, FLL = 26.3 mm, HLL = 28.6 mm, HL = 25.8 mm, HW = 19.7 mm, snout = 11.8 mm, EE = 6.4 mm, ED = 9.2, NL = 20.8 mm, NW = 6.7 mm, enlarged lamellae 4th finger = 19, enlarged lamellae 4th toe = 18, lamellae to junction 3rd and 4th finger = 19, lamellae to junction 3rd and 4th toe = 21 (includes 3 smaller scales at basal end), supralabials = 15 (1st in series fused), infralabials = 12.

Description of type series (Fig. 6): Data presented as range followed by mean in brackets. **Adult measurements** (mm)**:** SVL 106.4–118.3 (112.4); AG 53.5–58.3 (55.6); midBW 11.5–14.4 (13.2); Tail (original) 68.3 (only holotype has an original tail); Tip (original) 17. 2; TailL 53.1–68.3 (59.7); TailW 33.9–41.2 (37.3); L1 60.7–65.3 (62.5); L2 68.6–74.5 (71.2); FLL 26.3–30.5 (28.3); HLL 28.6–31.5 (29.9); HL 25.8–29.1 (27.5); HW 19.7–22.3 (21.2); snout 11.8–13.2 (12.5); NW 6.7–7.6 (7.2); NL 20.8–22.4 (21.8); EE 6.4–9.3 (7.8); ED 8.8–9.5 (9.1). **Adult proportions:** see Table 1. ***Head:*** Short, deep, triangular, distinct from neck; head depth 48–53% of head

TABLE 1. Morphological comparison of *S. eximius* **sp. nov.** with other *Saltuarius* species and *Orraya occultus*. Table shows data for SVL (mm) then length of traits as a proportion (%) of SVL. Mean is presented above range. Ranges for traits with proportions over 10% are rounded to nearest percent. For *S. eximius* **sp. nov.** and *O. occultus*, only a single specimen had an original tail, while for *S. kateae*, no specimens with original tails were available. Morphology codes are: SVL: snout to vent length, Tail: original tail length, Tip: original tail tip length, AG: axilla to groin length, midBW: mid–body width, L1: forelimb length, L2: hindlimb length, HL: head length, HW: head width, snout: snout length, NW: neck width, NL: neck length, EE: eye to ear distance, ED: eye diameter. For more details see Methods. For *S. eximius* **sp. nov.** the data comes from the three specimens comprising the type series. For the other species, the data is a summary of measurements taken from the specimens listed in the Appendix and data from Couper *et al.* (2008) and Couper *et al.* (1993).

	SVL	Tail/SVL	Tip/Tail	AG/SVL	midBW/ SVL	L1/SVL	L2/SVL	HL/SVL	HW/SVL	snout/ SVL	NW/SVL	NL/SVL	EE/SVL	ED/SVL
S. eximius **sp nov.**	**112**	**64.1**	**25.2**	**49.5**	**11.7**	**55.6**	**63.4**	**24.5**	**18.8**	**11.1**	**6.4**	**19.4**	**6.9**	**8.1**
	106–118			49–50	11–12	55–57	63–64	24–25	18–19	11–11	6.3–6.5	19–20	6.0–7.8	7.8–8.6
S. cornutus	**126**	**63.2**	**35.8**	**45.5**	**16.2**	**47.8**	**56.9**	**28.1**	**21.8**	**13.5**	**9.4**	**17.8**	**9.3**	**6.3**
	116–136	59–68	32–40	41–49	13–19	47–51	55–61	27–29	21–22	13–14	8.9–9.8	15–21	8.6–10.0	5.6–7.2
S. salebrosus	**132**	**63.9**	**25.6**	**44.6**	**17.7**	**47.3**	**55.5**	**26.6**	**22.7**	**12.3**	**9.4**	**19.6**	**9.7**	**5.8**
	121–144	58–72	22–30	43–47	14–21	45–51	52–61	26–27	22–24	12–13	8.8–10.7	18–21	9.3–10.0	5.2–6.5
S. swaini	**124**	**66.9**	**40.6**	**46.2**	**15.9**	**48.2**	**58.7**	**26.2**	**20.4**	**12.2**	**8.9**	**18.6**	**8.3**	**6.1**
	99–134	59–72	35–49	41–51	15–17	44–51	53–62	25–29	19–22	11–14	8.0–9.6	15–22	7.4–9.4	5.6–6.5
S. wyberba	**99**	**71.2**	**40.6**	**45.0**	**17.1**	**47.2**	**57.4**	**27.3**	**22.1**	**12.1**	**9.8**	**17.7**	**8.9**	**7.0**
	86–108	62–81	33–46	40–48	16–18	44–51	53–63	25–29	20–24	11–14	8.3–10.6	15–21	7.5–10.0	6.6–7.3
S. kateae	**104**			**46.8**	**17.8**	**46.3**	**58.0**	**27.2**	**21.3**	**12.2**	**8.3**	**17.4**	**8.3**	**6.4**
	97–110			45–48	17–19	45–47	55–60	27–28	21–22	12–13	7.5–8.7	15–20	7.5–9.2	6.3–6.6
S. moritzi	**98**	**68.9**	**39.3**	**45.1**	**16.7**	**47.4**	**57.7**	**26.9**	**21.2**	**12.2**	**9.1**	**19.4**	**8.4**	**6.8**
	88–109	63–76	29–47	40–50	15–19	42–52	52–62	25–30	20–24	11–14	8.3–10.6	16–23	7.4–10.3	6.4–7.1
O. occultus	**103**	**48.4**	**21.5**	**43.4**	**15.9**	**47.1**	**59.0**	**25.8**	**17.2**	**13.0**	**6.7**	**24.2**	**6.9**	**6.5**
	95–108			41–45	13–18	45–49	56–61	25–27	16–19	12–14	6.1–7.2	23–27	6.3–7.3	5.6–7.2

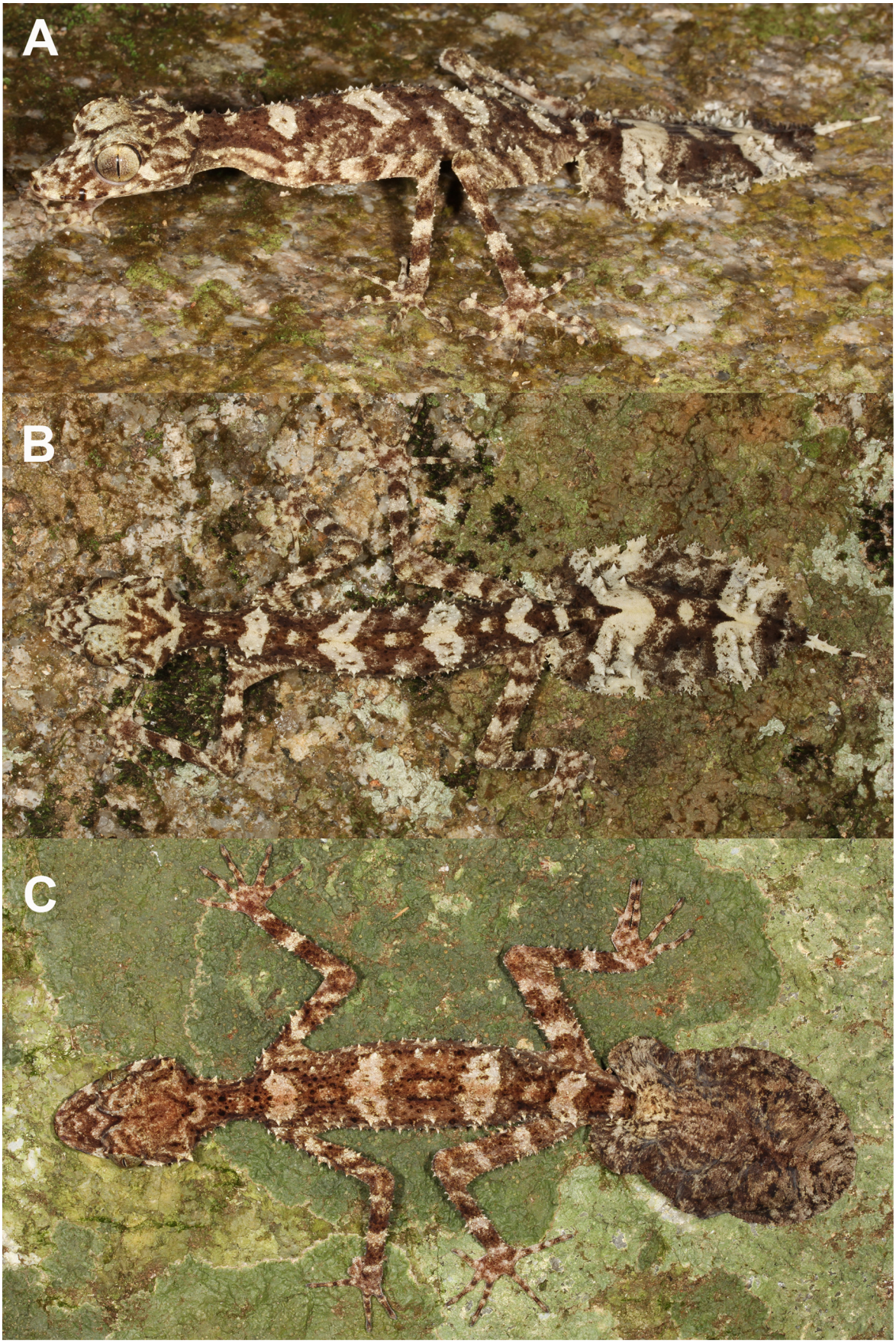

FIGURE 1. *Saltuarius eximius* **sp. nov.** in life: (A, B) original tail (QMJ92377), (C) regenerated tail (photos: Conrad Hoskin).

FIGURE 2. *Saltuarius eximius* **sp. nov.** in life (photo: Conrad Hoskin).

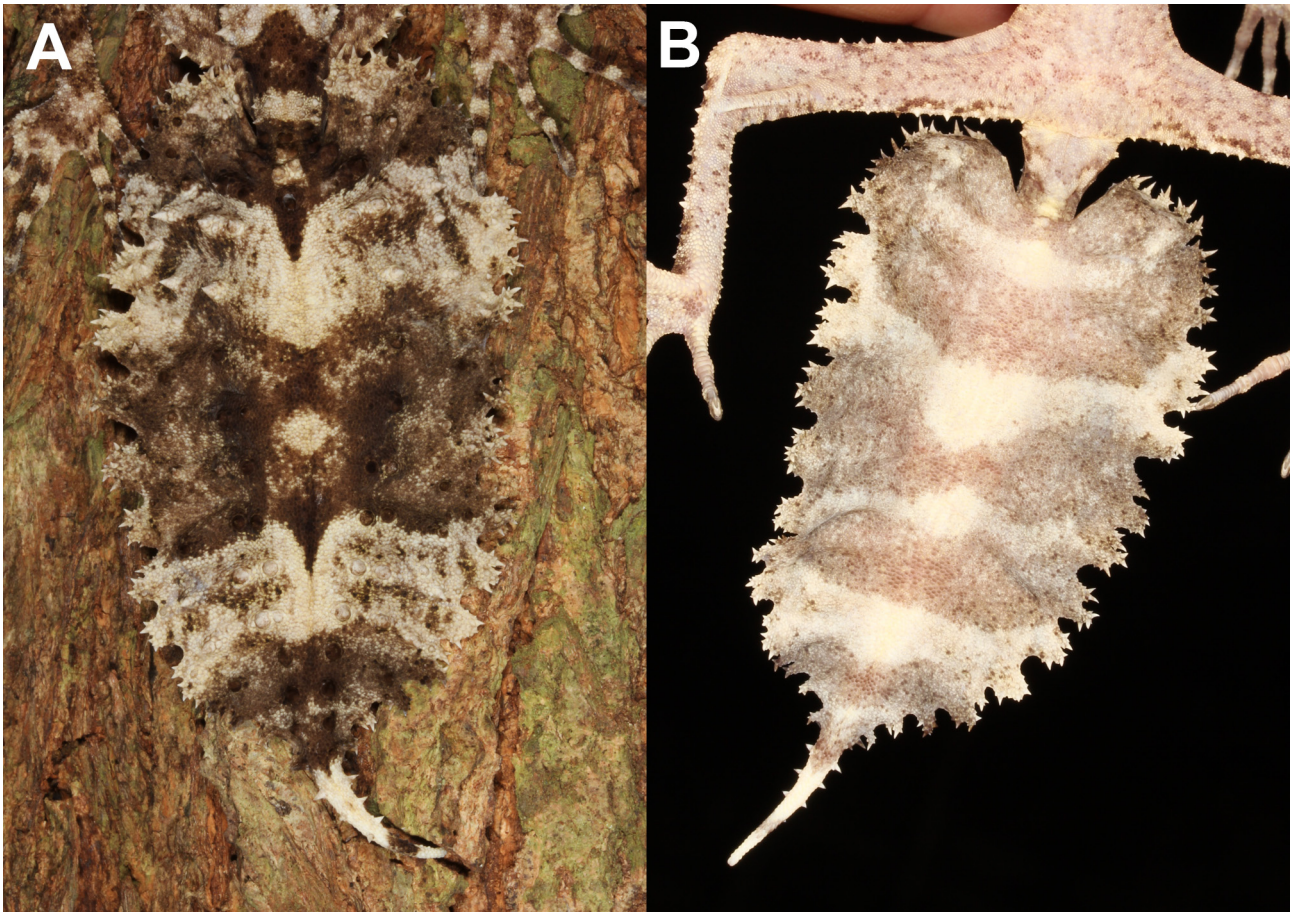

FIGURE 3. Original tail of *S. eximius* **sp. nov.** (QMJ92377): (A) dorsal, (B) ventral (photos: Conrad Hoskin).

width (mean = 50%); covered in small granules which are intermixed with larger conical tubercles; skin of head co-ossified with skull; rostral much broader than tall (Fig. 2), fully divided by a single medial groove (Fig. 2); rostral shield in contact with nostril (Fig. 2); 5–6 scales bordering dorsal edge of rostral scale (mean = 5.3); ear opening

elliptical, vertical, ~ ¼ as large as eye; supralabials 14–15 (mean = 14.3); infralabials 12. ***Neck:*** Distinct and narrow, with large, sharp-tipped tubercules on dorsum. ***Body:*** Narrow and elongate, covered in small granules; dorsal granules intermixed with larger conical, sharp-tipped tubercles; tubercles largest on back and upper flanks, and generally arranged as longitudinal rows (Fig. 2); ventrolateral skin fold with a row of small, bluntly tipped tubercules; medial scales on belly considerably larger than the small outer granules that lie adjacent to the ventrolateral skin fold; a patch of enlarged, centrally placed scales is present in both the pectoral and pelvic regions; preanal pores absent in males; armpit with two pronounced skin flaps that form a pocket enclosing the axillary region (Fig. 6), the lower of which is continuous with the ventrolateral fold. ***Limbs:*** Long and slender, covered in pronounced pointed tubercles dorsally; digits long and strongly compressed distally; enlarged subdigital lamellae 4th finger 19–21 (mean = 20); dorsal surface of fingers without enlarged conical tubercles extending along digits; enlarged subdigital lamellae 4th toe 18–20 (n = 3, mean = 19.3); dorsal surface of toes with enlarged conical tubercles on basal portion of all digits except the first digit; subdigital scales from tip of 4th finger to junction of 3rd and 4th fingers 19; subdigital scales from tip of 4th toe to junction of 3rd and 4th toes 21–22 (mean = 21.7). ***Original tail*** (holotype only; Fig. 3): Broadly flared with an elaborate, undulating ('frilled') outer flange, and a short, fine attenuated tip; outer frill edged with small sharp spines; attenuated tip with very small spines on first 2/3^{rds} of its length. ***Regenerated tail*** (paratypes; Figs. 1, 6): Broadly flared and paddle-shaped, 'pinched-in' about 1/3rd of the way along its length and with a broadly rounded posterior margin. **Colour pattern in preservative** (Fig. 6): Dorsal base colour grey to tan, overlain with dark grey/brown markings. ***Head:*** Predominantly grey to tan; dark nuchal band in the supraoccipital region; labials pale with two broad dark bars (one at mid-snout, the other below the anterior orbit); dorsal surface of snout bridged by a series of dark chevrons; a dark, deep, V-shaped marking extending back medially between eyes. ***Body:*** Flanks with bold, dark mottling; dorsum with dark chevrons that merge with flank pattern and enclose four to five pale blotches between the pectoral and pelvic regions. ***Original tail*** (holotype): Alternating dark and light bands; basal region with two broad, poorly defined, pale bands and three broad dark bands; attenuated tip with two pale bands (anterior-most widest) and one dark band. ***Regenerated tail*** (paratypes): Pale with heavy dark grey and brown mottling. ***Limbs and digits:*** Pale, with bold, well-defined, dark bands. ***Ventral surfaces:*** Chin, throat and trunk off-white with obscure brown mottling; limbs pale, peppered with dark flecks; original tail has broad dark and pale bands (dark bands are continuous with those on the dorsal surface but each is split in two; Fig. 3); regenerated tail mottled (less pronounced than on dorsal surface), with a paler central region.

Measurements of live individuals: Four adults were measured in the field. Measurements of the holotype (QMJ92377) in life were: SVL 109 mm, WT 16 g. Measurements for paratype QMJ92378 were: SVL 120 mm, WT 22 g. Snout to vent lengths of two individuals that were not collected were: 118 mm and 119 mm.

Colour pattern in life (Figs. 1–5): Dorsal colour an even mix of pale and dark markings; in some individuals this is a mix of white/pale grey and dark grey/black markings, while in others this is a mix of creamy brown and dark brown markings. Prominent markings include the following: a dark V behind the eyes; five pale bands along the back, with smaller pale markings in between; pale bands along the legs and fine pale bands on the digits; two broad, pale bands on the original tail and two white bands on the attenuated tail tip; and dark mottling on the regenerated tails. The iris is grey, tinged with yellowish green. Ventral surface is white but finely mottled with brown; underside of original tail white with soft brown bands; underside of regenerated tail pale in center but heavily mottled towards margin.

Comparison. *Saltuarius eximius* **sp. nov**. is a slender, long-bodied, long-legged, small-headed, large-eyed, large-tailed gecko which differs from all other Australian leaf-tailed geckos (*Orraya*, *Phyllurus* and *Saltuarius*) in the following ways. It is distinguished from *Orraya* (which it most resembles in general body form; Fig. 4) in possessing two lumbar vertebrae (*vs* three in *Orraya*) (Fig. 7); by the shape of the cervical vertebrae (marginally elongated *vs* distinctly elongated in *Orraya*) (Fig. 7); by the size of the preanal pores (male preanal pores very small *vs* greatly enlarged in *Orraya*); by the shape of the original tail (very large and broadly flared with a fine attenuated tip *vs* small and leaf-shaped in *Orraya*); and by the spinosity of the regenerated tail (smooth-edged *vs* enlarged spines along margin in *Orraya*) (Figs 1C, 4C). *Saltuarius eximius* **sp. nov**. is further separated from *Orraya* in having a longer and narrower body, longer limbs, a shorter head and snout, a shorter neck, and larger eyes (non-overlapping differences, Table 1; Figs 4, 5). *Saltuarius eximius* **sp. nov**. differs from *Phyllurus* in that the rostral contacts the nostril (*vs* nostril not in contact with rostral in *Phyllurus*), male preanal pores are present (*vs* absent in *Phyllurus*), and the original tail is strongly flared with an elaborate spinose outer flange (*vs* without elaborate outer flange in *Phyllurus*). *Saltuarius eximius* **sp. nov.** is distinguished from all *Saltuarius* species in

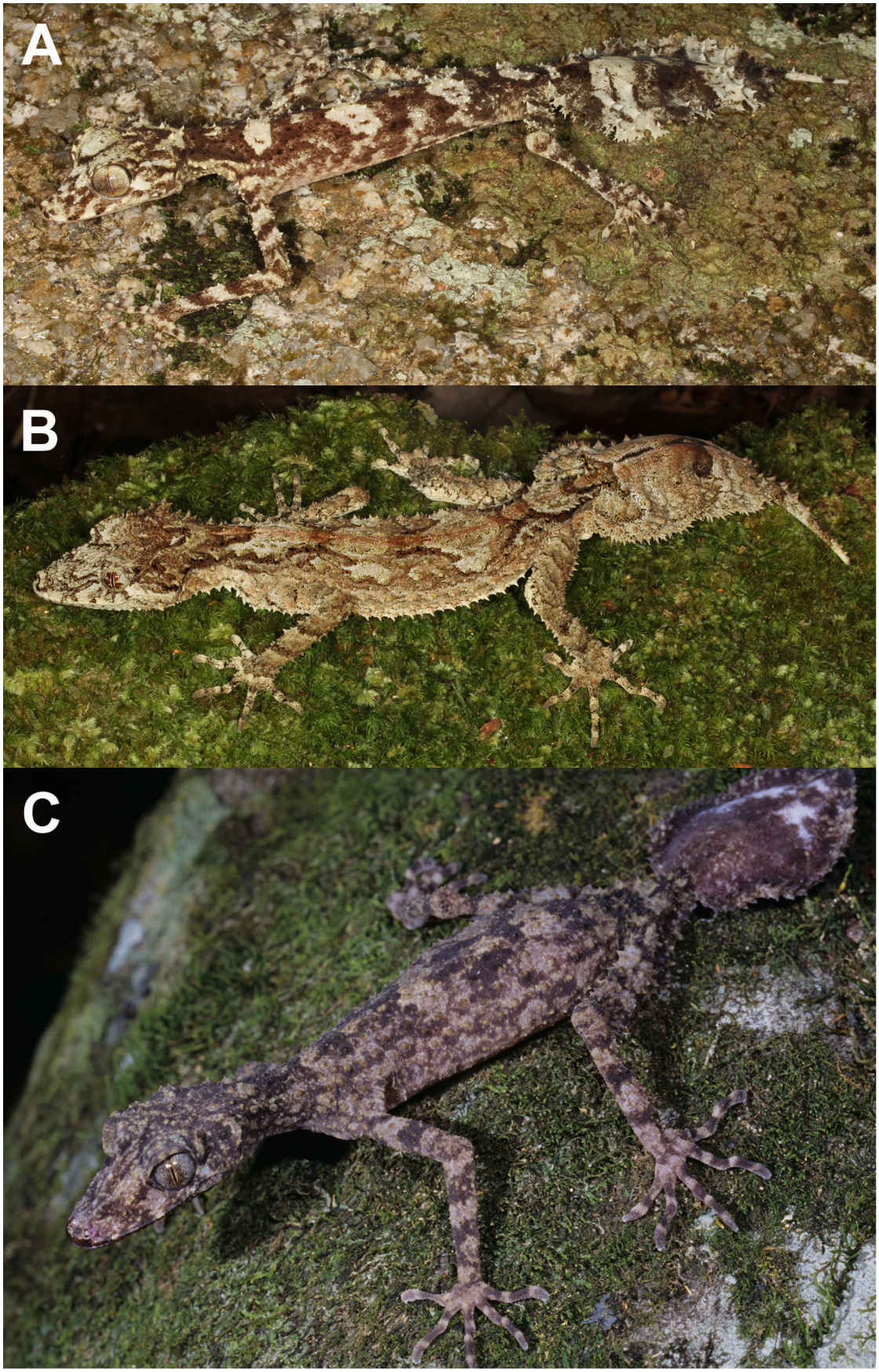

FIGURE 4. Comparison of: (A) *S. eximius* **sp. nov.** (QMJ92377), (B) *S. cornutus*, and (C) *Orraya occultus* (photos: A, B, Conrad Hoskin; C, Jeff Wright).

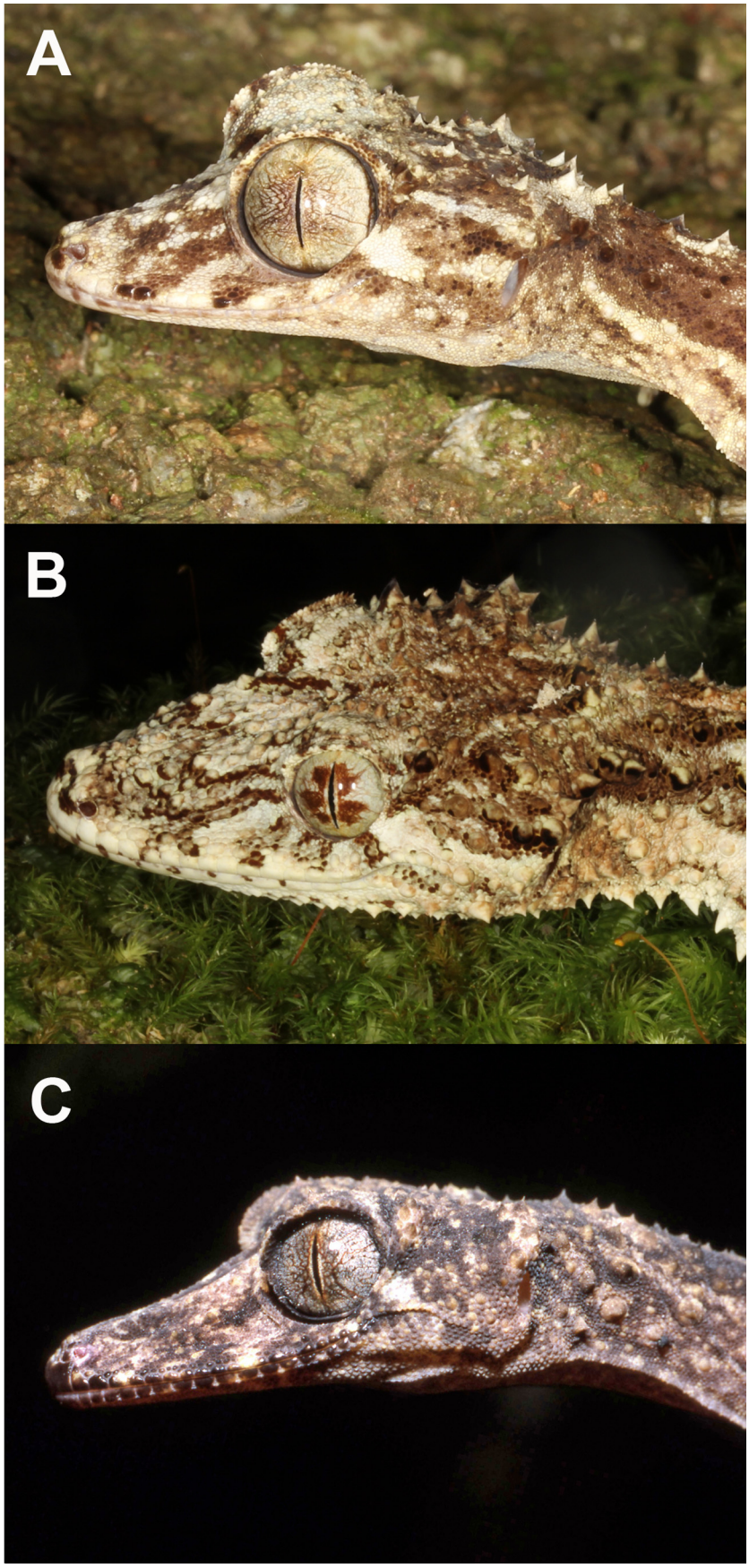

FIGURE 5. Comparison of heads of: (A) *S. eximius* **sp. nov.** (QMJ92377), (B) *S. cornutus*, and (C) *Orraya occultus* (photos: A, B, Conrad Hoskin; C, Steve Wilson).

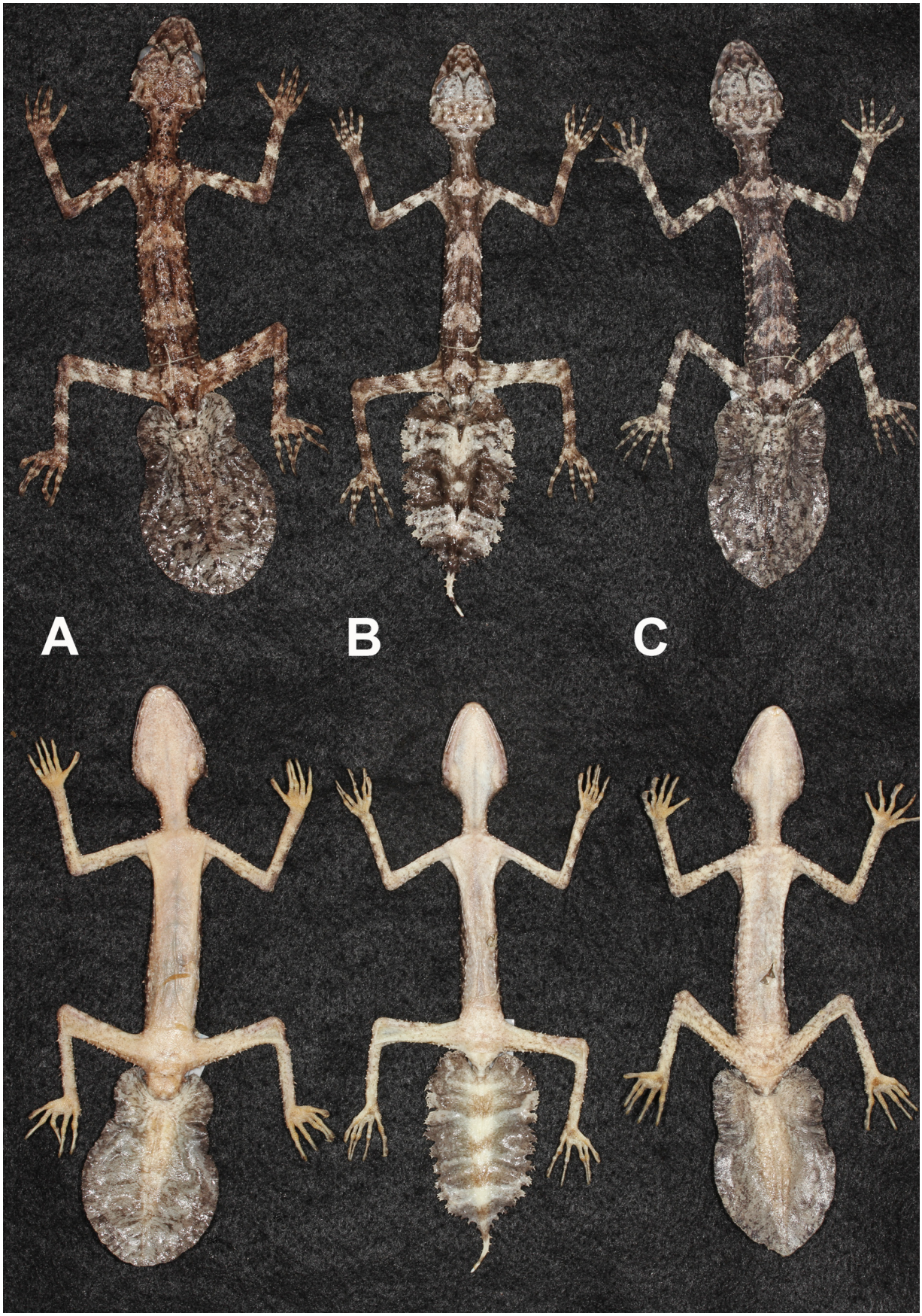

FIGURE 6. Type series of *S. eximius* **sp. nov.**. Specimens (left-right): QMJ92378 (paratype, male), QMJ92377 (holotype, female), QMJ92379 (paratype, female). (photos: Conrad Hoskin).

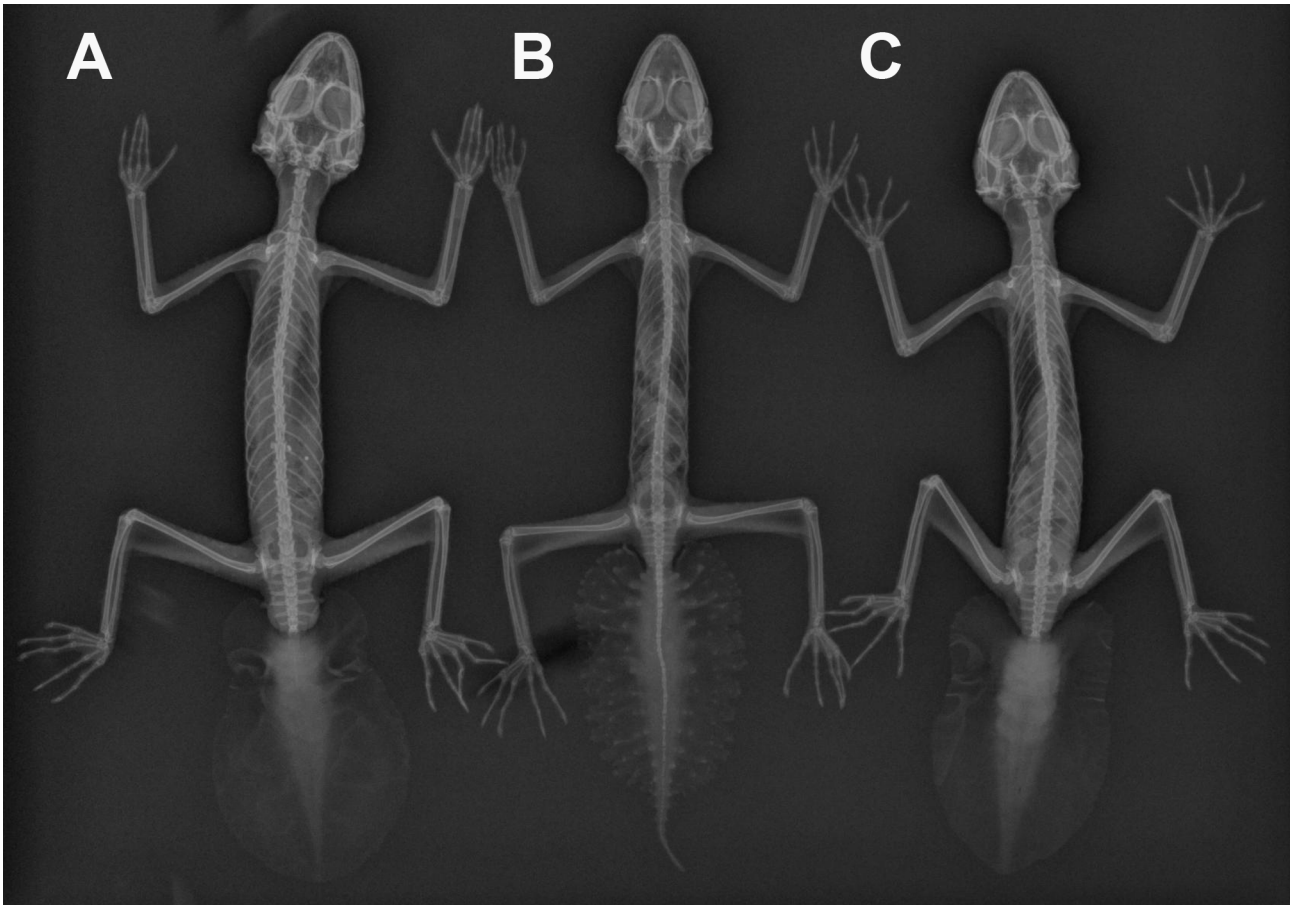

FIGURE 7. X-ray of *S. eximius* **sp. nov.** type series. Specimens (left-right): QMJ92378 (paratype, male), QMJ92377 (holotype, female), QMJ92379 (paratype, female). (image: Mike Jeffery).

having a longer and more slender body, longer limbs, a shorter and narrower head, a shorter snout, a shorter temporal region, a narrower neck, and larger eyes (Table 1). *Saltuarius eximius* **sp. nov.** also differs from all congeners in having an unpatterned grey eye (*vs* patterned) (Fig. 5). It is most closely related to *S. cornutus* (Figs 4B, 5B) and *S. salebrosus*, with which it shares preanal pores in males. In addition to the aforementioned traits, *Saltuarius eximius* **sp. nov.** is also smaller than both these species (max SVL = 118 mm *vs* 136 mm in *S. cornutus* and 144 mm in *S. salebrosus*). *Saltuarius eximius* **sp. nov.** is further distinguished from the southern '*S. swaini*' species group in that the males possess preanal pores (*vs* preanal pores absent in *S. swaini*, *S. wyberba*, *S. kateae* and *S. moritzi*). *Saltuarius eximius* **sp. nov.** does not co-occur with any other leaf-tailed gecko.

Genetics. 12S/cyt-*b* mtDNA data places *S. eximius* **sp. nov.** as a divergent (9.1%) sister-species to *S. cornutus* (Hoskin, unpub. data). 12S and cyt*b* sequences for two individuals are deposited on GenBank (12S: QMJ92378 = KF553907, QMJ92379 = KF553908; cyt*b*: QMJ92378 = KF553909, QMJ92379 = KF553910).

Distribution. Known only from the vicinity of the type locality in the uplands of the Melville Range, Cape Melville, north-east Australia (Fig. 8). The distribution falls within Cape Melville National Park.

Habitat and habits. Six individuals have been found, all in close proximity in an area of granite boulders covered by a rainforest canopy (Fig. 9). *Saltuarius eximius* **sp. nov.** was not found in searches of other areas of rocky rainforest in the general vicinity of the type locality or in a lowland area of Cape Melville to the south (14°18'54" S, 144°29'54" E). Nor was the species found in searches of exposed boulder-fields in the vicinity of the type locality (as seen in the background of Fig. 9A). At the type locality, individuals were found at night on vertical surfaces of boulders or trees, between one and five meters above the ground. When first sighted the geckos were motionless and positioned head-down, with the anterior half of their body raised well off the surface and their head held parallel with the surface. In this foraging pose, *S. eximius* **sp. nov.** is no doubt primarily a sit-and-wait predator like other leaftail geckos. Several of the geckos made an extended squeaking sound when first captured. The only other gecko species found in micro-sympatry with *S. eximius* **sp. nov.** was *Cyrtodactylus tuberculatus* (Lucas &

Frost 1900), which was present at higher abundance. Two frog species, *Litoria andiirrmalin* McDonald 1997 and *Cophixalus zweifeli* Davies & McDonald 1998, were also found foraging at night at the site.

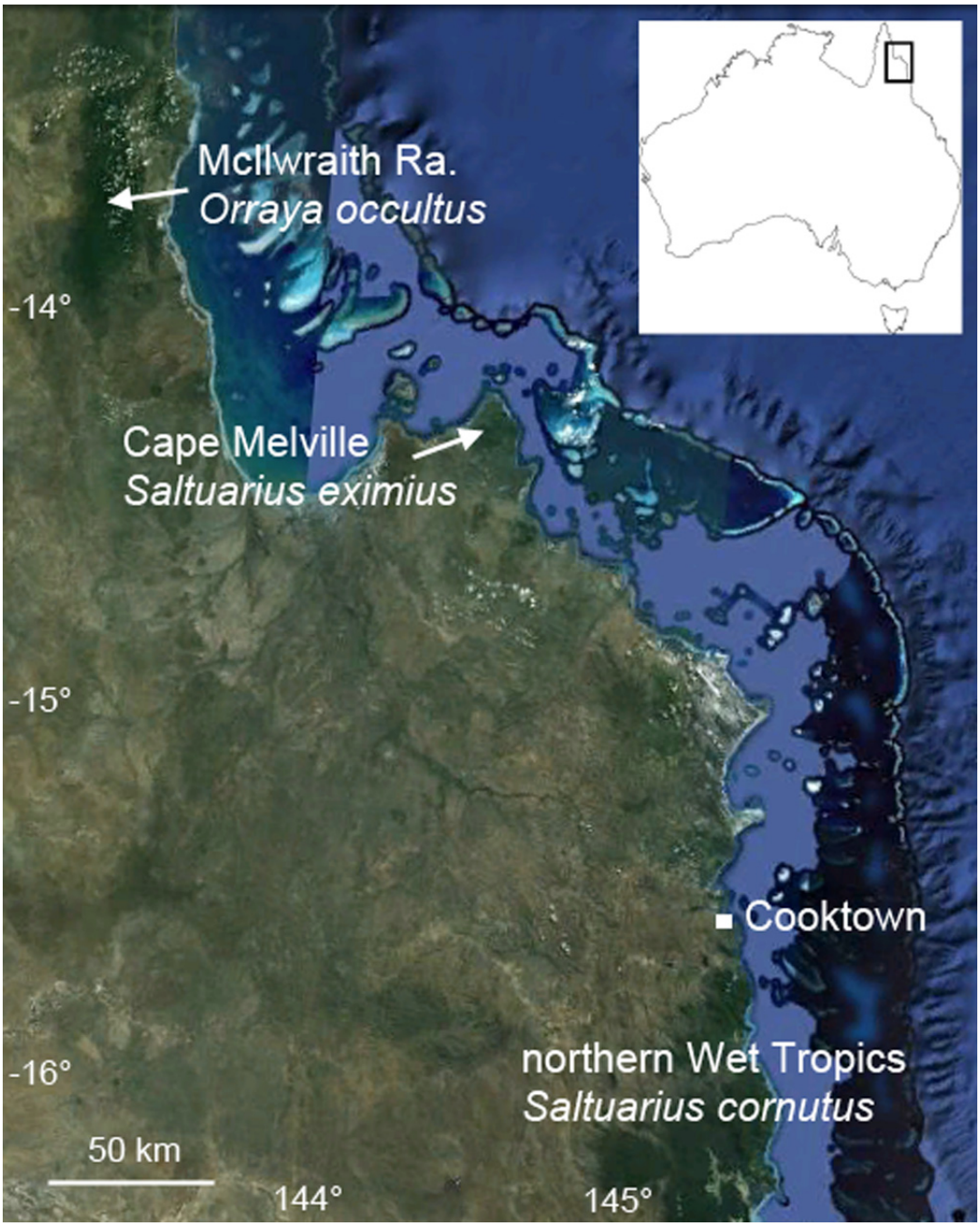

FIGURE 8. Map of north-east Queensland, showing locality of Cape Melville, McIlwraith Range and the northern Wet Tropics, and the leaf-tailed gecko present in each of these areas. The inset shows Australia. Background image is from Google Maps (2013).

FIGURE 9. Habitat of *S. eximius* **sp. nov.**, Cape Melville Range (photos: A, Conrad Hoskin; B, Tim Laman).

Discussion

The description of *S. eximius* **sp. nov.** brings the number of *Saltuarius* to seven, and extends the distribution of the genus 180 km north from the northern end of the range of *S. cornutus* in the Cooktown region to Cape Melville (Fig. 8). The only leaf-tailed gecko found further north is *Orraya occultus*, which is restricted to the McIlwraith Range (135 km to the north-west of Cape Melville; Fig. 8). *Saltuarius eximius* **sp. nov.** is almost certainly restricted to the Melville Range, an area of rainforest well-isolated both currently and historically from other rainforest areas. The Melville Range is a topographic isolate set well east of the chain of low mountain ranges that form the eastern spine of Cape York Peninsula. There is a moderate area of rainforest spread patchily across the approximately 400–590 m elevation plateau of the Melville Range. This upland rainforest is almost completely surrounded by extensive boulder-fields that slope down to the sea or dry open woodlands. *Saltuarius eximius* **sp. nov.** is no doubt more widespread in the uplands of the Melville Range than the single known site. However, surveys of other areas of rocky rainforest in the general vicinity of the type locality did not find the species and it may be rather patchy and have very specific habitat requirements. Surveys of exposed boulder-field near the type locality and elsewhere on the Melville Range did not detect the species, suggesting it requires rainforest canopy and does not occur in the extensive areas of exposed boulder-field that dominate the landscape of Cape Melville. Given that the upland area of rainforest in the Melville Range is small (for example, the area above 500 m elevation is only about 2.5 km^2) and the apparently patchy nature of occurrence of this species in the uplands, the area of occupancy and population size may be very small.

Six vertebrates are now known to be endemic to the Melville Range: two skinks, *Cryptoblepharus fuhni* Covacevich & Ingram 1978 and an undescribed *Saproscincus* (Hoskin, submitted); three frogs, *Litoria andiirrmalin*, *Cophixalus zweifeli* and an undescribed *Cophixalus* (Hoskin, submitted); and the gecko *S. eximius* **sp. nov.**. This tally of endemic vertebrates is almost unparalleled for a mountain range in Australia (the Clarke Range [Eungella] is comparable with six species), and may be unparalleled in Australia when calculated relative to area. All these species except *C. fuhni* are divergent members of rainforest-associated clades of north Queensland (Hoskin, in prep.), showing the past connection to the Wet Tropics region, the long-independent history of the Melville Range, and the incredible persistence of these rainforest lineages in such a small area. In part this persistence can be attributed to the alignment of the range perpendicular to the moisture-laden southeasterly winds coming directly off the ocean, resulting in high orographic rainfall and cloud intercept. However, the persistence of rainforest lineages can also probably be attributed to utilization of deep rock habitats by all these species. Deeply layered rock environments provide cool, moist microhabitats that can buffer organisms from short and long-term hot and/or dry climatic conditions (Couper & Hoskin 2008). Further, even during drier periods the extensive rocky slopes surrounding the Melville Range would have protected the upland rainforest areas from fire. In this way extensive rocky areas can act as lithorefugia for the persistence of rainforest lineages (Couper & Hoskin 2008). The extensive rainforest of the Wet Tropics region to the south is known to have experienced significant contractions during cool, dry global conditions associated with glacial maxima (and earlier periods), which shaped patterns of diversity and endemism (e.g., Mortiz *et al.* 2009; Hoskin *et al.* 2011). The Melville Range would have been subjected to these less favourable periods for rainforest and the utilization and gradual adaptation of lineages to rocky habitats may have been key in the persistence of these lineages through these restrictive periods.

Saltuarius eximius **sp. nov.** is morphologically highly distinct in a number of ways from all other *Saltuarius* and other leaf-tailed geckos. It has the longest legs, thinnest body and neck, smallest and deepest head, and largest eyes. Some of these traits, such as long, slender legs, are commonly seen adaptations to rock in reptiles (e.g. Goodman *et al.* 2008). The two other lizards endemic to Cape Melville (*C. fuhni* and *Saproscincus* sp.) are also rock associated and also have relatively long legs compared to congeners. The other unique morphological traits of *S. eximius* **sp. nov.**, however, are not so easily explained. The short, deep head is highly distinct, as are the very large eyes. Perhaps the large eyes are an adaptation to life in the dimly lit deep boulder-pile habitats, and the head shape is associated with large eye size or an adaptation to specific prey types that dominate this unusual habitat. Although the geckos were found on trees and surface rocks at night, they were always in the vicinity of deeply piled rock into which the geckos probably retreat during the day and through the dry season. Boulder adapted *Cophixalus* frogs at Cape Melville and elsewhere on Cape York retreat deep into the boulder-fields during dry conditions (Hoskin & Aland 2011) and it is interesting to note that the *Cophixalus* species also recently discovered at Cape Melville also has the largest eyes of any of its congeners (Hoskin, submitted). Finally, it is worth noting the

similarity in form between *S. eximius* **sp. nov.** and *Nactus galgajuga* (Ingram 1978), a boulder dwelling gecko endemic to the granite boulder-fields of Black Mountain, 175 km south of Cape Melville. This gecko is also highly distinct from congeners in having a slender form, long-limbs, large eyes and a deep head. While it is interesting to note similarities in form to other boulder-field vertebrates of north-east Queensland, the function of the unusual traits seen in *S. eximius* **sp. nov.** remains speculation until more is known about its ecology.

Acknowledgments

The fieldtrip to Cape Melville was organized in conjunction with Tim Laman as part of the Cape York Peninsula and Torres Strait Biodiversity Expedition (National Geographic Expeditions Council grant EC0566-12). Thanks to Tim Laman and Nancy Donnelly for funding and organization, and to Tim, Nancy and Mark Lamble for robust company in the field. We thank Janie White (Ranger In Charge, Cape Melville National Park) for access and discussions. The flying skills of Bungie Scott were essential for accessing the uplands of Cape Melville, and we thank Bungie and Lorraine Rocca of Bungie Helicopters. We thank Mike Jeffery (James Cook University Veterinary and Emergency Centre) for producing the X-ray, Chris Schneider for genetic data, Steve Wilson, Tim Laman and Jeff Wright for providing photographs, and Kieran Aland, Keith McDonald and Megan Higgie for discussions. This work was funded by National Geographic (grant EC0566-12) and the Australian Biological Resources Study (grant BBR210-27). Collecting was conducted under permit WITK05232208, provided by the Queensland Department of Environment and Resource Management.

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Additional Material Examined

Saltuarius cornutus: QMJ58944, west of Tully (18°00' S, 145°34' E), QLD; QMJ60642, Mt Boolbun South, via Cooktown (15°56' S, 145°09' E), QLD; QMJ60724, Kirrama State Forest, approx. 1.5 km east of forestry hut (18°11'24" S, 145°44'48" E), QLD; QMJ60729, Mt Misery area (15°53'23" S, 145°12'31" E), QLD; QMJ60730, Windsor Tableland (16°17'30" S, 145°05'30" E), QLD. ***Saltuarius kateae:*** QMJ83583–85, Wyans Creek Road, 11.4 km west of Old Tenterfield Road (29°08'31" S, 152°47'06" E), NSW. ***Saltuarius moritzi:*** QMJ83588, Blue Hole, upper reaches of Gara River, south-east of Armidale (30°36' S, 151°48' 09" E), NSW; QMJ83592, Bruxner Park, near Coffs Harbour (30°14'30" S, 153°05'36" E), NSW; QMJ83593, Ebor Falls (30°24'19" S, 152°20'20" E), NSW; QMJ56894, Evans Rd, Salisbury, Brisbane, found on wall of warehouse (27°33' S, 153°02' E), QLD. ***Saltuarius salebrosus:*** QMJ4474, Coongoola, Colosseum (24°24' S, 151°38' E), QLD; QMJ8142, Monto (24°52' S, 151°07' E), QLD; QMJ J74946, Blackdown Tableland NP (23°46'30" S, 149°04'30" E), QLD; QMJ J75084, Nathan Gorge (25°26' S, 150°10' E), QLD; QMJ J75085, Bells Pass Amphitheatre, Glenhaughton (25°19' S, 149°05' E), QLD. ***Saltuarius swaini:*** QMJ51094, Mt Superbus, via Warwick (28°13'18" S, 152°27'18" E), QLD; QMJ51638–40, O'Riellys, Lamington NP (28°14' S, 153°08' E), QLD; QMJ54846 Brays Ck, Border Ranges NP (28°24' S, 153°03' E), NSW. ***Saltuarius wyberba:*** QMJ28648, Girraween area, near Wyberba (28°50' S, 151°55' E), QLD; QMJ29116, Girraween NP, Stanthorpe area, (28°50' S, 151°55' E), QLD; QMJ51634–36, Natural Arch track, Girraween NP (28°50' S, 151°55' E), QLD. ***Orraya occultus:*** QMJ37038–39, 17 km ENE of Mt Croll, McIlwraith Ra. (13°46' S, 143°19' E), QLD; QMJ37040, Peach Ck, 19 km ENE of Mt Croll, McIlwraith Ra. (13°45' S, 143°19' E), QLD; QMJ60717, Peach Ck, McIlwraith Ra. (13°45'30" S, 143°19'30" E), QLD; QMJ86898, Peach Creek, McIlwraith Ra., Kulla NP (13°45'29" S, 143°19'57" E), QLD.