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Systematics of small *Gehyra* (Squamata: Gekkonidae) of the southern Kimberley, Western Australia: redescription of *G. kimberleyi* Börner & Schüttler, 1983 and description of a new restricted range species

PAUL M. OLIVER[1,3], GAYLEEN BOURKE[1], RENAE C. PRATT[1], PAUL DOUGHTY[2] & CRAIG MORITZ[1]

[1]*Division of Evolution, Ecology and Genetics, Research School of Biology, and Centre for Biodiversity Analysis, The Australian National University, Building 116, Daley Road, Acton, ACT, 2601, Australia*
[2]*Department of Terrestrial Zoology, Western Australian Museum, 49 Kew Street, Welshpool, Western Australia, 6016, Australia*
[3]*Corresponding author. E-mail: Paul.Oliver@anu.edu.au*

Abstract

Ongoing fieldwork and molecular research continues to reveal that the monsoonal tropics of northern Australia contain more vertebrate species than currently recognised. Here we focus on two morphologically distinctive, yet unrecognised forms in the genus *Gehyra* from the southern Kimberley region and surrounding deserts. We base our descriptions on a combination of unpublished genetic data and a morphological examination of voucher specimens. We recognise and re-describe *G. kimberleyi*, a species with a broad distribution extending over most of the south-west Kimberley, across the Great Sandy Desert and into the far northern Pilbara. This species has been previously assigned to *G. pilbara* owing to its frequent occurrence on termite mounds and short snout, but can be distinguished from *G. pilbara* and other regionally sympatric *Gehyra* by its moderate body size, moderate number of pre-cloacal pores in males (12–17) and aspects of dorsal colouration. We also describe *G. girloorloo* **sp. nov.**, a small rock-dwelling species with a short snout, low number of pre-cloacal pores in males (8–11) and pinkish-grey dorsal colouration with alternating series of indistinct pale spots and irregular transversely-aligned dark blotches. The new species appears to be restricted to a relatively small region of exposed limestone karst in the south-west Kimberley and is entirely circumscribed by morphologically similar congeners.

Key words: Australian Monsoonal Tropics, biodiversity, endemism, gecko, limestone, lizard, short range endemic

Introduction

The Australian Monsoonal Tropics (AMT) has long been known within Australia for its high vertebrate diversity (e.g. Cracraft 1991; Slatyer *et al.* 2007; Bowman *et al.* 2010; Powney *et al.* 2010). Nevertheless, ongoing surveys and genetic analyses indicate that the AMT is home to many unrecognised vertebrate species (Potter *et al*. 2011; Oliver *et al*. 2012, 2014a). For instance, at least eleven new or resurrected endemic vertebrate species have been added to the faunal inventory of this region since the beginning of 2014: a frog (Catullo *et al.* 2014), seven lizards (Oliver & Parkin 2014; Oliver *et al*. 2014a, b; Oliver *et al.* 2016), a snake (Maddock *et al*. 2015), a rock wallaby (Potter *et al.* 2014), and a dasyurid marsupial (Aplin *et al*. 2015). Many other genetic lineages that may represent further undescribed species have also been identified (e.g. Smith *et al*. 2011; Oliver *et al*. 2012, 2014c; Potter *et al*. 2012; Catullo & Keogh 2014). These new lineages include both widespread, apparently generalist, savannah taxa (Catullo *et al*. 2014; Oliver *et al*. 2014a), and more restricted lineages, often associated with isolated and/or geologically distinct rock formations (e.g. Hoskin *et al*. 2008; Doughty *et al.* 2009; Doughty 2011; Pepper *et al*. 2013; Oliver *et al*. 2014b, c).

Geckos from the genus *Gehyra* are among the most abundant lizards in the AMT, and are often seen on trees and rocks when spotlighting at night. Here we focus on the taxonomic status of the smaller-bodied *Gehyra* from the southern edge of the Kimberley region in north-west Australia (Fig. 1). This area lies at the border of the AMT and the arid zone and coincides with the uplifted ranges of the King Leopold Range in the west, the Durack Range in the east and other associated ranges such as the Oscar Range in the south-west (Tyler *et al.* 2012; Pepper & Keogh

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2014). The fauna reflects this overlap, with many widespread arid zone taxa occurring at the northern extremities of their range, and other monsoonal taxa occurring at the southern edge of their distribution (e.g. for mammals—McKenzie 1981; Start *et al*. 2012). A conspicuous geological feature of this area is a series of exposed fossilised reefs (Tyler *et al*. 2012). These outcrops are not particularly extensive, and tend to be narrow (usually less than a few kilometres wide) and low (maximum elevation usually less than 100 m above the surrounding blacksoil plains; Goudie *et al*. 1990). These limestone karst outcrops have a complex and highly eroded microtopography and provide an important local refuge from aridity and fire (Cameron 1992). Reflecting this they have a high local endemism of snails (Cameron 1992), however, the first endemic vertebrate of the limestone ranges was only recently described, a large-bodied *Oedura* gecko (Oliver *et al*. 2014b).

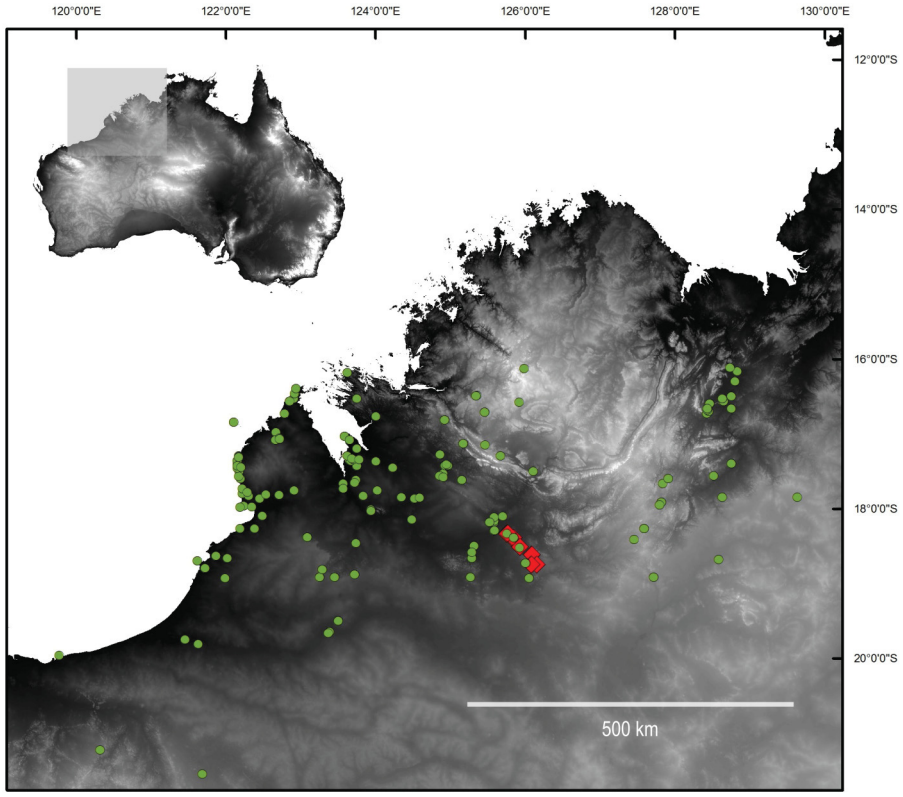

FIGURE 1. Distribution of *Gehyra kimberleyi* (circles) and *G. girloorloo* **sp. nov.** (diamonds) from the Kimberley and surrounding regions of Western Australia; lighter regions are higher in elevation.

Only three species of small (snout-vent length [SVL] < 70 mm) *Gehyra* are currently recognised from the King Leopold and nearby ranges in the south-west Kimberley. One form is part of a widespread species complex of small saxicoline forms with well-defined dorsal spotting currently referred to as *G. nana* Storr, 1978. Unpublished molecular data indicate *G. nana sensu lato* to be a complex of several morphologically similar forms (R. Pratt, unpublished data). A recently-described small-bodied form—*G. spheniscus* Doughty, Palmer, Sistrom, Bauer & Donnellan—occurs largely in the high rainfall region of the north-west Kimberley, but with outlying records in the western King Leopold Range (Doughty *et al.* 2012). Lastly, existing collections and databases suggest the occurrence of *G. pilbara* Mitchell, 1965 throughout this area (Storr *et al*. 1990; Wilson & Swan 2013; Atlas of Living Australia 2015). However, morphological (Storr *et al.* 1990; pers. obs.) and molecular genetic data (unpublished data) indicate that the northern records of *G. 'pilbara'* are a different taxon that can be distinguished from most other small-bodied *Gehyra* in the southern Kimberley (including *G. pilbara senso stricto*) by larger body size, more subdigital lamellae, short and deep head and dorsal pattern of less defined pale and dark markings on a pale to mid-tan background. This form is also somewhat of a habitat generalist—it usually occurs on trees and termite mounds away from saxicoline habitats but is also occasionally collected from rocks. Based on its medium size, colour pattern, distribution and often arboreal habits, we infer that this species is *G. kimberleyi* Börner & Schüttler, 1983, described from a single subadult arboreal *Gehyra* from a locality near Derby (at the south-western edge of the Kimberley). Some authorities have recognised the availability of this name in the past (e.g., Bauer

1994; Kluge 2001; Uetz & Hošek 2015), yet no redescription or indication of its distribution based on examination of specimens have been provided. As the taxon was named in a self-published journal the name has generally been ignored or simply missed owing to its obscurity (e.g., their synonomy of *G. purpurascens* Storr to *G. pilbara* has been universally ignored or rejected). The type material of this species is difficult to access—consultation with Australian state authorities indicate no collection or export permits to Germany from Australia were issued, and they are currently housed in a private residence in Germany (Uetz & Hošek 2015). However, although the short original description and accompanying photographs indicate the holotype is a small sub-adult, it provides sufficient images and diagnostic characters to assign the northern *G. pilbara s.l.* form to this name. Here we present a redescription of this species based on much more extensive material in Australian museums.

Recent surveys have also revealed another distinctive form of *Gehyra* in the far southern Kimberley that appears to be restricted to a small area of limestone karst just south-east of Fitzroy Crossing (Fig. 1). This small (SVL < 50 mm) *Gehyra* is morphologically similar to the widespread complex of geckos currently referred to as *G. nana* (small size, single egg, pattern of light and dark spots and blotches). The limestone form differs from the other four species from this region in having small body size, no wedge of granules at the base of the digits (diagnostic of *G. spheniscus*), a lower number of pre-cloacal pores in males and a pale pinkish dorsal colouration with a pattern of alternating dark smudges and pale bars. Unpublished genetic data using mtDNA and nDNA indicate the limestone form is highly divergent from *G. kimberleyi* and all *G. nana* complex forms. This genetic data will be presented elsewhere, but as the limestone form is morphologically diagnosable, we describe it as a new species below.

Material and methods

We examined recently-collected specimens held at the Australian National University (ANU, Canberra), and specimens housed at the Western Australian Museum (WAM) or Museum Victoria (NMV), where all type material is deposited (see type lists and Appendix). For detailed morphological comparisons, we chose specimens for which matching molecular data was available (unpublished data), with the exclusion of immature or poorly-preserved individuals. Additional comparative material of *G. nana* and *G. pilbara* were also examined (Appendix).

We examined 15 morphometric and 6 meristic characters (Table 1), comprising body, limb and head proportions, head scalation, pre-cloacal pore counts and counts of divided lamellae beneath the fourth finger and toe. Character descriptions generally follow those of Doughty *et al*. (2012). Bilateral measures were taken unilaterally from the right side of the body, unless prevented by damage or poor preservation. Measurements were taken to the nearest 0.1 mm using Mitutoyo electronic callipers and scale and pore counts were made under a dissecting microscope (Leica MZ8). Descriptions of colouration in life were made based on photographs of a subset of specimens taken either in life or just prior to preservation, in addition to notes taken in the field.

Taxonomy

Gehyra Gray, 1834

Type species. *Gehyra pacifica* Gray, 1834 (= *Gecko oceanica* Lesson, 1830 synonymy fide McCann 1955), by monotypy.

Gehyra kimberleyi Börner & Schüttler, 1983

Robust termitaria gecko
Figs. 2–4

Holotype. BSRC Geck 65 SC (private collection of Achim-Rüdiger Börner, Germany), '5 km south of Derby, W.A.'

Diagnosis. Digits broadly expanded basally and subdigital scansors present on all digits of manus and pes. Digit I of manus and pes clawless, penultimate phalynx of digits II–V free from scansorial pad. Differs from non-Australian *Gehyra* by the combination of: absence of webbing between third and fourth toes, absence of a skin fold

along the posterior hindlimb and medium adult size (SVL < 62 mm). Differs from Australian *Gehyra* by the combination of moderate size (SVL < 62 mm), short snout (SnEye/HL mean 0.42) and deep head (HD/HL mean 0.48), subdigital lamellae divided without basal wedge of granules, moderate number of pre-cloacal pores (12–17), postmentals not contacting the second infralabial, one pair of chin shields and dorsal background colour light reddish-brown to pale tan or greyish-brown with diffuse, widely-spaced pale spots and small dark-brown blotches.

Details of holotype. From original description (in mm). SVL 36; TailL 39; HeadL (tip of rostral to anterior corner of ear) 9; HW 7.3; HD 4.3; HD/SVL 0.119; SupLab* 6/7; InfLab* 6/7; FingSubDL 6; ToeSubDL 9; rostral with cleft, undivided; first SupLab higher than second (*not defined, possibly measured to centre of eye).

Description of species. Range of variation for measurements and scale counts are presented in Table 1. A medium-sized (adult SVL mean 50.4 mm, range 42.0–61.3 mm), moderately robust gecko. Head deep (HD/HL 0.48, 0.40–0.58), moderately wide (HW/HL 0.86, 0.76–0.97), widest posterior to eye, tapering to a rounded snout, narrowing posteriorly to a slightly constricted neck. Snout short (SnEye/HL 0.42, 0.39–0.46), generally shorter than twice eye length (OrbL/SnEye 0.58, 0.54–0.63), occasionally slightly concave on dorsal surface, canthus rounded; in profile view, snout convex with blunt tip. Body moderately long (TrunkL/SVL 0.42, 0.37–0.47) and robust, slightly depressed.

TABLE 1. Measurements (mean [range], in mm) and meristic data (mode [range]) for the four small-bodied *Gehyra* species treated here.

	G. kimberleyi N = 19 (M = 11/F = 8)	*G. girloorloo* **sp. nov.** N = 17 (M = 10/F = 7)	*G. nana* (south Kimberley) N = 40 (M = 20/F = 20)	*G. pilbara* N = 14 (M = 4/F = 10)
SVL	50.4 (42.0–61.3)	42.9 (39.8–47.4)	40.0 (35.0–44.3)	41.4 (33.4–45.1)
HL	12.0 (9.9–14.1)	10.4 (9.7–11.5)	10.3 (8.9–11.9)	9.4 (7.9–10.6)
HW	10.4 (8.5–12.6)	8.6 (7.6–9.1)	8.4 (7.6–9.4)	8.0 (6.9–9.1)
HD	5.8 (4.5–7.9)	4.7 (3.8–5.6)	4.3 (3.6–5.1)	5.2 (4.5–6.4)
ArmL	5.5 (4.1–7.7)	4.9 (4.6–5.6)	4.4 (3.6–5.8)	4.4 (3.0–5.3)
HindL	6.0 (4.6–8.7)	4.9 (4.4–5.5)	4.8 (3.6–6.7)	4.5 (3.1–5.6)
TrunkL	21.1 (16.2–27.9)	17.8 (15.1–20.7)	15.8 (12.0–19.5)	17.3 (15.1–19.6)
NarEye	4.0 (3.2–5.2)	3.4 (3.0–3.8)	3.4 (2.9–4.0)	2.9 (2.4–3.4)
SnEye	5.0 (4.1–5.9)	4.4 (3.9–4.9)	4.4 (3.7–5.0)	3.9 (3.6–4.3)
EyeEar	3.5 (2.8–4.2)	2.8 (2.3–3.2)	2.9 (2.4–3.9)	2.5 (1.9–3.2)
InterN	1.5 (1.1–2.1)	1.3 (1.2–1.5)	1.3 (0.9–1.6)	1.1 (0.9–1.3)
InterOrb	3.6 (3.0–4.4)	2.9 (2.5–3.3)	3.0 (2.5–3.7)	2.8 (2.3–3.1)
OrbL	2.9 (2.4–3.4)	2.6 (2.3–2.9)	2.3 (1.6–2.8)	2.3 (2.0–2.6)
RosH	1.1 (0.9–1.4)	0.9 (0.7–1.1)	1.0 (0.6–1.3)	1.0 (0.8–1.3)
RosW	1.8 (1.4–2.1)	1.5 (1.4–1.8)	1.6 (1.3–2.0)	1.5 (1.2–1.9)
SupLab	8 (7–9)	8 (7–9)	8 (7–10)	7 (7–8)
InfLab	7 (7–8)	7 (7–9)	8 (6–9)	7 (7–8)
InterNsc	1 (0–2)	0 (0–2)	1 (0–1)	0 (0–1)
PCP	16 (12–17)	9 (8–11)	14 (11–17)	13 (13–14)
FingSubDL	6 (5–7)	6 (5–6)	5 (5–6)	5 (5–6)
ToeSubDL	7 (6–9)	6 (6–7)	6 (5–7)	6 (5–7)

On head, dorsal scales largest on snout, ~2.5 times larger than scales on crown of head and body and slightly projecting and imbricate. Nostrils large and circular, bordered by rostral, supranasal, two postnasals of similar size and first supralabial; supranasals round to triangular in shape, usually separated by a single large internarial scale. Rostral scale wider than high (RosH/RosW 0.64, 0.56–0.74), slightly gabled, usually with a deep medial cleft ~60% of rostral height. Supralabials 7–9 (mode 8), infralabials 7–8 (mode 7). First supralabial higher than subsequent supralabials. Supralabials bordered dorsally by enlarged row of scales posteriorly that decrease in size

as for supralabials. Mental scale roughly triangular, divides postmentals 20–40%. Postmentals in contact with first infralabial only; single pair of outer chin shields smaller with rounded outer edge, ~two-thirds the height of postmentals, in contact with first and second infralabials, thereby excluding postmental from contact with second infralabial. Second or third infralabial notched and in contact with first parinfralabial. Eye small (OrbL/HL 0.24, 0.21–0.27), circular, small fringe of mostly rounded scales extends from the postero-dorsal to the anterio-ventral edge. Ear openings moderately large and circular.

FIGURE 2. Preserved specimens of *Gehyra kimberleyi*, showing variation in dorsal patterns. Scale bar = 1 cm.

Dorsal scales homogeneous, small, rounded and juxtaposed; gular scales granular; ventral midbody scales 2–3 as large as dorsal scales, slightly imbricate and tending to be diamond-shaped; limbs covered in granular scales, scales on anterior surfaces enlarged, especially on legs. Pre-cloacal pores 12–17, mode 16, perpendicular to body distally and medial curving forwards to form a sharply pointed 'v' with anteriorly-directed apex. Usually a single small post-cloacal spur present on each side in males. Females lack pre-cloacal pores and prominent post-cloacal spurs.

Limbs very short (ArmL/SVL 0.11, 0.09–0.13; HindL/SVL 0.12, 0.10–0.17); five digits on each limb, claws present on digits 2–5, claws long and free, arising from dorsal surface of expanded toe pads and extending above and well beyond toe pad, row of elongate and sharply pointed distal scales on periphery of dorsal surface of toe; toe pads ovoid; subdigital lamellae divided, 5–7 (mode 6) pairs on fourth finger, and 6–9 (mode 7) on fourth toe, apical lamellae wedge-shaped.

Tail moderately long and moderately thin to slightly swollen, slightly dorso-ventrally flattened in cross-section, tapering to fine tip. Dorsal scales of tail flattened with rounded posterior edge, tending to be arranged in rows. Enlarged, wide series of scales beneath tail, bordered peripherally by 2–4 rows of enlarged scales, decreasing in size on lateral surfaces.

Colouration in preservative. Background dorsal colour varies from dark reddish- or greyish-brown with fine dark stippling to light salmon-pink, pale and patternless in larger individuals (Fig. 2). Dorsal surfaces of head, torso and tail usually with scattered poorly-defined small, dark greyish-brown spots, blotches, flecks or short bars; pale grey spots interspersed among the darker markings, usually forming rows of 4–6 spots; on the neck and crown, blotches are usually separated, on the torso often transversely aligned to form loosely-defined bands on the body and on the tail often forming concentric bands. Dark longitudinal streaks on lateral surface of neck posterior to eye

or a series of small dark blotches. Limbs with similar pattern to dorsum, but generally less well defined. Ventral colour pale, lightly stippled but more darkly pigmented anteriorly, especially in gular region. Iris pale silvery blue, pupil vertical and pale with crenelated edge. Original tails with alternating dark and pale concentric rings or series of blotches. Regenerated tails with no clear pattern, although indistinct longitudinal brown streaks are sometimes apparent.

Colouration in life. Based on photographs of specimens captured in the south-western Kimberley. The dorsal background colour is pale or golden tan to medium dark brown, and the dorsal pattern consists of scattered dark brown blotches and smaller pale spots that occur in alternating rows, especially the vertebral zone, with smaller spots occurring on the head, flanks and limbs. The dorsal pattern tends to be less distinct in larger specimens (Fig. 3).

FIGURE 3. *Gehyra kimberleyi* in life. Top: weakly marked adult specimen from Roebuck Plains Homestead; bottom: strongly marked juvenile specimen from Broome (photographs—B. Maryan).

Habitat and reproduction. Habitat notes from collectors of specimens held at the WAM indicate most were collected from termite mounds (128 of 227 such records). Other collection locations indicate generalist habits, with specimens collected from trees, under logs and other ground cover and including vertical rock faces. Like other species in the *Gehyra variegata-punctata* species-group (Doughty 1996), *G. kimberleyi* lays a single egg.

Distribution. Occurs throughout the southern Kimberley region, from Cape Leveque at the northern edge of the Dampier Peninsula in the west, as far north as Mt Elizabeth in the central Kimberley, and north-east to Lake Argyle near Kununurra (Fig. 1). Most records are from south of the King Leopold and Durack barrier ranges, with several records south of the Fitzroy Crossing area. There are no records north of the Durack Range in the eastern Kimberley, although this region is the most poorly surveyed of the Kimberley. In the Northern Territory, the species is recorded from Buchanan Station. There are records of genotyped specimens as far south as the northern Pilbara (15 km north-east of Nifty Mine and Meentheena Nature Reserve), with several specimens from along the 80 mile beach extension of Dampierland between the west Kimberley and Pilbara regions. In the Great Sandy Desert, there are records from Dragon Tree Soak Nature Reserve in the south to records further north. The Great Sandy Desert remains poorly surveyed and this species may be more widely distributed in this region.

Etymology. Although the original description mentions the 'Kimberleys' (sic) (Börner & Schüttler 1983, p. 1), no explicit etymology was provided. The presumed correct formation of the specific name is 'kimberleyensis', which means the taxon is from the Kimberley region. The proposed name 'kimberleyi' would refer to a male named Kimberley. The error, however, cannot be emended under current ICZN rules of nomenclature. The suggested common name refers to species' body habitus, and 'termitaria' indicates this species' habitat preference (although it is not exclusive to termitaria).

Comparison with other species. *Gehyra kimberleyi* can be distinguished from all non-Australian *Gehyra* by the combination of absence of webbing between the third and fourth toes (*versus* present), the absence of a skin fold along the posterior hindlimb (*versus* present) and its smaller size (max SVL < 65 mm *versus* > 65 mm).

Within Australia, *G. kimberleyi* can be distinguished from all members of the *G. australis* species-group (which are largely restricted to the AMT) by its smaller size (max SVL < 65 mm *versus* max SVL > 65 mm), divided subdigital lamellae (*versus* at least some undivided) and single egg per clutch (*versus* two).

Gehyra kimberleyi can be distinguished from most other members of the *G. variegata-punctata* group that also occur in the AMT as follows; from *G. xenopus* Storr and *G. spheniscus* by the absence of a wedge of granules between proximal lamellae (*versus* present), and in the case of the former species, smaller size (max SVL 62 *versus* 79 mm); from *G. occidentalis* Storr by its smaller body size (max SVL 62 *versus* 76 mm), deeper head, postmentals 3 x longer than wide (*versus* 4 x), lower number of subdigital lamellae (6–8 *versus* 7–10), fewer pores in males (12–17 *versus* 18–30) and more clearly-defined spots on the dorsum; and from *G. multiporosa* Doughty, Palmer, Sistrom, Bauer & Donnellan, 2012 by fewer pores in adult males (12–17 *versus* 20–49), dark markings on dorsum not tending to form transverse bars and the absence of dark lateral head streaks.

Gehyra kimberleyi can be distinguished from both geographically proximate and type *G. nana* by short snout and deep head, tan or greyish brown dorsal colouration (*versus* reddish), generally larger body size (SVL 42.0–61.3 *versus* 35.0–44.3), more larger, irregular and pale blotches (*versus* small and clearly defined), diffuse and transversely oriented dark brown blotches on dorsum (*versus* clearly defined brown blotches or spots).

Gehyra kimberleyi overlaps with a number of other members of the *G. variegata-punctata* species-group from the Australian arid zone, especially in the northern Pilbara. It differs from species in this group in having dorsal markings of dark blotches that tend to coalesce to form transverse bars (*versus* continuous longitudinal lines or network in *G. variegata* and *G. montium*—Hutchinson *et al*. 2014), and by having 7–9 supralabial scales (*versus* 8–10 in *G. variegata* and 8–11 in *G. montium*—Hutchinson *et al*. 2014). It is distinguished from members of the *Gehyra punctata* species complex by its diffuse dorsal colouration (*versus* well defined dark and light spots or blotches) and postmentals that do not contact the second supralabial.

From *Gehyra pilbara* (with which it has frequently been confused) it can be distinguished by its larger size (max SVL 62.3 *versus* 45.1 mm), tall, narrow postmentals (*versus* extremely short and wide; cf. Fig. 4), and tan or greyish-brown dorsal colouration (*vs.* reddish-brown).

***Gehyra girloorloo* sp. nov.**
Kimberley Karst gecko
Figs. 4–7

Holotype. WAM R175045 (field number CCM3257) (male), Gogo Station, Pillara Range, south entrance of Menyous Gap (18.40439°S; 125.83698°E), collected on 4 November 2014 by P.M. Oliver, G. Armstrong and P. Skipwith.

Paratypes. WAM R113727 (female), Cadjbut Mine 90 km south-east Fitzroy Crossing (18.7500°S; 126.1500°E); NMV D77029 and NMV D77030 (females), and NMV D77031 and NMV D77032 (males), Ngumpan Cliff area (18.75625°S; 126.06474°E); WAM R175037 (PMO147) and WAM R175038 (PMO149) (males), < 1 km south of Galeru Gorge (18.61407°S; 126.08386°E); WAM R175039 (CCM3242) and WAM R175040 (CCM3243) (males), Gogo Station, Limestone Billy Hills (18.32724°S; 125.76498°E); WAM R175043 (CCM3246) (female), Gogo Station, Limestone Billy Hills (18.33516°S; 125.75244°E).

Diagnosis. Digits broadly expanded basally and subdigital scansors present on all digits of manus and pes. Digit I of manus and pes clawless, penultimate phalanx of digits II–V free from scansorial pad. Differs from non-Australian *Gehyra* by the combination of: absence of webbing between third and fourth toes, absence of a skin fold along the posterior hindlimb and small adult size (SVL < 48 mm). Differs from all other Australian *Gehyra* by the combination of small body size (SVL < 48 mm), divided subdigital lamellae without basal wedge of granules, short snout and large eyes (OrbL/SnEye 0.58, 0.51–0.72), low number of pre-cloacal pores in males (8–11), postmentals not in contact (at most in point contact) with the second supralabial, one pair of outer chin shields and pinkish-brown dorsal background colour with pattern consisting of alternating bands of indistinct off-white spots and dark-brown transverse blotches on heavily stippled background.

Description of holotype. Adult male with following dimensions (in mm): SVL 41.3, HD 4.7, HL 10.2, HW 8.2, HindL 5.4, ArmL 5.0, TrunkL 18.4, NarEye 3.2, SnEye 4.5, InterN 1.5, InterO 3.2, OrbL 2.4, RosW 1.5, RosH 0.9. Summary meristic data are as follows: SupLab 8; InfLab 7; InterNSc 0; PreCloacal 9; FingSubDL 6; ToeSubDL 7.

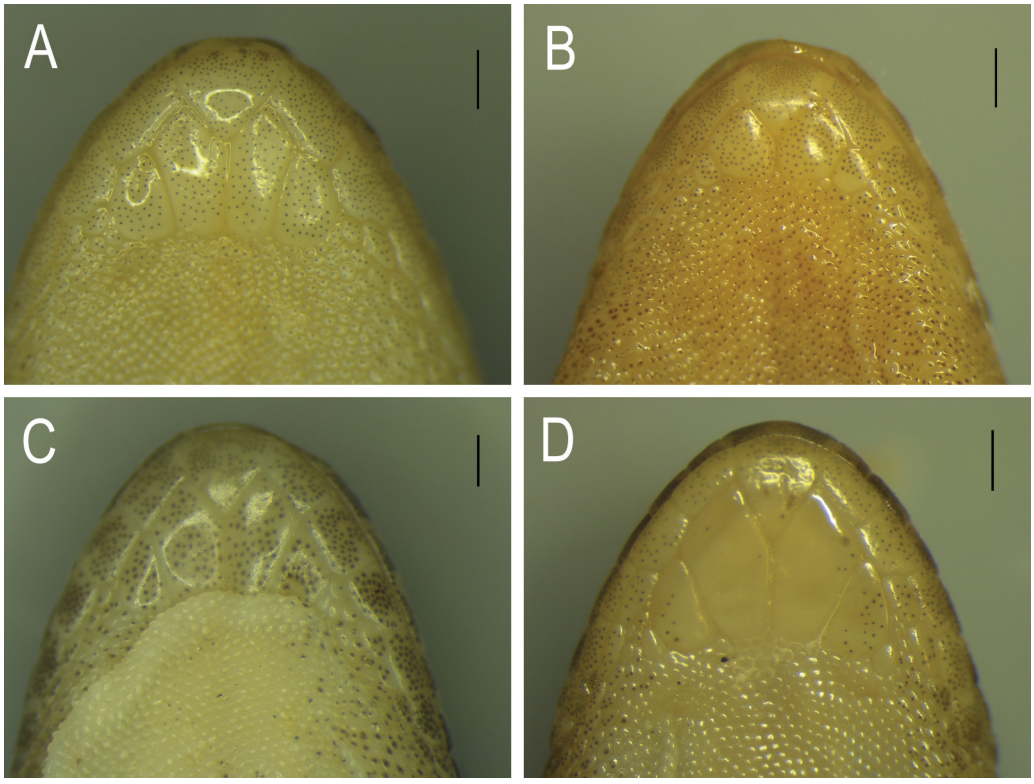

FIGURE 4. Chin shield configuration in *Gehyra* treated here; A) *G. kimberleyi* WAMR175035, B) *G. pilbara* WAMR108632, C) *G. girlooloo* sp. nov. WAMR175045 and D) *G. nana* WAMR175063. Scale bar = 1 mm.

FIGURE 5. Dorsal and ventral views of the *Gehyra girloorloo* **sp. nov.** holotype (WAM R175045, CCM3257). Scale bar = 1 cm.

A small (41.3 mm SVL), slender gecko (Fig. 5). Head slightly depressed (HD/HL 0.46), moderately wide (HW/HL 0.80), of similar width to midbody, widest at posterior edge of jaw, tapering to snout, narrows posteriorly to a moderately constricted neck. Snout short (SnEye/HL 0.44), less than twice eye length (OrbL/SnEye 0.54), rounded in dorsal profile, slightly convex from mid-eye to naris when viewed laterally in profile. Eyes moderately sized (OrbL/HL 0.24), pupil vertical. Ear openings small and circular. Nostrils rounded, contacted by rostral, supranasal, two postnasals and first supralabial; second (ventral) postnasal ~2 times larger than first (dorsal), supranasals in contact, no internarial scale. Rostral scale rectangular with nearly flat dorsal edge, wider than high, 1.5 mm wide, 0.9 mm high (RosH/RosW 0.58), deeply furrowed, rostral crease extending from dorsal edge ~40% of rostral height. Supralabials 8, infralabials 7. Scales on snout large, up to 3 times larger than scales on crown of head and body, imbricate and slightly projecting along posterior edge; fold of skin across snout from eye to eye (artefact of preservation). A row of slightly enlarged scales above supralabials gradually decrease in size posteriorly. Mental scale triangular, divides postmentals ~35%; postmentals narrowly separated from second infralabial on right side, in point contact on left side; single pair of outer chin shields with curved dorso-postero edge, ~two-thirds the height of postmentals and ~30–40% smaller in area; outer chin shield in point contact with first infralabial on right side, narrowly in contact on left.

Body long (TrunkL/SVL 0.46) and slender, slightly depressed and with a weak ventro-lateral fold posterior to axilla. Dorsal midbody scales small and granular, relatively homogenous, conical, juxtaposed; lateral scales slightly larger, more projecting and heterogeneous than those on dorsal surface, slightly imbricate; ventral scales ~3 times larger than dorsal scales, flat, diamond-shaped with rounded edges, juxtaposed. Pre-cloacal pores in a series of 9, forming a short continuous chevron with apex orientated anteriorly; pores centred in scales, innermost scales the largest. Two enlarged, rounded and protruding cloacal spurs present on either side of cloaca.

Limbs short (ArmL/SVL 0.12; HindL/SVL 0.13); dorsal and ventral scales generally small, rounded and juxtaposed; scales on anterior edge of limbs slightly larger and imbricate. Fingers and toes 5; expanded toe pads oval; distal row of dorsal scales on toe pads elongate and sharply pointed, forming a serrated 'fringe'. Claws long and free, present on digits 2–5, arising from dorsal surface of expanded toe pads and extending above and beyond toe pad, subdigital lamellae divided, 6 pairs on fourth finger, 7 pairs on fourth toe, all pairs of lamellae in contact, apical lamellae undivided and wedge-shaped.

Most of tail is original (52.0 mm, TailL/SVL 1.3), very thin, tapering gently to fine tip, slightly dorso-ventrally flattened at base, proximal 31 mm section original, distal 21 mm section regrown. At widest part near base—4.3 mm wide, 3.3 mm deep. Dorsal caudal scales small, granular and relatively homogeneous, subcaudal scales in a single large transversely widened series.

Colouration of holotype (in preservative). Background colour pale grey, lightly stippled with darker gray, a series of pale circular spots tending to form oblique transverse rows, enclosed by more extensive transversely-oriented darker grey markings or larger variegations; crown of head with small pale spots above tympanum region, snout and sides of head dark grey, no streaks emanating posteriorly from eye, labials heavily stippled; limbs as for dorsum with smaller pale spots; undersurfaces pale off-white; dorsal surface of tail encircled by pale (wider) and dark brown (thinner) bands.

Variation. Table 1 presents ranges of variation for the characters measured. In a small number of specimens, the postmental and second infralabial are in point contact, otherwise they are separated. The same pattern holds for internasals—in most specimens the supranasals are in broad contact above the rostral, in a small number a tiny internasal scale is present.

Colouration in preservative is as follows: background dorsal colour pale tan or grey (Fig. 6), densely stippled with fine blackish-brown variegations, moderate sized (0.5–1.5 mm wide) poorly defined pale circular to oval spots scattered on the dorsum, separated by concentrated patches of dark-brown markings that coalesce to form weakly defined transverse bands; density and distribution of dorsal pattern elements varies along body: usually little or no clear pattern on anterior portion of head, more clearly defined on nape with scattered small light spots and indistinct dark blotches, and consisting of alternating series of comparatively large and more well defined pale spots and indistinctly defined transverse brown bands on the torso and original tail. Limbs as for torso, with scattered distinct to indistinct small pale spots; undersurfaces largely unpigmented, but with dense fine dark brown maculations around the ventrolateral regions of head, limbs and ventral tail scales. Regrown tail light greyish-brown with diffuse longitudinally aligned narrow dark streaks.

Colouration in life. The following notes are based on photographs of specimens NMV D77030 and WAM R175037 shown in Fig. 7 and WAM R175042–3 (not shown). Dorsal surfaces pale purplish buff very finely stippled with medium brown, overlain on dorsum and tail with alternating transverse series of pale spots lacking borders and irregular dark-brown blotches that tend to be transversely aligned and intermittently bordered with yellow-orange. Head with smaller pale and dark spots with scattered yellow-orange flecks or fine spots. Regenerated tails often have a distinctive yellowish wash and very fine brown longitudinal markings. Iris dark golden brown with fine black reticulations.

Habitat and reproduction. This species is closely associated with dissected limestone outcrops, and also occurs on small trees and shrubs (Fig. 8). It tends to be less common on exposed vertical rock faces than its much larger sympatric congener *G. koira* Horner. The locally occuring form of *Gehyra nana* tends to utilise different habitats—it is rarely found on limestone and generally on smaller boulders and rocky debris in surrounding areas. *Gehyra girloorloo* **sp. nov.** can be abundant in its preferred habitat, for example, most large shrubs along an open rock face in Menyous Gap had at least one specimen, often positioned head down close to the ground in what appeared to be a hunting posture. In contrast, we found this species to be scarce in early July 2014 when temperatures were low (< 15°C), with only two specimens observed over two nights of searching around Mt Piere Station.

Like all *Gehyra* in the *variegata-punctata* species-group, this species lays a single egg. Some females were gravid in November in spring at the end of the dry season.

Distribution. *Gehyra girloorloo* **sp. nov**. is only known from a small area of limestone outcropping in the King Leopold Range of the south-west Kimberley on Gogo and Mt Piere Stations (Fig. 1). Known localities extend in a narrow band from the limestone Billy Hills in the north-west, to just north-west of Ngumpan Cliff in the south-east, a straight line distance of approximately 55 km.

Etymology. Girloorloo, pronounced "gir-loor-loo", is a word the local Gooniyandi mob use for the limestone this species appears to be restricted to. This species name was suggested by elders from the Gooniyandi mob who speak for country on which this species occurs.

Comparisons. *Gehyra girloorloo* **sp. nov.** can be distinguished from all non-Australian *Gehyra* by the absence of webbing between third and fourth toes (*versus* present), the absence of a skin fold along the posterior hindlimb (*versus* present) and its generally smaller size (max SVL < 50 mm *versus* > 50 mm).

Within Australia, *G. girloorloo* **sp. nov.** can be distinguished from all members of the *G. australis* species-group (which are largely restricted to northern Australia) by its smaller size (max SVL < 50 mm *versus* > 50 mm), divided subdigital lamellae (*versus* at least some undivided), lower number of pores in the males (< 12 *versus* > 12) and females laying just one egg per clutch.

FIGURE 6. Small saxicoline *Gehyra* of the southern Kimberley, Western Australia. Top: *G. girloorloo* **sp. nov.** NMV D77030 near Ngumpan Cliff; middle: *G. girloorloo* **sp. nov.** WAM R175037 (PMO147), Galeru Gorge; bottom: *G. nana* NMV D77035 near Ngumpan Cliff (photographs—P. Horner and T. Parkin).

Gehyra girloorloo **sp. nov.** can be distinguished from members of the *G. variegata* group from the Australian arid zone by its lower number of pre-cloacal pores in males (< 12 [mode 9] *versus* usually more than 10 [Hutchinson *et al*. 2014]), no conspicuous dark streaks emanating from behind the eyes, at most only light red hues (*versus* rich reddish-brown) and less contrasting dorsal pattern combining diffuse dark markings (*versus* extensive reticulations) and diffuse light spots (*versus* tending towards smaller and well defined). A further species in this group, *G. pilbara,* is similarly small, but differs in dorsal colouration (reddish-brown *vs.* pinkish-grey), the presence

of obviously enlarged loreal scales above the infralabials (*versus* absent) and in having an extremely short snout resulting in short, wide postmentals (*versus* tall and thin in *G. girloorloo* **sp. nov.**) (Fig 4.).

FIGURE 7. *Gehyra girloorloo* **sp. nov.** paratypes showing variation in colour and pattern (in preservative). Scale bar = 1 cm.

FIGURE 8. Habitat of *Gehyra kimberleyi* (small trees in foreground) and *G. girloorloo* **sp. nov.** (karstic limestone in background) at Gogo Station, Western Australia (photograph—P.M. Oliver).

Gehyra girloorloo **sp. nov.** can be distinguished from most other members of the *G. variegata* group that also occur in the AMT as follows: from *G. xenopus* and *G. spheniscus* by the absence of a wedge of granules between proximal lamellae (*versus* present), and in the case of the former species, also much smaller size (max SVL 48 *versus* 79 mm); from *G. occidentalis* by its lower number of subdigital lamellae (5–7 *versus* 7–10) and small body size (max SVL 48 mm *versus* 76 mm); and from *G. multiporosa* by the absence of dark lateral head streaks, and fewer pores in males (8–11 *versus* 20–49).

A final taxon from this region, *G. nana*, is a complex of species (*unpublished data*). However, *G. girloorloo* **sp. nov.** can be distinguished from both geographically proximate and type *G. nana* by its pinkish-grey dorsal colouration (*versus* reddish), background stippled (*versus* plain), larger and more diffuse pale spots (*versus* small and clearly defined), diffuse and transversely-oriented dark brown blotches on dorsum (*versus* clearly defined brown blotches or [usually] spots), and low number of pre-cloacal pores in males (8–11 *versus* 11–17). *Gehyra nana* from around localities from where *G. girloorloo* **sp. nov.** has been recorded are also particularly small (SVL 39.0, 35.0–41.9 mm) and strongly spotted (see Fig. 5).

Discussion

The mesic and topographically complex ranges and islands of the northern Kimberley are widely recognised for their high biodiversity and endemism, and attract considerable scientific interest (Burbidge and McKenzie 1978; Palmer *et al*. 2013). In contrast, the low ranges fringing the southern Kimberley are not currently recognised as an endemism hotspot, with the first endemic vertebrate species only recently described (Oliver *et al*. 2014b). The distribution of *G. girloorloo* **sp. nov.** suggests that it may also be restricted to the limestone outcrops of the southern Kimberley. Ongoing work in other gecko lineages indicates that additional taxa from these limestone ranges remain unrecognised (R. Pratt, R. Laver, P.M. Oliver *submitted*).

Gehyra girloorloo **sp. nov.** is sympatric with the much larger saxicoline congener *G. koira*. It is also regionally sympatric with *G. nana* (predominantly saxicoline), *G. kimberleyi* (termite mounds, otherwise generalist) and *G. australis* (arboreal). However, although the range of the latter three species seems to largely circumscribe that of *G. girloorloo* **sp. nov.**, and all have been recorded within less than a kilometre of the new species, they have not yet been observed using the same limestone outcrops. Of particular note is the absence of the small and widespread saxicoline generalist *G. nana* from limestone inhabited by *G. girloorloo* **sp. nov.**—even though this species often utilises narrow gaps on and around rock boulders, and has been found on laterites just metres from limestone outcrops inhabited by *G. girloorloo* **sp. nov.** This partitioning of saxicoline environments suggests that variation in microhabitats in outcrops of differing geology is mediating co-existence in regional sympatry, presumably on the basis of varying physiological tolerances and/or competitive ability.

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APPENDIX. Comparative (non-type) material examined.

***Gehyra girloorloo* sp. nov.** (n = 6). Western Australia: WAM R175041 (CCM3244), (female), Gogo Station, Limestone Billy Hills (18.32724°S; 125.76498°E); WAM R175042 (CCM3245), and WAM R175044 (CCM3247), (females), Gogo Station, Limestone Billy Hills (18.33516°S; 125.75244°E); WAM R175046 (CCM3258) (male), Gogo Station, Pillara Range, south entrance of Menyous Gap (18.40439°S; 125.83698°E); WAM R175047 (field number—CCM3327), and WAM R175048 (CCM3328) (males), Gogo Station, Virgin Hills, 1 km from road near Bob's Bore (18.5149°S; 125.9256°E).

Gehyra kimberleyi (n = 19). Western Australia: WAM R108744 (male), 6 km N Gordon Downs Homestead (18.6833°S; 128.5833°E); WAM R108771 (male), Supplejack Bore (18.9166°S; 125.2667°E); WAM R112966 (male), Beagle Bay Aboriginal Community (17.0730°S; 122.7122°E); WAM R112967 (male), Beagle Bay Aboriginal Community (17.0780°S; 122.7111°E); WAM R112970 (male), Beagle Bay Aboriginal Community (17.0836°S; 122.6597°E); WAM R114212 (female) and WAMR114213 (male), Cape Leveque (16.4000°S; 122.9333°E); WAM R114370 (female), 17 km SE Gogo Homestead (18.3333°S; 125.7500°E); WAM R119943 (female), 15 km NE Nifty Mine Site (21.5500°S; 121.6833°E); WAM R154501 (female), Erskine Range (17.8486°S; 124.3425°E); WAM R172737 (male), Windjana Gorge National Park (17.4233°S; 124.9194°E); WAM R172740–172741 and WAM R172744 (females), WAM R172742 and WAM R172743 (males), Windjana Gorge National Park (17.4233°S; 124.9278°E); WAM R172746 (female), Old Police Station ruins, Windjana Gorge National Park (17.4258°S; 124.9636°E); WAM R175035 (CCM1332) (male), Meda Station (17.36813°S; 124.00420°E); WAM R175036 (CCM1336) (male), Birdwood Downs Station (17.34519°S; 123.77831°E).

Gehyra nana (n = 40). Western Australia: NMV D76950 (male), ridge west of Leopold Downs Road (17.90913°S;

125.28525°E); NMV D76997–76999 (males), Gibb River Road, King Leopold Ranges (17.12977°S; 125.24276°E); NMV D77006–77007 (females), Gibb River Road, King Leopold Ranges (17.14182°S; 125.23882°E); NMV D77035 (female), NMV D77036 (male) and NMV D77037–77038 (females), Ngumpan Cliff area (18.75625°S; 126.06474°E); NMV D77042 (male), The Pinnacles, just off Great Northern Highway (18.73955°S; 125.96368°E); NTM R22918 (female) and NTM R22919 (male), Spirit Hills, Keep River (15.41666°S; 129.05000°E); NTM R36598 (female), Jasper Gorge, Gregory NP (16.02783°S; 130.78733°E); WAM R108729 (male), Calico Springs, Mabel Downs Station (17.2833°S; 128.1833°E); WAM R108733 (male) and WAM R108735 (female), 11km SE Dave Hill, Mabel Downs Station (17.3000°S; 128.1000°E); WAM R113728 (male), Cadjbut Mine, 90 km SE Fitzroy Crossing (18.7500°S; 126.1500°E); WAM R114449 (female), Koolan Island (16.1500°S; 123.7500°E); WAM R125993 (female), ~15 km N Mt Septimus (15.5944°S; 129.0186°E); WAM R132858 (female), 10 km S Bow River Station (16.9663°S; 128.2328°E); WAM R140429 (male), ~22 km N Warmun (18.0500°S; 127.6667°E); WAM R172155 (female) Windjana Gorge (17.2272°S; 124.8958°E); WAM R175049 (CCM0534) (male), Victoria River Escarpment Walk (15.61091°S; 131.11597°E); WAM R175050 (CCM1489) (male), Gibb River Road (17.13767°S; 125.07829°E); WAM R175051 (CCM1786) (female), Texas Downs Station (17.66931°S; 128.30934°E); WAM R175052 (CCM1803) (female), Springvale basalt (17.64743°S; 127.69274°E); WAM R175053 (CCM2808) (male), Lake Argyle rocks (16.11707°S; 128.73813°E); WAM R175054 (CCM2926) (female), East Baines, Gregory NP (15.97138°S; 130.29541°E); WAM R175055 (CCM2984) (male), East Baines camp, Gregory NP (16.45158°S; 130.10257°E); WAM R175056 (CCM3001) (female), Calcite Flow camp, Gregory NP (16.05033°S; 130.4021°E); WAM R175057 (CCM3033) (male), WAM R175058 (CCM3039) (male) and WAM R175059 (CCM3040) (male), Sawtooth Gorge (18.42522°S; 127.81967°E); WAM R175060 (CCM3079) (male), Nyulasy (17.76222°S; 129.09862°E); WAM R175061 (CCM3099) (male), Elephant Rock, Purnululu NP (17.52655°S; 128.36438°E); WAM R175062 (CCM3103) (female), Kurrajong Limestones, Purnululu NP (17.38542°S; 128.32997°E); WAM R175063 (CMWA78) and WAM R175064 (CMWA79) (females), Springvale Homestead dump (17.77460°S; 127.69636°E).

Gehyra pilbara (n = 14). Western Australia: WAM R102167 (female), 5.8 km NNW Mt Windell (22.6022°S; 118.5208°E); WAM R108632 and WAM R108633 (females), 15 km SW Pannawonica (21.8000°S; 116.2333°E); WAM R112678 (male) and WAM R112705 (female), 7.5 km SSE Onslow (21.7038°S; 115.1278°E); WAM R129420 (female), 1km SE Griffin Gas Plant, 30 km WSW Onslow (21.7833°S; 114.8500°E); WAM R131748 (male), Four Corner's Bore, Hamersley Station (22.3333°S; 117.8667°E); WAM R139441 (male), Mount Minnie (21.3733°S; 115.3733°E); WAM R140311 and WAM R140312 (females), Millstream Chichester NP (21.4116°S; 117.1561°E); WAM R157285 (female), Yanrey Station (22.2997°S; 114.5931°E); WAM R158434 (male), Giralia Station (22.6833°S; 114.3667°E); WAM R158438 and WAM R158439 (females), 11 km N Giralia Homestead (22.5869°S; 114.3872°E).