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Taxonomic assessment of *Diporiphora* (Reptilia: Agamidae) dragon lizards from the western arid zone of Australia

PAUL DOUGHTY[1,3], LUKE KEALLEY[1] & JANE MELVILLE[2]

[1]*Department of Terrestrial Zoology, Western Australian Museum, 49 Kew St, Welshpool, Western Australia, Australia.*
[2] *Department of Sciences, GPO Box 666, Museum Victoria, Melbourne, Victoria, Australia*
[3]*Corresponding author email: Paul.Doughty@museum.wa.gov.au*

Abstract

Members of the genus *Diporiphora* are slender perching agamid lizards from Australasia, with a conservative morphology and some outstanding taxonomic issues. Here we assess morphological variation in the morphologically similar *D. pindan*, *D. valens*, and *D. winneckei* from the western deserts of Australia. A reassessment of morphological differences that included the presence or absence of a gular fold, revealed *D. pindan* to be much more widely distributed than previously thought, occurring as far south as the northern Pilbara and east to the Tanami Desert. Examination of *D. valens* specimens revealed a north-south split within the Pilbara, with specimens conspecific with the types from the Hamersley Range in the southern Pilbara, whereas recently collected specimens from the Chichester and Roebourne regions in the northern Pilbara differ morphologically, and are described as a new species. Examination of the type of *D. winneckei* and topotypic material indicates that populations referable to this species are confined to the eastern arid zone. The isolated far western population of '*D. winneckei*' from the Carnarvon Basin differs in morphology from the eastern arid zone *D. winneckei* and is described as a new species. The western arid zone '*D. winneckei*' is also morphologically distinctive from the eastern arid zone *D. winneckei* and is described as a new species. We also redescribe *D. pindan*, *D. valens*, and *D. winneckei*, and return *Caimanops amphiboluroides* to *Diporiphora* based on the results of previous genetic studies.

Key words: *Caimanops amphiboluroides*, *Diporiphora adductus* **sp. nov.**, *Diporiphora paraconvergens* **sp. nov.**, *Diporiphora pindan*, *Diporiphora valens*, *Diporiphora vescus* **sp. nov.**, *Diporiphora winneckei*, Great Sandy Desert, morphology, Pilbara, Tanami

Introduction

Lizards of the genus *Diporiphora* are a moderately diverse group of 16 endemic Australian dragons in the family Agamidae. They are slender-bodied and usually perch on low-lying cane grass, Spinifex clumps, shrubs and on the branches of slender, low trees (Greer 1989; Wilson & Swan 2011). By the end of the 19th century, there had been four nomimal species described that are still currently recognized: *D. australis* (Steindachner), *D. bilineata* Gray, *D. bennettii* Gray, and *D. winneckei* Lucas & Frost. No further species were described until *D. reginae* by Glauert in 1959, followed by many more in the 1970s, especially by G.M. Storr who described nine species (Storr 1974, 1979). No other species of *Diporiphora* have been described for over 30 years since then until *D. phaeospinosa* by Edwards and Melville (2011), who also transferred *Amphibolurus nobbi* Witten to *Diporiphora*.

Taxonomic problems, however, remain within the genus. *Diporiphora* are conservative in their morphology, and do not often vary appreciably in overall appearance. Workers have traditionally used scalation related characters such as the gular, scapular, and post-auricular folds, orientation of the dorsal scales, the number of pores, and pattern and coloration to diagnose species. Recently, Smith *et al.* (2011) used genetic data to identify several lineages within the nominal taxa *D. bilineata* and *D. magna* Storr, indicating the possible presence of multiple cryptic taxa with highly conserved morphology and making species identifications difficult.

In this study, we carried out a morphological examination of *Diporiphora* from the Australian arid zone, focusing on *D. pindan* Storr, *D. valens* Storr, and *D. winneckei*. These three species were previously regarded as a

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single taxon, but the western species were described as new by Storr (1979), following Houston's (1977) treatment of *D. winneckei*. We chose to focus on these taxa owing to an unusual form of *Diporiphora* that was detected just outside of the rocky Pilbara on sandy substrates during a recent large-scale survey of the Pilbara region (see Doughty *et al.* 2011a; J. Rolfe, pers. comm.). This led us to re-examine the morphological boundaries and natural ranges of *D. winneckei* and *D. valens*, and also to examine the status of a confusing variety of forms on the western coast that lacked gular folds. *Diporiphora pindan* has generally been considered to be endemic to the Dampier Peninsula and slightly to the south in the southwestern Kimberley region, a concept stemming from the original description of the species by Storr (1979) and later in more general treatises (Fig. 1; Storr *et al.* 1983; Cogger 2000). Similarly, *Diporiphora valens* was presumed to be confined to the Hamersley Range of the southern Pilbara region, with an outlying record outside the Pilbara to the south-east at Kumarina (Storr 1979; Storr *et al.* 1983). Both species were originally considered as variants of *D. winneckei* by Storr (1974), but later recognized as distinct taxa by virtue of having a slightly robust habitus and more extensive keeling on the scales compared to *D. winneckei*, and the two species differed in that *D. pindan* lacks a gular fold, whereas *D. valens* possesses one. *Diporiphora winneckei* remains a poorly-defined taxon despite the work of Houston (1977) and Storr (1979). This species is believed to have a massive natural range (Fig. 1), with the lectotype specimen collected near the center of its distribution on the Horn Expedition to central Australia (Lucas & Frost 1896; Coventry 1970; Houston 1977). One character that has been presumed to vary within *D. winneckei* is the presence or absence of a gular fold (Houston 1977; Storr *et al.* 1983). When present, the gular fold is defined by much smaller, granulated scales underneath the fold, whereas species lacking a gular fold have scales of the same size on the underside of the neck. However, we consider it to be extremely unlikely that such a character would be variable within a single species (e.g. Doughty & Reznick 2003), and is therefore indicative of more than one species within *D. winneckei*.

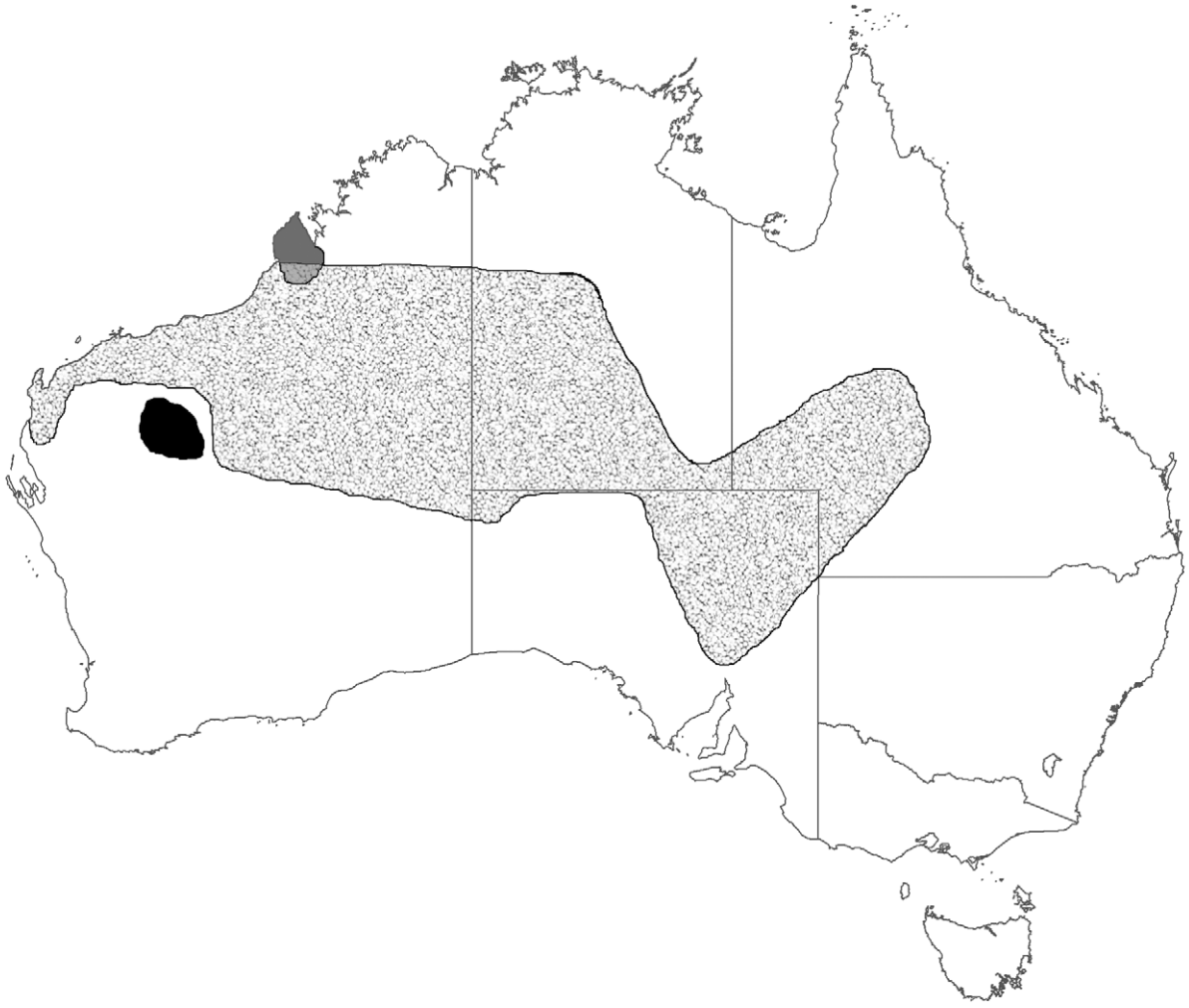

FIGURE 1. Map of Australia summarizing current understanding of the distributions of *Diporiphora pindan* (shaded), *D. winneckei* (stippled), and *D. valens* (solid) based on field guides.

We made use of an unpublished molecular pilot study to initially guide our morphological examinations; an expanded molecular appraisal will be published elsewhere (JM, unpublished data). We found differences in morphological characters that clearly diagnose the species we recognize here. As such, *D. pindan*, formerly considered a Dampierland near-endemic is now much more widely distributed, including the northern Pilbara and as far as the Tanami Desert. *Diporiphora valens* is confirmed to be a Hamersley Range near-endemic. Specimens from the northern Pilbara initially thought to be *D. valens* differ subtly, yet consistently, in morphology from topotypic *D. valens* and are described as a new species. The status of *D. winneckei* is not completely resolved as the species is widely distributed from the western coast of Australia then east through the arid zone to Queensland and New South Wales. To refine the concept of this taxon, however, we describe two new species from the *D. winneckei* species complex. The isolated western population from the northern Carnarvon Basin in the far western arid zone is described as a new species, as it lacks any folds and differs in several other characters. True *D. winneckei* is confined to the eastern arid zone and differ from populations in the western arid zone in several characteristics, including ventral patterning and dorsal scalation. We therefore describe the western arid zone populations as a new species. Last, we also formally return the western arid zone Mulga Dragon *Caimanops amphiboluroides* (Lucas & Frost) back to *Diporiphora* based on previously published molecular results (see Schulte *et al.* 2003; Edwards & Melville 2011) and synonomize two genera proposed by Wells & Wellington (1984, 1985) with *Diporiphora*.

Methods

Specimens were examined from the collections of the Western Australian Museum (WAM; where new type material is deposited) and the South Australian Museum, Adelaide (SAMA). The exception was for the type of *D. winneckei* held at Museum Victoria (NMV). Table 1 presents the morphological variables assessed. Measurements were made with electronic calipers to the nearest 0.1 mm, with SVL, TailL, and TrunkL to 0.5 mm (broken tails were not measured). Individuals were sexed by observations of everted hemipenes in males or heavily gravid females, or by direct examination of the gonads. We measured at least 10 well-preserved adult specimens from each taxon, except for the northern Pilbara taxon for which only seven adult specimens were available. For the statistical tests, we first tested for significant differences in SVL as a function of sex and taxon with a 2-way ANOVA. As there were sex and taxon differences for SVL (see Results, below), we kept males and females separated for analyses of meristic characters, but report pooled summary statistics if sex was not significant in the analysis, or if scale counts were tested. For all other tests involving size-related variables (e.g. head, limbs, and tail) we used ANCOVAs with SVL as the covariate. No interaction terms were significant (P>0.10 level), and were therefore excluded from models. All scale bars in the figures are 10 mm.

TABLE 1. Morphological characters measured in this study.

Character	Description
SVL	Snout-vent length
TailL	Tail length from cloaca to tip (unbroken tails only)
HeadL	Head length, measured obliquely from tip of snout to anterior margin of tympanum
HeadW	Head width, measured at the widest point
HeadD	Head depth, measured level with center of the tympanum, at the highest point
SupLab	Number of supralabial scales
InfLab	Number of infralabial scales, ending with the last small scale in contact with the posterior margin of the last upper labial
MBSR	Number of midbody scale rows, counted midway between axilla and groin
4TLam	Number of enlarged subdigial lamellae under fourth toe, counted from toe junction to base of claw
PCP	Number of pre-cloacal pores
LegL	Leg length, measured from the knee bend to the tip of the 4th toe including claw.

Results & Discussion

A summary of morphometric variation among taxa is presented in Table 2. Examination of types and specimens from across the arid zone enabled us to reassess the distribution and morphological limits of the previously described species. We found that using the absence of the gular fold (Fig. 2a) (supplemented by general habitus, scalation, color, and pattern) greatly clarified the distribution of *D. pindan*. The distribution of *D. pindan* is much more extensively distributed beyond the Dampier Peninsula and surrounds than previously reported (Storr 1979; Storr *et al.* 1983; cf. Fig. 1). We found 55 specimens previously classified as *D. winneckei* and 12 specimens classified as *D. lalliae* Storr in the WAM collections that were referable to *D. pindan*. These specimens occurred along the Dampierland extension to the IBRA subregion along the coast and extending to the northern Pilbara, and east through the Great Sandy Desert to the Tanami Desert near the Western Australian-Northern Territory border, greatly expanding its known distribution (Fig. 3).

Diporiphora valens specimens were also checked for lack of a gular fold, but none were found. We also re-examined three isolated populations of *D. valens* outside of the Pilbara craton area. The isolated Kumarina specimens to the south-east of the Pilbara (= paratypes) were similar to other *D. valens* from the Pilbara craton. The collector of the Kumarina *D. valens* specimens, C. Snell, provided many herpetological specimens to the WAM during the 1960s, including many from Newman and the Hamersley Range. Collection details usually seemed sufficient but at times were vague, thus it is possible the locality details for these specimens are in error. New collections of *Diporiphora* from Kumarina would resolve the issue. Specimens from two other collections of *Diporiphora* from the Little Sandy Desert also correspond to typical *D. valens* (not *D. 'winneckei'* as expected), suggesting that these populations (including the Kumarina specimens) may be relicts from a formerly wider distribution.

Recent collections of *D. valens* from the northern Pilbara (Chichester and Roebourne regions) revealed that they were less robust and spinose than *D. valens* from the Hamersley Range to the south, and they also differed in pattern with lighter background color, fewer cross-bands, and lacked additional medial markings on the ventrum. Based on the consistency of the phenotypic differences between the two allopatrically distributed populations, in combination with information from the genetic pilot study which recovered southern and northern *D. valens* as two reciprocally monophyletic clades (JM, unpublished data), we recognize the northern Pilbara taxon as a new species, *D. vescus* **sp. nov.**

All specimens classified as *D. winneckei* from the isolated west coast population (from Onslow south to the North West Cape and inland of Carnarvon) lacked a gular fold (Fig. 2e). The absence of a gular fold clearly distinguishes this taxon on the west coast from all other *D. winneckei* and from *D. valens*, both of which possess a gular fold. These specimens were clearly not referable to *D. pindan* which also lacks a gular fold on the basis of differences in color and pattern (see below). We therefore recognize the west coast population formerly assigned to *D. winneckei* as a new species, *D. adductus* **sp. nov.**

Recognition of *D. adductus* **sp. nov.** and a redefinition of *D. pindan* necessitated a revaluation of the status of *D. winneckei*. We compared the western arid zone form of *D. winneckei* with the lectotype and typotopic material from the collections of SAMA from Charlotte Waters in the Northern Territory. Both western and eastern arid zone forms possessed dorsal scales with keels that converged towards the midline. This is reported in the original description of *D. winneckei*, but has not been reported in more recent field guides and keys (e.g., Storr *et al.* 1983; Cogger 2000; Wilson & Swan 2011). We found evidence supporting Houston's (1977) observation of eastern forms with a wide medial pigmented element on the gular region (cf. fig. 2 vs. 4 & 5 in that paper; Fig. 2d), whereas the western arid zone form had no medial elements (or at most only a thin marking) on the gular region, but thin curved dark lines to either side of the midline. In addition, *D. winneckei* from the eastern arid zone possessed no precloacal pores, whereas the western form possessed from 2–4 pores. We therefore describe the western form as a new distinctive species here, *D. paraconvergens* **sp. nov.**, based on the keels of the dorsal scales strongly converging towards the midline as in *D. convergens* Storr, and the characters mentioned above. We acknowledge, however, that several cryptic forms may still exist within *Diporiphora* from across the arid zone, including individuals assigned to *D. lalliae*, but this will require further investigation including the use of molecular genetic techniques and further sampling over wide areas (JM, unpublished data).

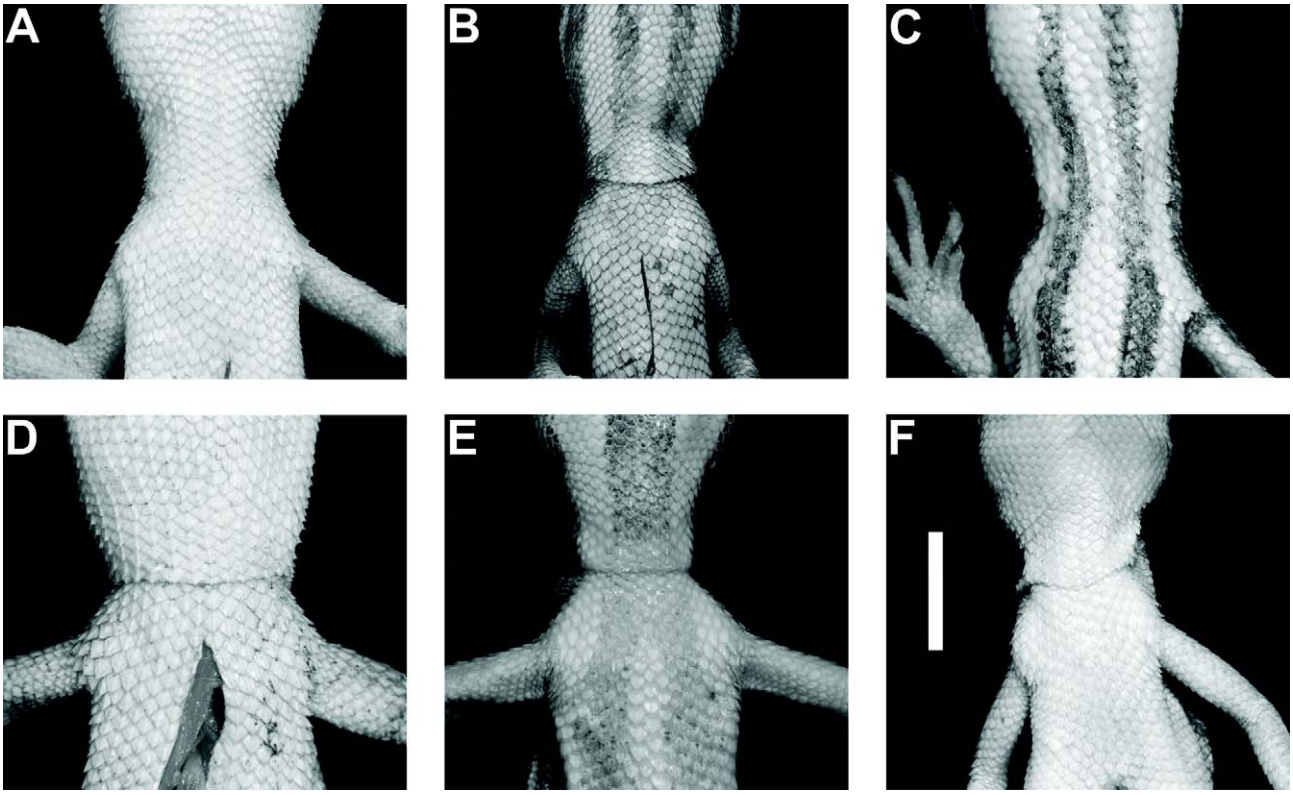

FIGURE 2a–f. Gular fold appearance of *Diporiphora*. A) *D. pindan*, B) *D. vescus sp. nov.*, C) *D. adductus sp. nov.*, D) *D. valens*, E) *D. winneckei*, F) *D. paraconvergens sp. nov.*

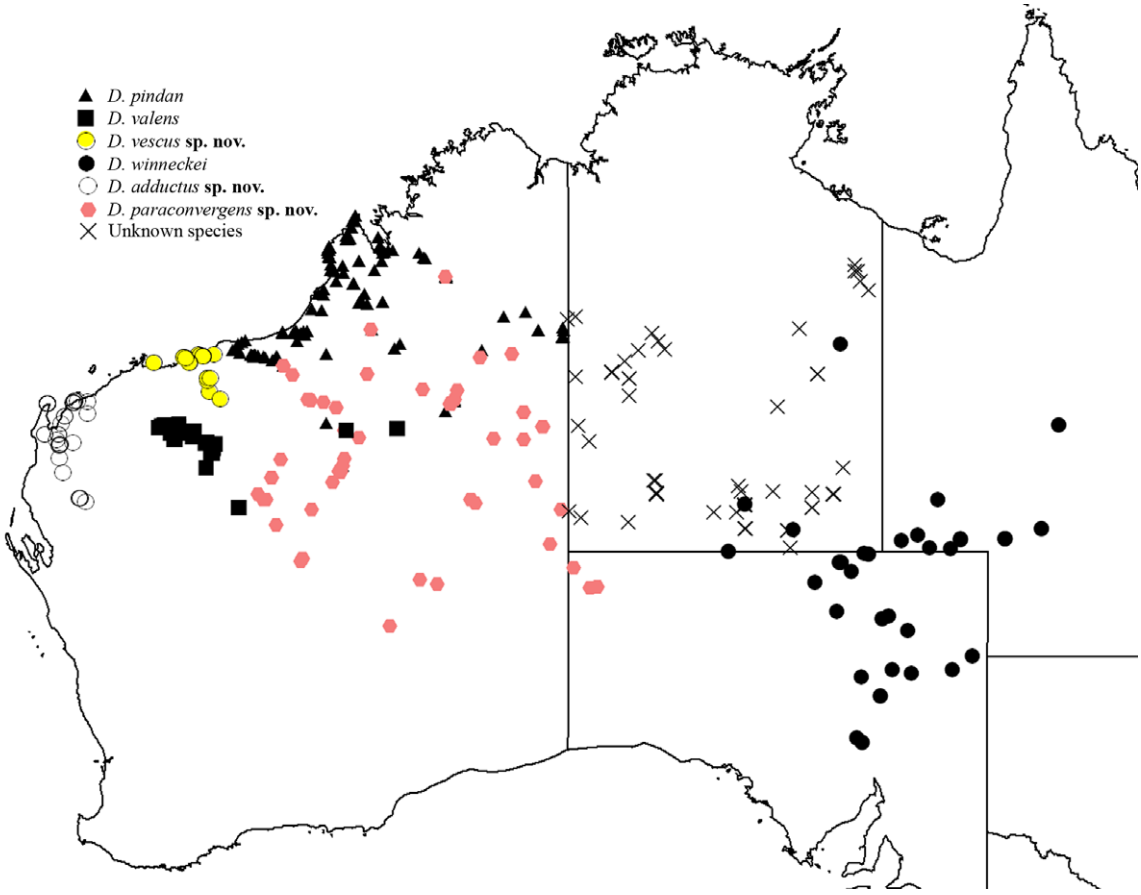

FIGURE 3. Revised distributions of *Diporiphora* species from the Australian arid zone treated here.

TABLE 2. Summaries of characters and ratios measured for *Diporiphora* species. All measurements in mm. Mean±S.D. (range). See Table 1 for abbreviations. Sample sizes are listed in column headings, unless noted for individual characters below. Juveniles with SVL <42 mm were excluded from statistics, but were included in scale counts. SVL was tested with a 2-way ANOVA. 2-way ANCOVAs (factors: species and sex; covariate: SVL) were carried out (see text for explanation) and reported in the last column. All species X sex interaction terms were not significant with alpha = 0.05. Key: NS (not significant): $P>0.10$, *$P<0.05$, **$P<0.01$, ***$P<0.001$, ****$P<0.0001$.

Character	*D. pindan* N = 11 (7♀, 4♂)	*D. valens* N = 10 (7♀, 3♂)	*D. vescus* **sp. nov.** *N = 7* (1♀, 6♂)	*D. winneckei* N = 10 (6♀, 4♂)	*D. adductus* **sp. nov.** N=10 (6♀, 4♂)	*D. paraconvergens* **sp. nov.** N=14 (1♀, 13♂)	Statistics
SVL	♀♀: 57.1±2.5 (53.5–60.5) ♂♂: 55.9±2.8 (54.0–60.0)	♀♀: 70.0±5.0 (65.0–78.0) ♂♂: 62.8±1.0 (62.0–64.0)	♀♀: 57.0±0 (57.0–59.0) ♂♂: 58.6±3.8 (45.5–62.5)	♀♀: 60.3±2.1 (57.5–64.0) ♂♂: 53.3±3.3 (50.5–58.0)	♀♀: 62.0±6.0 (50.5–67.5) ♂♂: 57.6±3.1 (54.5–61.0)	♀♀: 55.0±0 (55.0) ♂♂: 51.5±4.7 (41.5–58.5)	Spp.—$F_{11,61}= 8.706^{****}$ Sex—$F_{11,61}= 7.377^{**}$
TailL	134.9±12.3 (115–151)	166.7±9.7 (153–181)	149.6±13.6 (133–174)	141.2±8.9 (129–159)	157.9±10.0 (146–173)	150.2±15.9 (109–171)	SVL—$F_{12,45}=17.240^{***}$ Spp.—$F_{12,45}=5.988^{***}$ Sex—$F_{12,45}=0.557^{NS}$
HeadL	15.4±0.9 (14.4–17.0)	17.7±1.0 (16.1–19.0)	15.7±1.0 (13.3–17.0)	15.5±1.1 (13.7–16.6)	15.3±1.0 (13.6–16.7)	14.2±1.1 (12.6–16.1)	SVL—$F_{12,47}=87.961^{***}$ Spp.—$F_{12,47}=4.263^{**}$ Sex—$F_{12,47}=0.220^{NS}$
HeadW	9.7±0.7 (8.9–11.5)	11.0±0.7 (9.8–11.9)	9.8±0.6 (7.8–10.4)	9.3±0.6 (8.6–10.1)	8.8±0.7 (7.8–9.8)	8.3±0.6 (6.9–9.2)	SVL—$F_{12,47}=50.282^{***}$ Spp.—$F_{12,47}=12.107^{****}$ Sex—$F_{12,47}=0.819^{NS}$
HeadD	7.3±0.5 (6.8–8.3)	8.5±0.5 (7.9–9.5)	7.9±0.5 (6.1–8.6)	7.0±0.5 (6.1–7.8)	7.1±0.5 (6.0–8.0)	6.5±0.5 (5.4–7.0)	SVL—$F_{12,47}=46.878^{***}$ Spp.—$F_{12,47}=6.027^{***}$ Sex—$F_{12,47}=3.079^{NS}$
SupLab	10.2±0.9 (8–12)	9.3±0.5 (8–10)	9.9±1.0 (9–12)	10.4±0.5 (10–12)	10.3±0.9 (9–12)	10.0±0.9 (9–11)	Spp.—$F_{11,48}=3.004^{*}$ Sex—$F_{11,48}=2.008^{NS}$
InfLab	9.8±0.7 (8–11)	9.6±1.0 (8–12)	9.8±1.0 (8–11)	10.0±0.8 (9–12)	10.1±1.5 (8–13)	9.3±0.7 (8–11)	Spp.—$F_{11,48}=0.825^{NS}$ Sex—$F_{11,48}=0.155^{NS}$
MBSR	67.3±5.6 (64–77)	56.8±1.8 (54–60)	60.4±2.3 (55–63)	61.9±2.6 (57–66)	58.1±1.8 (56–61)	61.2±1.7 (57–64)	Spp.—$F_{11,48}=6.904^{****}$ Sex—$F_{11,48}=0.053^{NS}$
4TLam	22.5±1.4 (20.5–24)	23.6±1.0 (22–25)	24.4±1.7 (23.5–28)	28.7±1.2 (26–31)	26.7±1.4 (25–29)	26.1±1.5 (23.5–29.5)	Spp.—$F_{11,48}=29.478^{****}$ Sex—$F_{11,48}=0.058^{NS}$
PCP	3.0±1.4 (0–4)	3.8±0.6 (2–4)	3.9±0.2 (2–4)	0±0 (0–0)	1.5±0.8 (0–2)	2±0 (2)	Spp.—$F_{11,48}=21.413^{****}$ Sex—$F_{11,48}=0.764^{NS}$
LegL	27.7±2.0 (24.5–29.5)	33.2±2.2 (29.5–36.5)	30.8±1.0 (26–32)	28.7±0.9 (27.5–30.5)	30.8±2.6 (26.5–34.5)	28.3±2.1 (23–30.5)	SVL—$F_{12,47}=43.319^{***}$ Spp.—$F_{12,47}=3.459^{**}$ Sex—$F_{12,47}=2.631^{NS}$
HeadW/ SVL	0.17±0.01 (0.15–0.19)	0.16±0.01 (0.15–0.17)	0.17±0.01 (0.16–0.17)	0.16±0.01 (0.15–0.19)	0.15±0.01 (0.14–0.16)	0.16±0.01 (0.14–0.17)	
LegL/ SVL	0.49±0.04 (0.43–0.55)	0.49±0.05 (0.44–0.59)	0.53±0.02 (0.50–0.57)	0.50±0.04 (0.46–0.56)	0.51±0.02 (0.48–0.54)	0.55±0.03 (0.50–0.58)	
TailL/ SVL	2.38±0.26 (2.05–2.72)	2.46±0.24 (2.14–2.78)	2.70±0.18 (2.44–2.93)	2.43±0.15 (2.24–2.66)	2.63±0.20 (2.35–2.97)	2.91±0.15 (2.63–3.14)	

Here we also address the generic assignment of *Caimanops amphiboluroides* (Lucas & Frost, 1902). Although described originally as a *Diporiphora*, Storr (1974) erected a new genus for this species, *Caimanops*. Other than describing the diagnostic characters of *D. amphiboluroides* in his generic account, Storr provided no comment in his paper on why he felt this action was necessary. Several recent molecular genetic studies have unambiguously placed *C. amphiboluroides* well within the *Diporiphora* clade (Schulte *et al.* 2003; Hugall *et al.* 2008; Edwards & Melville 2011). As with the case of *D. nobbi* (Edwards & Melville 2011), *C. amphiboluroides* has several characters that diverge from those typically seen in other *Diporiphora*, including five crests on the forebody, short tail, and no dorsolateral stripes (Storr 1974; Storr *et al.* 1983; Cogger 2000). As pointed out by Hugall *et al.* (2008; p. 329), all but the crests are autapomorphies that present no difficulty to its inclusion in *Diporiphora*. The recent transfer of *Amphibolurus nobbi* to *Diporiphora* and the description of *D. phaeospinosa* (both of which possess dorsal crests) by Edwards & Melville (2011) indicate that dorsal crests are also no barrier to species being included within *Diporiphora*. To render the genus *Diporiphora* as a monophyletic clade, we synonomize *Caimanops* with *Diporiphora* and return *C. amphiboluroides* to *Diporiphora*. Lastly, the genus *Mantichorasaurus* Wells & Wellington was proposed for *D. albilabris* Storr and *D. sorbia* Storr, and *Houstoniasaurus* Wells & Wellington for *D. linga* and *D. winneckei* in their self-published catalogs (Wells & Wellington 1984, 1985). There is no morphological or molecular evidence to support such an arrangement, therefore we synonomize both names here with *Diporiphora*.

Taxonomy

Diporiphora Gray, 1842

Type species—*Diporiphora bilineata* Gray, 1842, by monotypy.

Diporiphora pindan

Pindan Dragon
Figs. 2a, 4, 5

Holotype. WAM R58402, an adult female collected 2 km north of Coulomb Point, Western Australia (17°18′S, 122°10′E), on 17 April 1977 by R.E. Johnstone.

Paratypes. All from Western Australia. WAM R166, Streeters Station, Broome(17°48′S, 122°14′E); WAM R15185, WAM R20262–4, WAMR20317–29, WAM R26834, WAM R46661, Derby (17°18′S, 123°37′E); WAM R26216, La Grange (18°40′S, 122°01′E); WAM R27638, Indujinah Creek (18°38′S, 121°52′E); WAM R32167, 24 km south of Derby (17°26′S, 123°45′E); WAM R36336, 130 km east of Broome (17°58′S, 123°28′E); WAM R40266, Coulomb Point (17°22′S, 122°09′E); WAM R46463, Beagle Bay (16°59′S, 122°40′E); WAM R53979, WAMR53998, WAMR54013–4, WAMR54018–22, WAM R54028–31, WAM R54038, Edgar Ranges (18°21′S, 122°53′E); WAM R54080, 37 km SSE of McHughes Bore (18°39′S, 123°11′E); WAM R58403–10; WAM R58461, WAM R58516, WAM R58503, 5 km north of Coulomb Point (17°19′S, 122°10′E); WAM R58500, WAM R58514, WAM R58515, Martins Well (16°34′S, 122°51′E); WAM R58517, Dampierland (20°40′S, 116°40′E); WAM R58605, 26 km ESE Derby (17°23′S, 123°51′E).

Diagnosis. A slender, small-bodied *Diporiphora*, with no gular or post-auricular folds, and a weak scapular fold, no crests on the forebody, homogeneous dorsal scales with keels parallel to midline, 0–4 precloacal pores, no femoral pores, 64 or more mid-body scale rows, <24 lamellae on the fourth toe, coloration not yellow-green, and usually with prominent dorsolateral stripes.

Description. A slender and elongate dragon; body round in cross-section with flat venter; head medium with short angular snout; from above, sides of snout slightly convex with rounded tip; head widest behind eyes (HW%SVL: 15–19); neck constricted to ¾ maximum head width; gular and post-auricular folds absent, a weak scapular fold present; limbs slender, arms moderately long, legs long; digits long and slender; finger length: 4>3>2>5>1; toe length: 4>3>5>2>1; canthus well defined; nasal scale below canthal ridge, nare at anterior of nasal. Tail very long and slender (TL%SVL: 205–275); flexible; tapering gradually to fine tip.

FIGURE 4. *Diporiphora pindan* in life. Left—complex pattern (J. Melville); right—plain pattern (H. Cook).

Supralabials 8–12 (avg. 10), infralabials 8–11 (avg. 10); tympanum circular; scales on temporal stripe enlarged from eye to posterior edge of tympanum; 0–2 small postauricular spines present; rows of low sharp teeth; upper canines 2; lower canines 2; scales above supralabials angle back from jaw for 2–3 scale rows, uppermost rows comprised of minute scales, and above a row of thin keeled longitudinally-oriented scales beginning at nasal and ending just posterior to midpoint of eye; snout and anterior top of head with distinct keels terminating in 1–4 perforations on posterior edge and aligned horizontally, following contours of snout and eye socket; on posterior top of head scales are more rugose with direction of keels more scattered; 1–2 low post-auricular spines may be present.

Dorsals homogeneous, imbricate, diamond-shaped with low keels terminating posteriorly with small perforation; upper keels on dorsum parallel throughout or at most only weakly converging towards midline; upper lateral scales smaller with keels directed slightly dorsally; lower lateral scales enlarged with low keels; gular and ventral scales keeled, keel terminating in spine projecting past posterior edge of scale; dorsal and ventral scales similar in size; 0–4 precloacal pores, pore located on edge of scale; no femoral pores; hemipenes bifid.

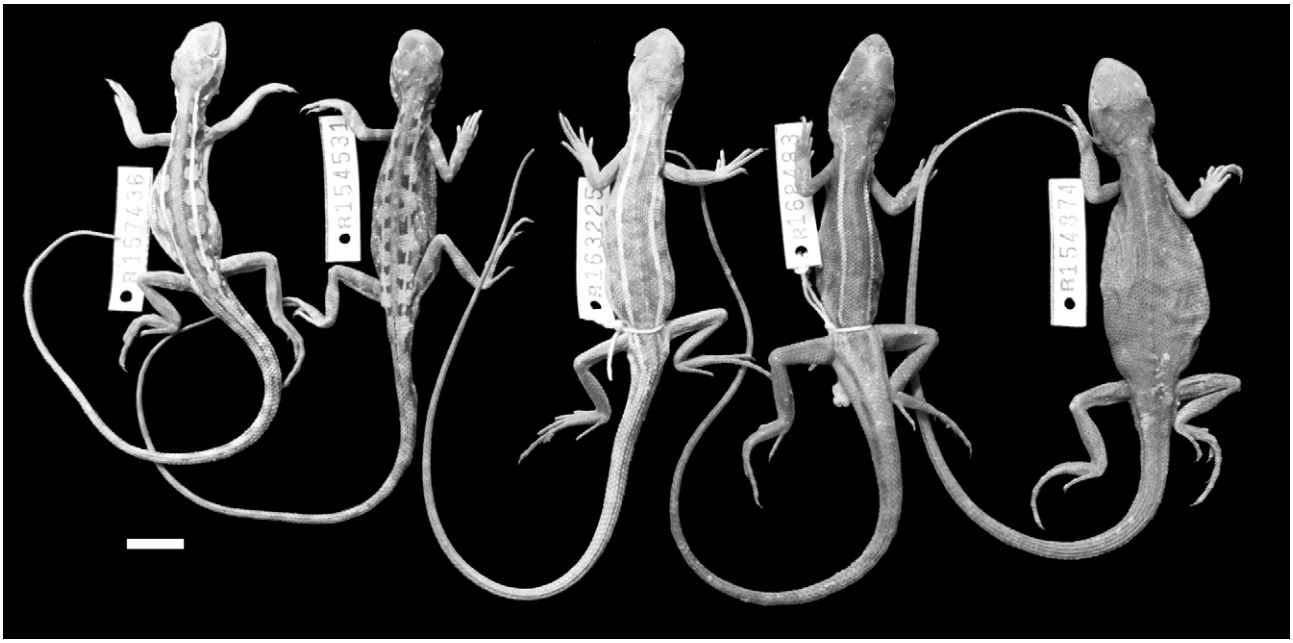

FIGURE 5. Variation in *Diporiphora pindan*.

Background pattern and color variable, from complex patterning or plain. Complex pattern (Fig. 4a) —background color light brown; pale silver vertebral stripe 2–3 scales wide; prominent pale yellowish-white dorsolateral stripe 1–2 scales wide; dark brown longitudinal markings (4–6 scales long) to either side of dorsolateral stripe, interrupted regularly by background color for 4–8 scales; dorsolateral stripes continuing posteriorly along tail; well-defined lateral stripe absent, lateral zone a mosaic of light and dark scales that transition to pale ventral color; head matches background color; prominent pale temporal stripe often with dark brown border, continuous with dorsolateral stripe with hiatus posterior to tympanum; labials and eyelids pale white; labial stripe terminates at posterior edge of mandible or on neck. Plain pattern—brown to black uniform background color with highly contrasting pale yellow dorsolateral stripes (usually males; Fig. 4b) or lighter uniform color with no dorsolateral stripes (usually females); males often have a large black circular mark on the sides posterior to the arms. Ventrum pale white; if well-marked, a pair of brownish-gray stripes from near tip of snout, separating through gular region, then in close proximity on neck (often enclosing medial element projecting from neck), then widening and separating on venter (for heavily-marked individuals these ventral lines can merge creating a single dark ventral patch), converging at cloaca; below infralabials a dark stripe continuous with silvery-gray coloration on sides of neck. Strength of ventral patterning appears to vary independently with dorsal coloration.

Habitat. Occurs in vegetation associated with sands, such as Spinifex, grasses, and *Acacia*. Observed perching on vegetation in the day and while asleep at night; some individuals were found under low ground cover and one specimen was dug from a burrow.

Distribution. Occurs from the Dampier Peninsula in the south-west Kimberley, south through the Great Sandy Desert and occurring along the Pilbara coast as far west as Karratha; east to the Tanami (Fig. 3).

Etymology. The specific name refers to the pindan country of the south-west Kimberley region where the type series was collected and to which it was believed to be confined.

Remarks. Houston (1977) first identified *D. pindan* and *D. valens* in his analysis of variation in *D. winneckei* and description of *D. linga*, but deferred describing them. Storr (1979) described both forms identified by Houston with more material available at the WAM. In this study it was surprising to find so many *D. pindan* specimens identified as '*D. winneckei*' in the WAM collections. We suspect part of this was due to a kind of circular logic of believing that *D. pindan* was restricted to the region around the Dampier Peninsula in the southwest Kimberley (first indicated in Houston's 1977 paper), combined with the lack of a detailed investigation of morphological variation of arid zone *Diporiphora* for many decades.

Diporiphora pindan is now known to occur widely through the Great Sandy Desert and in to the Tanami, greatly extending its known range. It also occurs in the sandy coastal region of the Pilbara, a pattern seen in the distributions of several other recently-studied species complexes including the 'sand-swimming' skink *Eremiascincus musivus* (Mecke *et al.* 2009) and the frog *Uperoleia talpa* (Catullo *et al.* 2010) (see also Doughty *et al.* 2011a).

Diporiphora valens

Southern Pilbara Tree Dragon
Figs. 2d, 6, 7, 8

Holotype. WAM R31009, an adult female collected near Tom Price, Western Australia (ca. 22°45′S, 117°45′E), in December 1968 by C. Tideman and R.S. Robinson.

Paratypes. All from Western Australia. WAM R23970–3, Kumarina (24°45′S, 119°35′E); WAM R25135, 3 km south of Turee Creek (23°37′S, 118°39′E); WAM R31009, Tom Price town site (22°42′S, 117°47′E); WAM R52703, WAM R52737–8, Marandoo Minesite, Mount Bruce (22°36′S, 118°09′E).

Diagnosis. A robust, medium-large *Diporiphora*, with gular and scapular folds, post-auricular fold weak, no crests on the forebody, homogeneous dorsal scales with keels parallel to midline, 2–4 precloacal pores, no femoral pores, 60 or fewer mid-body scale rows, ≤25 fourth toe lamellae, and with pale yellow dorsolateral stripes. Further distinguished from *D. vescus* **sp. nov.** by larger body size, more robust habitus, spinier scalation, slightly shorter limbs and tail, darker background color, more dark crossbands and a medial marking on gular region.

Description. A medium-large (to 78 mm) dragon with relatively robust habitus; body oval in cross-section with flat venter; head stout with short angular snout; from above, sides of snout slightly convex with rounded tip; head widest behind eyes (HW%SVL: 15–17); neck constricted to ¾ maximum head width, skin on neck loose; gular fold almost straight and moderately developed, post-auricular fold weak or absent, and scapular fold strong; limbs moderately slender, arms moderately long, legs long; digits long and slender; finger length: 4>3>2>5>1; toe length: 4>3>5>2>1; canthus well defined; nasal scale below canthal ridge, nare at anterior of nasal. Tail very long and slender (TL%SVL: 214–278), flexible; tapering gradually to fine tip.

FIGURE 6. *Diporiphora valens* in life. Left—plain pattern (M. Peterson); right—complex pattern (R. Lloyd).

Supralabials 8–10 (avg. 9.3), infralabials 8–12 (avg. 9.6); tympanum nearly circular, except ventro-posterior edge with angle in some specimens; scales on dorsolateral stripe on neck and above arms slightly enlarged and raised from surrounding scales; scales underneath temporal stripe enlarged from eye to anterior edge of tympanum; enlarged keeled scales at posterior edge of labial stripe; rows of low triangular teeth; upper canines 2; lower canines 2; scales above supralabials angle back from jaw for 2–3 scale rows (uppermost row comprised of minute scales), above a row of longitudinally-oriented scales with low keels beginning at nasal and ending just posterior to midpoint of eye; snout and anterior top of head with distinct keels terminating in usually 1 or 2 perforations on posterior edge and aligned horizontally, following contours of snout and eye socket; on posterior top of head scales are more rugose with direction of keels more scattered.

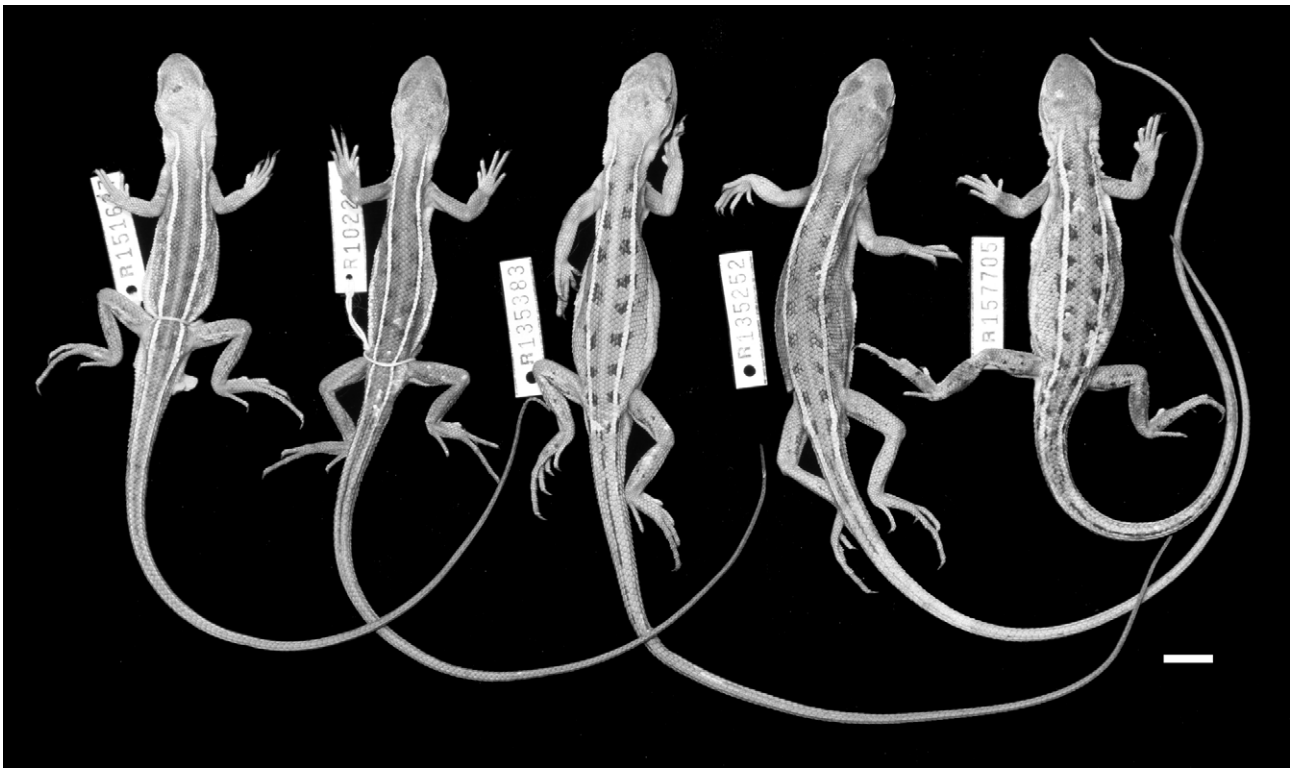

FIGURE 7. Variation in *Diporiphora valens*.

Dorsal scales homogeneous, imbricate, diamond-shaped with low slightly raised keels terminating past the posterior edge of scale with small spine; upper keels on dorsum parallel throughout; keels of upper lateral scales directed slightly dorsally; scales on gular region feebly keeled anteriorly, then increasing to moderately keeled towards gular fold; ventral scales with low keels and short spine projecting past posterior edge of scale; dorsal, lateral, and ventral scale size similar; 2–4 precloacal pores; hemipenes bifid.

In preservative, background color light to dark brown; dorsal pattern ranges from complex (described below) to plain (brown but with dorsolateral lines still present); feint pale silver vertebral stripe (or absence of silver on larger specimens) ~3 scales wide; prominent pale yellowish-white dorsolateral stripe ~2 scales wide; in paravertebral zone (between vertebral and dorsolateral stripes) 9–11 dark brown cross-bands (3–4 scales long), extending from 0–2 scales below dorsolateral stripe; dark markings interrupted regularly by 3–6 scales; dorsolateral stripes continuing posteriorly along tail or fading to background color above pelvis; narrow pale yellow lateral stripe usually discernible, varyingly bordered by dark edge or not visible if lateral zone is very pale, terminates anteriorly at arm, posteriorly at insertion of leg; between lateral and ventral stripes a light brown lateral zone, lower lateral surfaces blending to ventrum shade; head medium brown; pale temporal stripe usually present, often with dark brown border terminating at dorsal edge of tympanum; dorsolateral stripe begins on anterior portion of neck and usually positioned inside temporal stripe; labials and eyelids pale white. Ventrum pale white; usually plain; well-marked individuals have a pair of brownish-gray stripes from near tip of snout, separating through gular region then angling back along jaw near gular fold; a medial marking is present on posterior gular region, sometimes extending anteriorly to converge with paired marking; on ventrum, paired curved markings follow outline of body, converging at cloaca, and continuing as medial stripe on proximal portion of tail; a thin straight medial ventral marking inside paired outer markings; below infralabials a dark stripe continuous with silvery-gray coloration on sides of neck.

Variation. Table 2 presents variation in morphological characters within *D. valens*. Males and females did not differ conspicuously in pattern or tendency to have the plain or complex dorsal patterns. Juveniles had more vivid markings; the smallest individual was 26 mm SVL.

Habitat. Specimens have been collected from stands of *Acacia* and from Spinifex bushes.

Distribution. Confined to the southern Pilbara region of Western Australia, with isolated populations to the east and south-east in the Little Sandy Desert (Fig. 3). Most specimens are from the Hamersley Range.

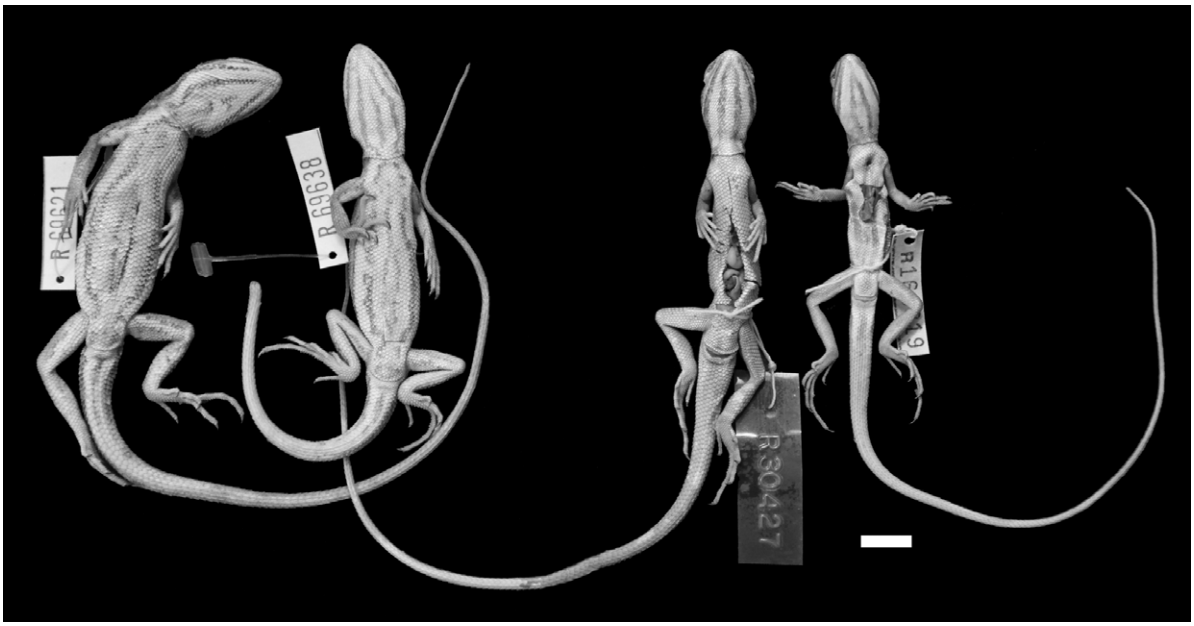

FIGURE 8. Comparison of ventral patterns of *Diporiphora valens* (two specimens to the left) and *D. vescus* **sp. nov.** (right).

Etymology. The specific name *valens* is Latin for strong (according to Storr *et al.* 1983, not the original description), presumably in reference to the habitus and scalation relative to '*D. winneckei*' (= *D. adductus* **sp. nov.** and *D. paraconvergens* **sp. nov.**), which Storr compared them to.

Remarks. *Diporiphora valens* is the only member of the genus to occur on the Hamersley Range. The three known outlying populations occur on breakaway country to the east and south-east, and more isolated populations may occur 'stranded' on rocky country surrounded by vast dunefields.

Diporiphora vescus sp. nov.

Northern Pilbara Tree Dragon
Figs. 2b, 8–11

Holotype. WAM R145536, an adult male collected 86 km south of Port Hedland (21°03′36″S, 118°45′00″E), Western Australia, in May 2001 by R.J. Teale and colleagues.

Paratypes. All from Western Australia. WAM R30427, collected 16 km south-west of Port Hedland (20°26′S, 118°33′E); WAM R117871, collected 1 km north of Mundalbullangana Homestead (20°30′S, 118°03′E); WAM R161256, collected 45 km north-east of Whim Creek (20°36′26″S, 118°09′23″E); WAM R163224, collected at Cape Lambert (20°37′17″S, 117°09′06″E).

Diagnosis. A moderately robust, medium-sized *Diporiphora*, with gular and scapular folds, post-auricular fold weak, no crests on the forebody, homogeneous dorsal scales with keels parallel to midline, 2–4 precloacal pores, no femoral pores, 63 or more mid-body scale rows, ≤28 fourth toe lamellae, and with pale yellow dorsolateral stripes. Further distinguished from *D. valens* by smaller body size, less robust habitus, scalation less spiny, slightly longer limbs and tail, lighter background color, fewer dark crossbands and medial marking on gular region usually absent.

Description of holotype. A medium-sized (62.5 mm SVL) dragon with moderately robust habitus; body oval in cross-section with flat venter; head stout with short angular snout; from above, sides of snout slightly convex with rounded tip; head widest behind eyes (HW%SVL: 17); neck constricted to ¾ maximum head width, skin on neck loose; gular fold moderately developed with gradual curve (medial portion posterior), post-auricular fold weak, and scapular fold strong; limbs moderately slender, arms moderately long, legs long; digits long and slender; finger length: 4>3>2>5>1; toe length: 4>3>5>2>1; canthus well defined; nasal scale below canthal ridge, nare at anterior of nasal. Tail very long and slender (TailL%SVL: 214), flexible; tapering gradually to fine tip.

FIGURE 9. *Diporiphora vescus* **sp. nov.** in life. Left—gravid female (R. Lloyd); right—male (J. Vos).

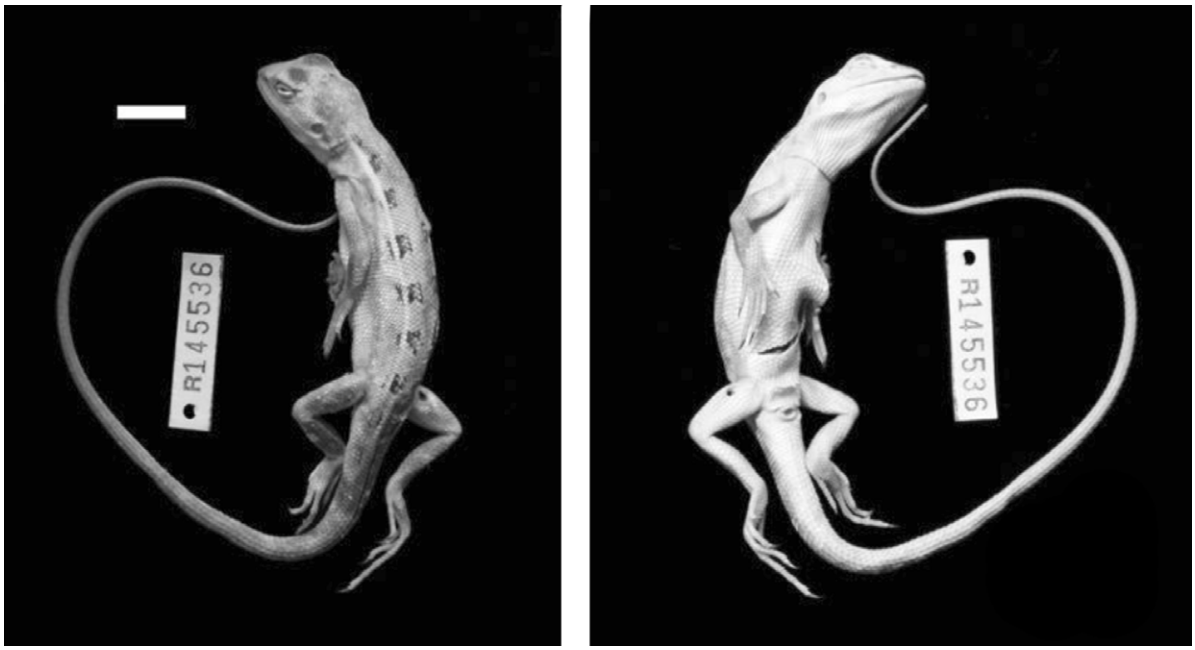

FIGURE 10. Holotype of *Diporiphora vescus* **sp. nov.** in dorsal and ventral views.

Supralabials 11, infralabials 11; tympanum nearly circular; scales on dorsolateral stripe on neck and above arms slightly enlarged and raised from surrounding scales; temporal scales enlarged from eye to anterior edge of tympanum; rows of low triangular teeth; upper canines 2; lower canines 2; scales above supralabials angle back from jaw for 2–3 scale rows (uppermost row comprised of minute scales), above a row of longitudinally-oriented scales with low keels beginning at nasal and ending just posterior to eye; snout and anterior top of head with distinct keels terminating in usually 1 or 2 perforations on posterior edge and aligned horizontally, following contours of snout and eye socket; on posterior top of head scales are more rugose with direction of keels more scattered.

Dorsal scales homogeneous, imbricate, diamond-shaped with low slightly raised keels terminating at or just past the posterior edge of scale with small spine; upper keels on dorsum parallel throughout; keels of upper lateral scales directed dorsally; scales on gular region smooth to feebly keeled anteriorly, then increasing to weakly keeled towards gular fold; ventral scales with low keels and short spine projecting just past posterior edge of scale; dorsal, lateral, and ventral scale size similar; 4 precloacal pores.

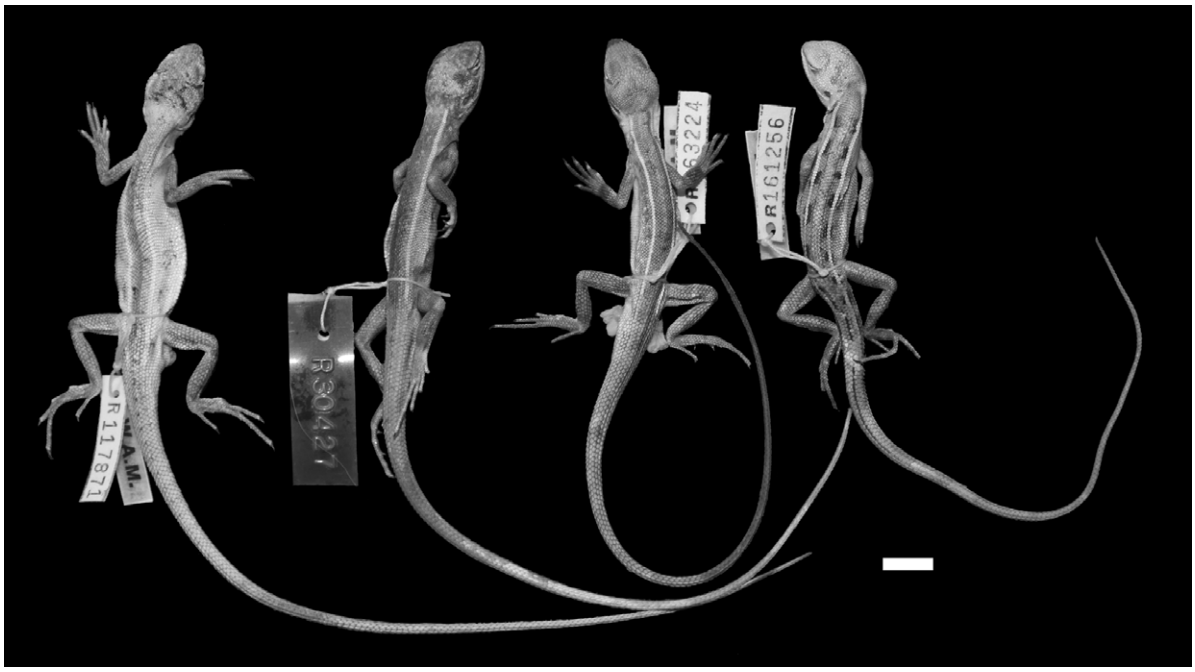

FIGURE 11. Variation in *Diporiphora vescus* sp. nov.

In preservative, background color light brown; dorsal pattern complex; feint pale silver vertebral stripe ~3 scales wide; pale white dorsolateral stripe ~2 scales wide; in paravertebral zone (between vertebral and dorsolateral stripes) 6 dark brown cross-bands (3–6 scales long), extending from 0–3 scales below dorsolateral stripe; dark markings interrupted regularly by 5–6 scales; dorsolateral stripes fading to background color above pelvis; lateral zone pale with feint bluish-grey variegations, lower lateral surfaces blending to ventrum shade; head light brown; dorsolateral stripe begins on anterior portion of neck; labials and eyelids pale white. Ventrum pale white.

Variation. Tables 2 and 3 present variation in morphological characters within *D. vescus* **sp. nov.** Males and females did not differ conspicuously in pattern or tendency to have the plain or complex dorsal patterns. Juveniles had more vivid markings.

Habitat. Specimens have been collected on sandy and clayey alluvial and colluvial surfaces, and on coastal sand dunes. Two individuals were initially detected perched on fence posts.

Distribution. Confined to the northern Pilbara region of Western Australia (Fig. 3), including the Chichester and Roebourne subregions.

Etymology. The specific name *vescus* is Latin for weak, poor, thin, or little, in reference to the more gracile build and less spiny scalation relative to *D. valens*. Used as a noun in apposition.

Remarks. *Diporiphora vescus* **sp. nov.** occurs in the northern Pilbara, and is allopatric to *D. valens*. The occurrence of the northern coastal population is somewhat unusual given the presence of the other two species also occurring on the coastal sands of this region: *D. pindan* and *D. paraconvergens* **sp. nov.** The presence of three species from this region has confused previous workers and is not limited to *Diporiphora*, as recent revisions of other groups have found arid-adapted taxa here, including new species, that enter from the Great Sandy Desert and the Dampierland extension along the coast (Mecke *et al.* 2009; Catullo *et al.* 2011). The separation of the two *Diporiphora* species on the Pilbara craton by the Fortescue River mirrors several other recent studies on reptiles, and likely indicates a barrier to movement that can lead to speciation within the region (Doughty *et al.* 2010, 2011a, 2011b, unpublished data).

TABLE 3. Summary of meristic (mm) and mensural data for the type series of *Diporiphora vescus* **sp. nov.** All specimens are from WAM and measurements in mm.

Character:	R145536 Holotype	R30427 Paratype	R117871 Paratype	R161256 Paratype	R163224 Paratype
Sex	Male	Male	Male	Male	Male
SVL	61.5	61.0	63.5	55.0	59.5
HeadL	16.1	15.9	17.6	15.3	16.4
HeadW	10.2	10.2	10.4	9.4	10.0
HeadD	8.1	8.6	8.4	7.4	7.5
SupLab	11	11	9.5	8	10
InfLab	11	11	9	8.5	9
MBSR	64.5	65	59	57	58
LegL	31	30.5	32	29.5	30.5
4TLam	23	27	24	23	24
PCP	4	4	4	4	4
TailL	146	157	173	137	152

The range of *D. vescus* **sp. nov.** is restricted, with populations occurring in the Chichester subregion and the coastal Roebourne subregions within the Pilbara. They are not commonly encountered, but no effort has been made to estimate population size or trends. We suggest the conservation of this species is listed as 'data deficient'.

Diporiphora winneckei Lucas & Frost, 1896

Cane Grass Dragon
Figs. 2e, 12, 13

Lectotype. NMV D10156, an adult male from Charlotte Waters, Northern Territory, Australia, collected on the Horn Expedition to central Australia; lectotype designation by Coventry (1970).

Paralectotype. NMV D10155, an adult female, collection details as above; paralectotype designation by Coventry (1970).

Diagnosis. A slender, medium-sized *Diporiphora*, with weak gular and post-auricular folds, strong scapular fold, no crests on the forebody, homogeneous dorsal scales with keels converging towards midline, upper lateral scales conspicuously reduced in size relative to surrounding scales, no precloacal or femoral pores, and gular region with wide medial dark marking.

Description. A small, slender and elongate dragon; body round in cross-section with flat venter; head small with short angular snout; from above, sides of snout slightly convex with rounded tip; head widest behind eyes (HW%SVL: 15–19); neck constricted to 2/3 maximum head width; gular fold present and weak (1–3 rows of smaller scales present, but fold not usually overhanging other scales), post-auricular and scapular folds absent; limbs slender, arms moderately long, legs long; digits long and slender; finger length: 4>3>2>5>1; toe length: 4>3>5>2>1; canthus well defined; nasal scale below canthal ridge, nare at anterior of nasal. Tail long and slender (TL%SVL: 244–266), flexible; tapering gradually to fine tip.

Supralabials 10–12 (avg. 10.4), infralabials 9–12 (avg. 10.0); tympanum circular; 1–3 low stout post-auricular spines often present; scales below temporal stripe only slightly enlarged from eye to anterior edge of tympanum; rows of low triangular teeth; upper canines 2; lower canines 2; scales above supralabials angle back from jaw for 1–3 scale rows (uppermost row comprised of minute scales), above a row of slightly raised larger longitudinally-oriented scales (without keels) beginning at nasal and ending just posterior to midpoint of eye; scales on snout and top of head only weakly keeled.

Dorsals homogeneous, imbricate, diamond-shaped with low keels terminating posteriorly with small perforation; keels on dorsum converging slightly towards midline; upper lateral scales much smaller and smoother; lower lateral scales enlarged and with keels directed slightly dorsally; gulars smooth; dorsal and ventral scales similar in size; precloacal and femoral pores absent.

FIGURE 12. *Diporiphora winneckei* in life (S. Wilson).

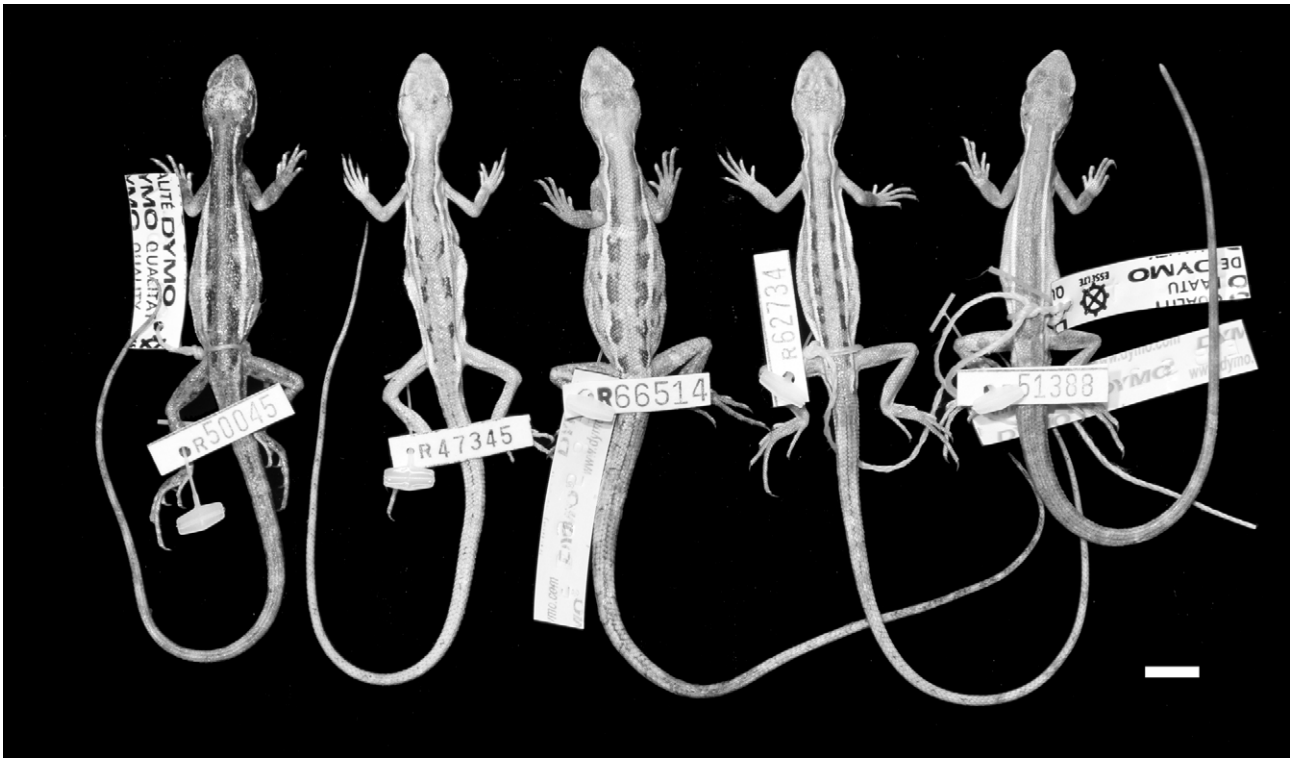

FIGURE 13. Variation in *Diporiphora winneckei*.

Background color light brown; pale silver vertebral stripe 4–6 scales wide; prominent pale yellowish-white dorsolateral stripe ~2 scales wide; 6–8 dark brown longitudinal markings (6–10 scales long) medial to dorsolateral stripe, interrupted regularly by 3–10 scales of background color; dorsolateral stripes continuing posteriorly along tail or fading near hindlimbs; narrow pale gray lateral stripe, terminating ~1 cm anterior to arm and posterior to insertion of leg; between lateral and ventral stripes a grayish-brown pigmented zone transitioning to pale ventral color; head light brown; prominent short pale temporal stripe with dark brown border, beginning at posterior of eye and fading half-way to tympanum; labials and eyelids pale white; labial stripe continuing to anterior portion of neck. Ventrum pale white; a medial brownish-gray stripe on gular region from near tip of snout, then widening and separating on venter, converging anterior to hindlimbs, continuing on tail or fading; below infralabials a dark stripe continuous with silvery-gray coloration on sides of neck.

Variation. Table 2 presents variation in morphological characters within *D. winneckei*. Breeding males have reddish coloration on the flanks, and females can have a dull yellow wash to the ventral surfaces.

Habitat. Observed on Canegrass (*Zygochloa paradoxa*) on sandridges (Houston & Hutchinson 1998).

Distribution. Eastern arid zone, occurring in south-eastern Queensland, north-eastern South Australia and the south-eastern Northern Territory (Fig. 3).

Etymology. Named after Charles Winnecke, leader of the Horn Expedition to central Australia in the late 1800s when the syntype series was collected.

Remarks. The clarification of the morphological limits of *D. winneckei* s.s. has helped to identify the two new taxa in the western arid zone (see below), and helps to further resolve Houston's (1977) treatment of variation within this taxon. The two type specimens were collected over 100 years ago from near the extreme western edge of this species' distribution near the center of the Australian arid zone. This perhaps influenced workers to conservatively refer specimens throughout the arid zone to this taxon in the absence of a regionally comprehensive review.

***Diporiphora adductus* sp. nov.**

Carnarvon Dragon
Figs. 2e, 14–16

Holotype. WAM R141589, an adult male collected 2 km west of Bullara Homestead, Western Australia (22°40′23″S, 114°0′58″E), on 22 June 2000 by B. Bush and B. Maryan.

Paratypes. All from Western Australia. WAM R71582, collected 4 km north of Mia Mia High School (23°21′S, 114°26′E); WAM R129009, collected at Urala Station (21°45′18″S, 14°51′02″E); WAM R140984, collected at Urala Station (21°45′13″S, 114°51′08″E); WAM R157296, collected at Yanrey Station (22°09′51″S, 114°35′23″E).

Diagnosis. A slender, medium-sized *Diporiphora*, with no gular or post-auricular folds, scapular fold absent or very weak (small scales present but skin not folded over), homogeneous dorsal scales with keels parallel to midline, no femoral pores, 0–2 precloacal pores, 61 or fewer mid-body scale rows, ventral scales larger than dorsal scales, coloration not yellow-green, and lateral line with dark border present.

FIGURE 14. *Diporiphora adductus* **sp. nov.** in life, including view of gular region (M. Peterson).

FIGURE 15. Holotype of *Diporiphrora adductus* **sp. nov.**

Description of holotype. A slender and elongate dragon; body round in cross-section with flat venter; head small with short angular snout; from above, sides of snout slightly convex with rounded tip; head widest behind eyes (HW%SVL—14.3); neck constricted to ¾ maximum head width; gular, post-auricular, and scapular folds absent; limbs slender, arms moderately long, legs long; digits long and slender; finger length: 4>3>2>5>1; toe length: 4>3>5>2>1; canthus well defined; nasal scale below canthal ridge, nare at anterior of nasal. Tail very long (TailL%SVL—263) and slender, flexible; tapering gradually to fine tip.

Supralabials 10, infralabials 10; tympanum circular, bordered anteriorly by slightly enlarged scales parallel to edge; scales underlying temporal stripe slightly enlarged from eye to posterior edge of tympanum; rows of low triangular teeth; upper canines missing; lower canines 2; scales above supralabials angle back from jaw for 3 scale rows (uppermost row comprised of minute scales), above a row of slightly raised longitudinally-oriented scales beginning at nasal and ending just posterior to midpoint of eye; snout and anterior top of head with distinct keels terminating in 1 or 2 perforations on posterior edge and aligned horizontally, following contours of snout and eye socket; on posterior top of head scales are more rugose with direction of keels more scattered.

Dorsals homogeneous, imbricate, diamond-shaped with low keels terminating posteriorly with small perforation; upper keels on dorsum parallel throughout; upper lateral scales smaller with keels directed slightly dorsally; lower lateral scales enlarged with only weakly defined horizontal keels or smooth; gulars smooth; ventral scales ~1.5 x larger than dorsals; 2 precloacal pores; on edge of scale (right) or perforating posterior edge of scale (left).

Background color light brown; pale silver vertebral stripe ~3 scales wide; prominent pale yellowish-white dorsolateral stripe ~2 scales wide; dark brown longitudinal markings (4–6 scales long) to either side of dorsolateral stripe, interrupted regularly by 2–4 scales with background color; dorsolateral stripes continuing posteriorly along tail; narrow pale gray lateral stripe bordered by dark edge, terminating anterior to arm; posterior to past leg on to tail; between lateral and ventral stripes a grayish-brown pigmented zone; head light brown with dark pigmentation behind eyes on top of head; prominent pale temporal stripe with dark brown border, continuous with dorsolateral stripe with hiatus of dark border posterior to tympanum; labials and eyelids pale white. Ventrum pale white; a pair of brownish-gray stripes from near tip of snout, separating through gular region, then in close proximity on neck, then widening and separating on venter, converging at cloaca, continuing as medial stripe on tail for ~2 cm; below infralabials a dark stripe continuous with silvery-gray coloration on sides of neck.

Variation. Table 2 presents variation in morphological characters within *D. adductus* **sp. nov.**, and Table 4 presents the measurements for the types. No obvious differences were apparent in the patterning between males and females, but juveniles tended to have brighter, more contrasting patterns.

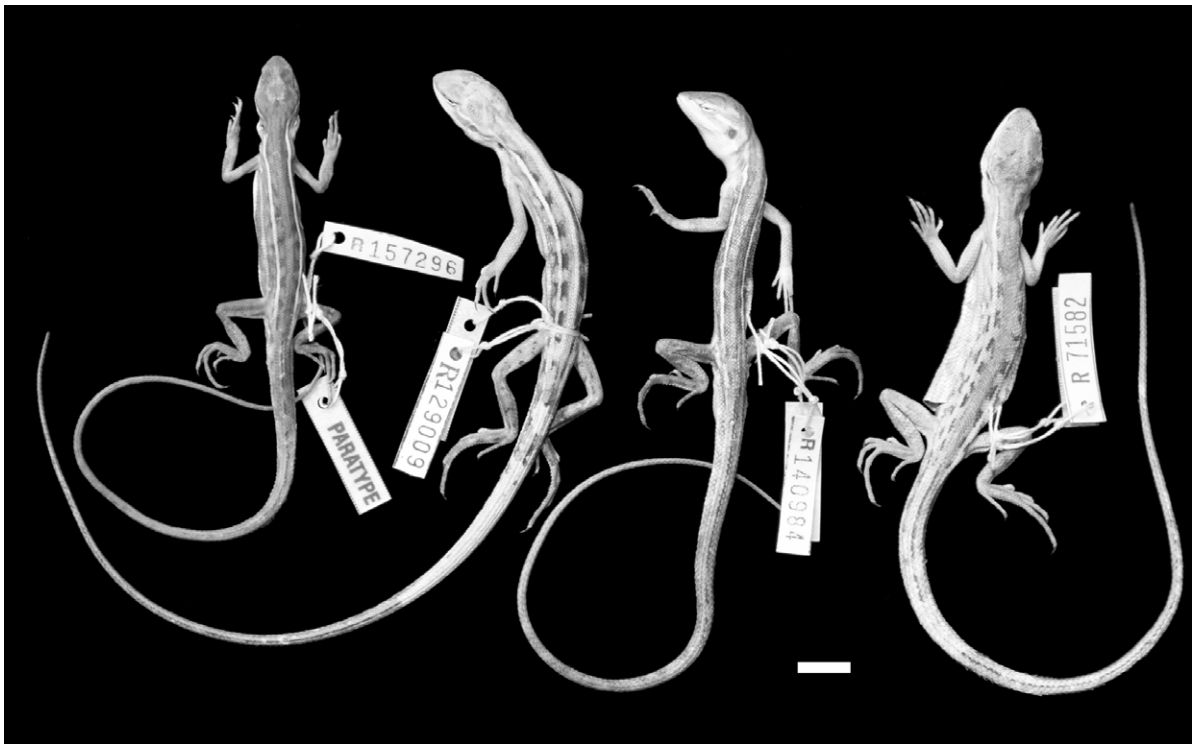

FIGURE 16. Variation in *Diporiphora adductus* sp. nov.

TABLE 4. Summary of meristic (mm) and mensural data for the type series of *Diporiphora adductus* **sp. nov.** All specimens are from WAM and measurements in mm.

Character:	R141589 Holotype	R71582 Paratype	R129009 Paratype	R140984 Paratype	R157296 Paratype
Sex	Male	Female	Female	Male	Female
SVL	55.5	67.5	63.0	59.5	50.5
HeadL	14.4	16.7	15.2	15.2	13.6
HeadW	8.8	9.8	8.7	8.4	7.8
HeadD	7.2	7.0	7.3	7.3	6.0
SupLab	10	10	12	10	10
InfLab	10	10	13	12	10
MBSR	57.5	61	56.5	56.5	59
4TLam	25.5	24.5	27.5	25	28.5
PCP	2	1.5	2	0	0
LegL	29.0	32.5	31.0	32.0	26.5
TaiL	146	163	159	170	150

Habitat. Occurs on low-lying Spinfex and *Acacia* and other low shrubs, usually on sand dunes or red sandy/loamy soils.

Distribution. Restricted to the northern portion of the Carnarvon Basin in Western Australia (Fig. 3).

Etymology. The specific name is modified from Greek and refers to the elongated body shape and also the lack of the folds traditionally used for *Diporiphora* taxonomy (gular, post-auricular, scapular). Used as a noun in apposition.

Remarks. The distribution of *D. adductus* **sp. nov.** conforms with few other lizard species from the area, except for a resemblance to *Ctenophorus ruber* Storr (Storr *et al.* 1983). The sandy western coast of Australia has

been subject to inundation in the past. These changes are believed to have caused increased speciation for lizards that prefer sandy substrates, such as *Aprasia* and several species-groups of *Lerista* (Storr *et al.* 1990; Smith & Adams 2007); and also sand-adapted frogs (Doughty & Edwards 2008).

Diporiphora paraconvergens sp. nov.

Grey-striped Western Desert Dragon
Figs. 2f, 17–19

Holotype. WAM R163948, an adult male collected 23 km north-east of Warrawagine Homestead, Pilbara Biodiversity Survey quadrat PHYE01 (20º41′54″S, 120º51′23″E), Western Australia, on 6 October 2006 by J.K. Rolfe, A.H. Burbidge and T. Rolfe.

Paratypes. All from Western Australia. WAM R63525, 2 km NNE of Murguga, Well 39, Canning Stock Route (21°46′S, 125°40′E); WAM R131073, collected at Kiwirrkurra (22°49′S, 127°45′E); WAM R133348 and WAM R133475, collected at Lake Mackay (22°26′47″S, 128°17′33″E); WAM R137921, collected at Telfer (21°43′38″S, 122°1′06″E); WAM R164250, collected at Mina Mina Clutterbuck Hills, Gibson Desert (24°31′02″S, 126°13′04″E).

Diagnosis. Distinguished from other *Diporiphora* (except *D. convergens* and *D. winneckei*) by possession of posterior dorsal scales with keels that converge towards midline. Further distinguished from *D. convergens* by possession of weak post-auricular fold and vertebral, dorsolateral, and lateral lines. Distinguished from *D. winneckei* by possession of two precloacal pores (vs. zero), no reduction of scale size on upper lateral region, longer tail, and thin dark markings to either side of midline of gular region (vs. thick medial marking).

Description of holotype. A slender and elongate dragon; body round in cross-section with flat venter; head small with short angular snout; from above, sides of snout slightly convex with rounded tip; head widest behind eyes (HW%SVL—17); neck constricted to ¾ maximum head width; gular fold present and weak, with medial portion extending posteriorly; post-auricular fold weak, scapular fold present; limbs slender, arms moderately long, legs long; digits long and slender; finger length: 4>3>2>5>1; toe length: 4>3>5>2>1; canthus well defined; nasal scale below canthal ridge, nare at anterior of nasal. Tail very long and slender (TL%SVL—314); flexible; tapering gradually to fine tip.

FIGURE 17. *Diporiphora paraconvergens* **sp. nov.** in life. Left—male (G. Gaikhorst); right—female (M. Peterson).

Supralabials 9, infralabials 9; tympanum circular, bordered anteriorly by slightly enlarged scales parallel to edge; scales below temporal stripe slightly enlarged from eye to posterior edge of tympanum; rows of low triangular teeth; upper canines 2; lower canines 2; scales above supralabials angle back from jaw for 2–3 scale rows (uppermost row comprised of tiny scales); snout and top of head with distinct keels, following contours of snout and eye socket.

Dorsals homogeneous, imbricate, diamond-shaped with low keels not extending past posterior edge of scale; keels on upper dorsum converging towards midline; upper lateral scales slightly smaller with low keels directed

dorsally; lower lateral scales slightly enlarged with low keels; gulars smooth; ventral scales ~1.5 x larger than dorsals; ventrals moderately keeled with spine projecting past posterior edge of scale; 2 precloacal pores, located on edge of scale.

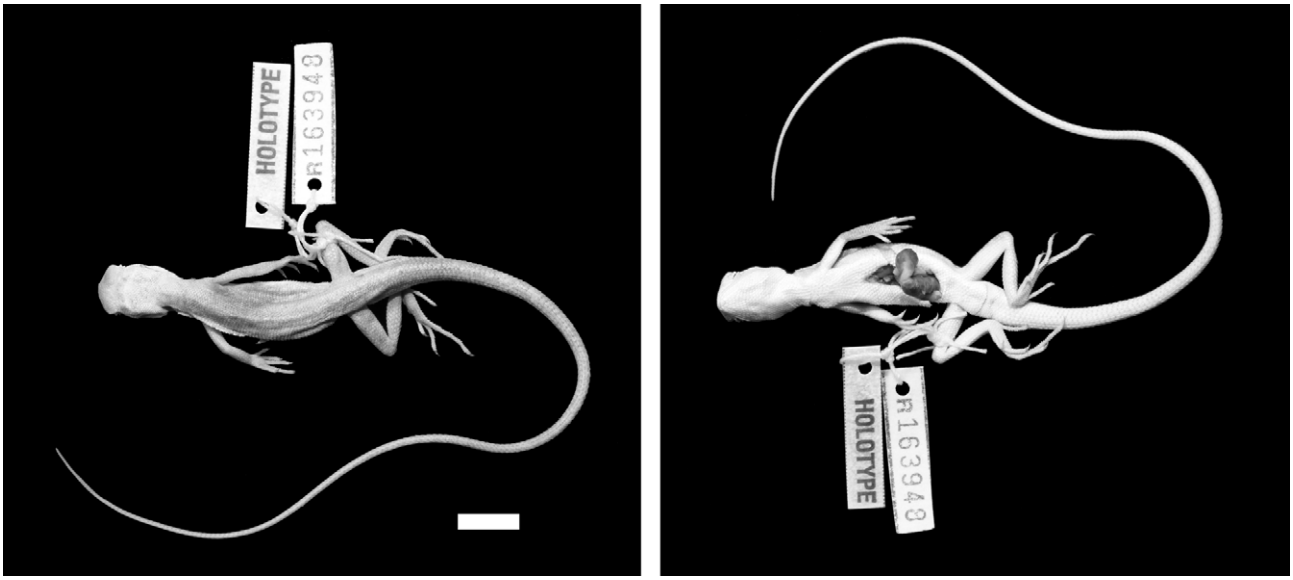

FIGURE 18. Holotype of *Diporiphora paraconvergens* **sp. nov.**

TABLE 5. Summary of meristic (mm) and mensural data for the type series of *Diporiphora paraconvergens* **sp. nov.** All specimens are from WAM and measurements in mm.

Character:	163948 Holotype	137921 Paratype	131073 Paratype	164250 Paratype	133348 Paratype	63525 Paratype	133475 Paratype
Sex	Male	Female	Male	Male	Male	Male	Male
SVL	47.5	55.0	41.5	50.0	50.5	52.5	58.5
HeadL	13.0	16.1	12.6	13.3	14.3	13.7	14.1
HeadW	8.0	9.2	6.9	8.4	8.2	7.8	8.1
HeadD	6.1	6.9	5.4	7.0	6.4	6.4	6.4
SupLab	9	10	9	11	10	10	11
InfLab	9	9	9	10	8	9	10.5
MBSR	61	61	63	64	63	62	60
4TLam	24	25	27	26	29	25	26
PCP	2	2	2	2	2	2	2
LegL	27.5	30.5	23.0	29.0	29.5	27.5	29.5
TailL	149	171	109	147	146	146	170

In life, background color a dull light red to pink hue; vertebral stripe very faint, ~3 scales wide; dorsolateral stripes gray, beginning on neck and continuing to tail, ~2 scales wide; narrow pale gray lateral stripe, terminating anterior to arm and continuing weakly posterior to leg on to side of tail; head dull yellow-brown; nuchal region with a yellow wash; pale white temporal stripe to anterior tympanum; labials and eyelids pale white. Ventrum pale white; a pair of wide brownish-gray stripes from near tip of snout, separating through gular region, then converging on neck, then widening and separating on venter, converging before insertion of hindlimbs, then widening as gray underside of tail; below infralabials a dark stripe to sides of neck.

In preservative, color is reduced to a dull pale gray, dorsolateral and lateral stripes barely discernible.

Variation. Table 2 presents variation in morphological characters within *D. paraconvergens* **sp. nov.**, and

Table 5 shows the measurements of the type series. Morphologically, males and females resembled one another, however, color pattern varied between a complex and plain pattern. The complex pattern involved stippling on the sides below the dorsolateral line, often extending along the sides of the tail. The plain pattern lacked the stippling; however, the dorsolateral and lateral lines are still discernible. Males tended to possess the plain pattern more often than females.

Males often had a salmon-pink wash over the body with a yellow head that is apparent in live photographs, but fades with time in preservative.

Habitat. Occurs primarily on sand dunes, perching on a variety of foliage including *Acacia*, *Grevillea*, and Spinifex.

Distribution. Known mainly from the Great Sandy Desert in Western Australia. Records from WAM from Western Australia include specimens collected in dunefields that abut the northern Pilbara, and extend east to Lake Mackay near the Western Australian-Northern Territory border and south to the north-western portion of the Great Victoria Desert. Also occurs in north-western South Australia, and probably the south-western arid portion of the Northern Territory.

Etymology. The specific name is in allusion to the similar orientation of the scales on the posterior of the dorsum in *D. paraconvergens* **sp. nov.**, *D. convergens* and *D. winneckei*.

Remarks. In this paper, the description of *D. paraconvergens* **sp. nov.** (along with *D. adductus* **sp. nov.**) resolves Houston's (1977) treatment of the *D. winneckei* species complex in the Australian arid zone. Houston (1977) described *D. linga* from the southern arid zone, and delineated the issues with *D. pindan* and *D. valens* that Storr (1979) described shortly thereafter based on a larger series of specimens available at WAM. Future work on arid zone *Diporiphora* is likely to reveal more hidden species owing to exploration of remote regions and detailed genetic screening for cryptic species (JM, unpublished data).

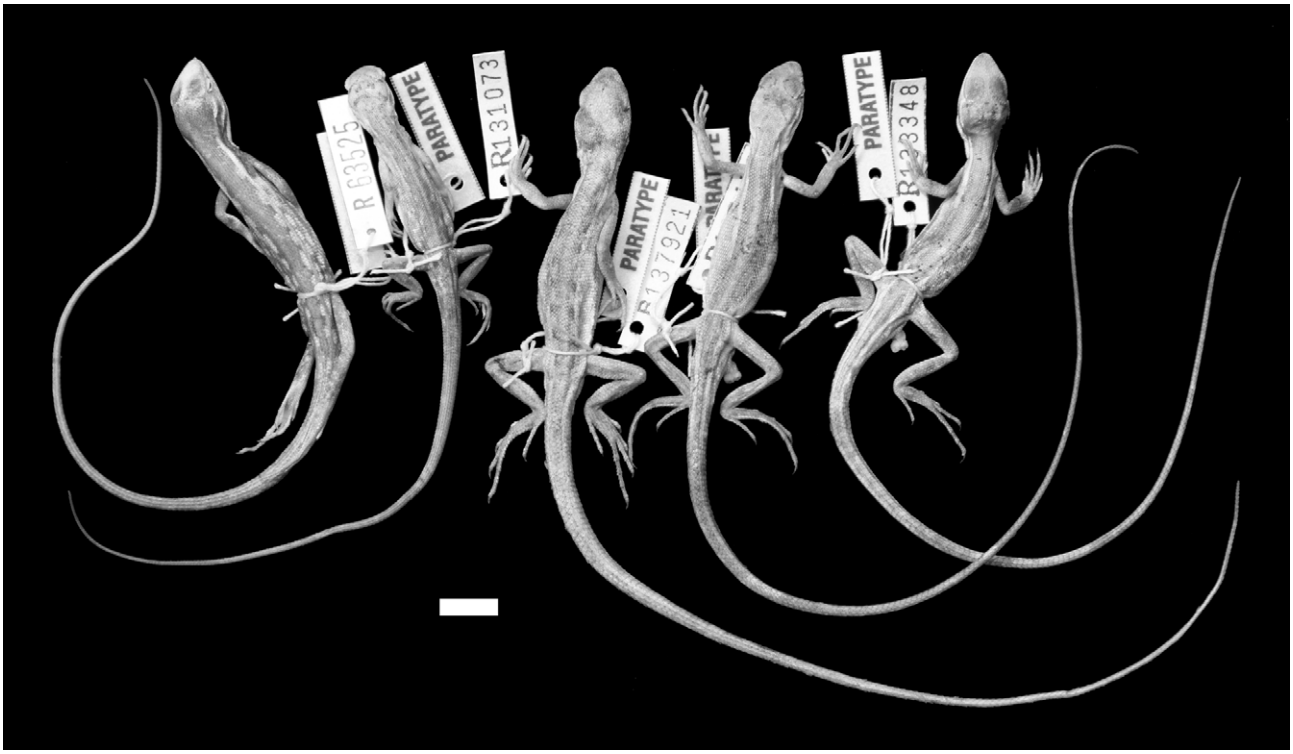

FIGURE 19. Variation in *Diporiphora paraconvergens* **sp. nov.**

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APPENDIX. Non-type material examined.

Diporiphora pindan (all specimens from Western Australia and in the collections of WAM)
R87057 (female), 7 km east of Sandfire Roadhouse (19°46′S, 121°10′E); R87064 (female), 6 km west-north-west of Fitzroy Crossing (18°11′S, 125°31′E); R112948 (female), Beagle Bay Aboriginal Community (17°03′35″S, 122°43′00″E); R112961 (female), Beagle Bay Aboriginal Community (17°04′23″S, 122°42′44″E); R139027 (male), Mandora (19°47′29″S, 121°26′54″E); R139047 (male), Moandora (19°48′30″S, 121°27′50″E); R161563 (female), 23 km north-east of Warrawagine Homestead (20º41′54″S, 120º51′23″E); R163225 (female), Cape Lambert (20°36′27″S, 117°09′40″E); R168482 (male), Coulomb Point (17°34′23″S, 122°10′09″E); R168484 (female), Coulomb Point (17°34′23″S, 122°10′09″E); R168523 (male), Coulomb Point (17°36′12″S, 122°11′30″E).

Diporiphora valens (all specimens from Western Australia and in the collections of WAM)
R69621 (female), 4 km west of Marandoo (22°38′S, 118°05′E); R69638 (female), 3 km west of Mount Bruce (22°36′S, 118°07′E); R102214 (female), 15 km east of Juna Downs Homestead (22°52′34″S, 118°40′10″E); R119930 (female), 3.5 km north-east of Mount Brockman (22°28′S, 117°18′E); R135252 (female), at Hope Downs (22°55′05″S, 118°38′40″E); R135383 (female), Mount Brockman (22°25′11″S, 117°25′48″E); R135399 (male), Mount Brockman (22°25′11″S, 117°25′48″E); R135463 (male), Mount Brockman Area (22°28′S, 117°18′E); R151637 (male), Coondewanna Flats (23°00′51″S, 118°52′29″E); R157705 (female), Packsaddle Range (22°56′27″S, 118°54′18″E).

Diporiphora vescus **sp. nov.** (all specimens from Western Australia and in the collections of WAM)
R30427 (male), 16 km south-west of Port Hedland (20°26′S, 118°33′E); R30431 (female), 16 km south-west of Port Hedland (20°26′S, 118°33′E); R117871 (male), 1 km north of Mundabullangana Homestead (20°30′09″S, 118°03′40″E); R145536 (male), 86Km South Port Hedland (21° 03` 36″S, 118° 45` 00″E); R161256 (male), 45Km north-east Whim Creek (20° 36` 26″S, 118° 09` 23″E); R163224 (male), Cape Lambert (20°37′17″S, 117°09′06″E); R163226 (male), at Cape Lambert (20°37′17″S, 117°09′06″E).

Diporiphora winneckei (all specimens from South Australia and in the collections of SAMA)
R45303 (female), 6 km west of Yeltacowie Racecourse Dam (31°21′S, 137°16′E); R47345 (female), 2.8 km west-south-west of Hermit Hill (29°35′43″S, 137°24′04″E); R49991 (male), 74.4 km south-west of Approdinna Attora Knolls, Rig road (26°34′36″S, 137°07′06″E); R50045 (female), 66.8 km east of Purni Bore, Rig road (26°19′28″S, 136°45′47″E); R51388 (male), 1.1 km south-south-east of Approdinna Attora Knolls (26°04′50″S, 137°36′43″E); R51415 (female), 13.1 km west-north-west of Approdinna Attora Knolls (26°02′48″S, 137°28′53″E); R54755 (male), 5 km east of Twilight Bore, Bollards Lagoon Station (28°59′45″S, 140°33′35″E); R62734 (female), 7.5 km east of Pernatty High School (31°28′01″S, 137°25′39″E); R65576 (male), R66514 (female), 17 km south-south-west of Witchelina High School (30°09′14″S, 137°56′12″E).

Diporiphora adductus **sp. nov.** (all specimens from Western Australia and in the collections of WAM)
R42939 (female), collected 13 km west of Barradale Crossing (22°54′S, 114°50′E); R61015 (male), collected 1 km north of Bullara High School (22°40′S, 114°02′E); R61179 (female), collected at Vlaming Head (21°48′S, 114°06′E); R61215 (female), collected at Vlaming Head (21°48′S, 114°06′E); R71582 (female), collected 4 km north of Mia Mia High School (23°21′S, 114°26′E); R73083 (male), collected at Old Onslow, 18 km south-west of Onslow (21°43′S, 114°57′E); R129009 (female), collected at Urala Station (21°45′18″S, 114°51′02″E); R140984 (male), collected at Urala Station (21°45′13″S, 114°51′08″E); R141589 (male), collected 2 km west of Bullara Homestead (22°40′20″S, 114°00′52″E); R157296 (female), collected at Yanrey Station (22°09′51″S, 114°35′23″E).

Diporiphora paraconvergens **sp. nov.** (all specimens from Western Australia and in the collections of WAM)
R63525 (male), 2 km from 36 Degree Murguga Well #39 Canning Stock Route (21°46′S, 125°40′E); R102709 (male), Little Sandy Desert (23°53′18″S, 120°31′18″E); R102751 (male), Little Sandy Desert (24°31′55″S, 120°17′28″E); R130449 (male), Lake Mackay (22°26′47″S, 128°17′33″E); R130933 (male), Lake Mackay (22°26′47″S, 128°17′33″E); R131073 (male), Kiwirrkurra (22°49′S, 127°45′E); R133348 (male), Lake Mackay (22°26′47″S, 128°17′33″E); R133475 (male), Lake Mackay (22°26′47″S, 128°17′33″E); R137921 (female), Telfer (21°43′38″S, 122°01′06″E); R145457 (male), Lorna Glen Station (26°17′05″S, 121°22′09″E); R157943 (male), Lake Disappointment (23°20′26″S, 122°36′44″E); R163948 (male), 23 km north-east of Warrawagine Homestead (20º41′54″S, 120º51′23″E); R163975 (male), 23 km north-east of Warrawagine Homestead (20º41′54″S, 120º51′23″E); R164250 (male), at Mina Mina Clutterbuck Hills Gibson Desert (24°31′02″S, 126°13′04″E).