



Article

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Description of two new *Carlia* species (Reptilia: Scincidae) from north-east Australia, elevation of *Carlia pectoralis inconnexa* Ingram & Covacevich 1989 to full species status, and redescription of *Carlia pectoralis* (de Vis 1884)

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Abstract

Scincid lizards belonging to the genus *Carlia* are found in eastern and northern Australia and in New Guinea and associated islands. These skinks are a particularly diverse component of the reptile fauna of north-east Australia. *Carlia pectoralis* (de Vis 1884) was formerly regarded as occurring over much of eastern Queensland, in north-east Australia. Here we show that it consists of four species: *Carlia pectoralis*, *Carlia decora* **sp. nov.**, *Carlia rubigo* **sp. nov.** and *Carlia inconnexa* Ingram & Covacevich 1989 (which was formerly described as a subspecies of *C. pectoralis*). Herein, we describe two new species, elevate *C. p. inconnexa* to full species status with a revised description, and redescribe *C. pectoralis sensu stricto*. The four species differ in aspects of scalation, morphology and colour pattern. *Carlia decora* **sp. nov.** occurs in vine thickets, rainforest margins and moist open forests in high rainfall coastal areas of mid-east and north-east Queensland. *Carlia rubigo* **sp. nov.** occurs in dry open forests of inland eastern Queensland and in some coastal areas of mid-eastern Queensland. *Carlia pectoralis* is distributed through open forests of south-east Queensland. *Carlia inconnexa* is restricted to rocky open forests on islands of ‘the Whitsundays’ off mid-eastern Queensland. The addition of these three species brings the number of Australian *Carlia* to 22 species, 17 of which are found in Queensland.

Key words: *Carlia decora*, *Carlia rubigo*, *Carlia inconnexa*, reptile, lizard, skink, Queensland, Whitsunday islands

Introduction

Carlia Gray 1845 is a diverse genus of skinks found in Australia, New Guinea and the Wallacea region of Southeast Asia. *Carlia* has at times also included members of the genus *Lygisaurus* de Vis 1884 (Cogger *et al.* 1983; Ingram & Covacevich 1988; Stuart-Fox *et al.* 2002) but genetic evidence does not support this generic assignment and *Lygisaurus* is currently recognised as a separate genus (Dolman & Hugall 2008). Genetic data also supports the recognition of *Liburnascincus* Wells & Wellington 1984, for several rock-adapted species formerly assigned to *Carlia* (Dolman & Hugall 2008). This leaves 39 currently recognised *Carlia* species: 19 in Australia, 1 in the Torres Strait between Australia and New Guinea, 13 in New Guinea, and 7 in Wallacea (Donnellan *et al.* 2009; Zug 2010). Only one species, *C. storri* Ingram & Covacevich 1989 is shared between these regions, occurring in north-east Australia and south-east New Guinea (Ingram & Covacevich 1989; Zug 2010). In Australia, *Carlia* spp. are restricted to eastern and northern parts of the country, with the highest diversity in the north-east (Ingram & Covacevich 1989; Couper *et al.* 2005; Donnellan *et al.* 2009; Wilson & Swan 2010). Ingram & Covacevich (1989) published a complete revision of Australian *Carlia*, describing two new species. Since then, an additional two species have been added, both resurrected from synonymy (Donnellan *et al.* 2009). Several other species that were described as *Carlia* during this period (Couper *et al.* 1994; Couper *et al.* 2005) were subsequently separated out with the resurrection of *Lygisaurus* (Dolman & Hugall 2008). Phylogenetic analyses of *Carlia* spp. support the status of all recognised species (Stuart-Fox *et al.* 2002; Dolman & Hugall 2008; Donnellan *et al.* 2009).

Ingram & Covacevich (1989) recognised two subspecies of *Carlia pectoralis*: *C. p. pectoralis* for mainland populations and *C. p. inconnexa* for populations on islands of ‘the Whitsundays’ off the coast of mid-east

Queensland. This was based on tricarinate versus bicarinate dorsal scales and the dorsal patterns of breeding males. Unusually broad ranges were noticeable in several of the scale counts presented by Ingram & Covacevich (1989) for *C. p. pectoralis* hinting that the mainland populations may be polytypic. However, *C. pectoralis* has not been assessed in detail since Ingram & Covacevich's 1989 revision. Based on extensive fieldwork over the last decade, we have become aware of significant differences in colour pattern, morphology and scalation in *Carlia pectoralis* across its range. Here we quantify this variation and conclude that four species are present: *Carlia pectoralis*, the formerly recognised subspecies *inconnexa*, and two new species. We describe the new species, elevate *inconnexa* to species status giving a more detailed description, and redescribe *C. pectoralis sensu stricto*. The four species are diagnosable on aspects of morphology, scalation and colour pattern. They are also supported by genetic data that is not presented herein, representing monophyletic lineages that differ by over 10% from each other for protein-coding mtDNA (C. Hoskin, unpublished data).

Materials and methods

Specimens examined are held in the Queensland Museum (QMJ numbers) or the Australian Museum (R numbers). All measurements were taken using Mitutoyo electronic callipers and rounded to the nearest 0.1 mm. The following scale traits were counted: keels on the dorsal scales of the midbody; midbody scale rows; paravertebral scales, counted from the posterior margin of the hindlimb to the posterior edge of the parietal scales; supralabials; infralabials; supraciliaries; lamellae under the 4th toe, from claw sheath to junction of 3rd and 4th toes; lamellae under the 3rd finger, from claw sheath to the junction of the 2nd and 3rd fingers. The following scale traits were also scored: shape and contacts of the upper preocular scale (variation in this character was also assessed for multiple *Carlia* spp. and representatives of the closely related genera *Lygisaurus* and *Liburnascincus*—see Appendix for details); size of the palpebral disc; size of ear opening relative to size of palpebral disc; shape and orientation of the ear opening; number of ear lobules and their shape; degree of separation between the nasals; degree of separation between the prefrontals. Scales were generally counted/scored on the left side of the specimen. The following measurements were taken: snout to vent length (SVL); length of original tail (original versus regenerated tail determined by eye); interlimb distance, measured from axilla to groin; hindlimb length, from insertion to tip of longest digit, with limb stretched straight perpendicular to body (HLL); tibia length, measured from knee to heel with hindlimb compressed against body (TL); head width (HW), measured just anterior to the tympana at widest point of the head; head length (HL), from anterior edge of tympanum to snout. The following colour pattern traits were scored: the extent of the white mid-lateral line along flanks (females); evidence of a dorso-lateral pale line (females); position and extent of orange on flanks (males); colour of throat, neck and head; degree and extent of black edging to scales of throat, neck and head (males); colour of ventral and dorsal surfaces; degree of spotting or blotching on dorsal and lateral surfaces. The sex of adult specimens was determined by colour pattern—females lack breeding colours and have a white mid-lateral stripe from the nare to at least the forearm, whereas mature males lack the white stripe and show some indication of breeding colours and markings on the flanks, neck, throat and head.

Systematics

The skinks discussed herein can readily be assigned to *Carlia* Gray 1845 by the following character states: limbs well-developed with manus reduced to four digits; lower eyelid with a transparent palpebral disc; supranasal scales absent; rostral–frontonasal suture as wide as, or wider than the frontal; frontoparietal scales fused; interparietal small and distinct; ear-opening with enlarged lobules; dorsal body scales strongly keeled; males with conspicuous breeding colours on flanks (Ingram & Covacevich 1989; Cogger 2000; Dolman and Hugall 2008; Wilson and Swan 2008). Other ‘*Carlia* group’ genera (Dolman and Hugall 2008), *Liburnascincus* Wells and Wellington 1984 and *Lygisaurus* de Vis 1884, can be excluded from further consideration. *Liburnascincus* spp. have dorsoventrally flattened bodies, long sprawling limbs and the males lack breeding colours, whilst *Lygisaurus* spp. have smooth to weakly striate dorsal scalation.

***Carlia decora* sp. nov.**

Elegant Rainbow Skink

(Figs 1A & B, 2A, 3A, 4A, 5A, 6A, 7A, 8A, 9A, 10A–C.)

Holotype. QMJ90875, female, Alligator Ck, Mt Elliot, Bowling Green Bay National Park (19°26'07"S, 146°56'48"E, 50 m), north-east Queensland, C. J. Hoskin, 6 October 2011.

Paratypes. J42498-500 Townsville Common (19°16'S, 146°49'E); QMJ90878-79 Riverside Gardens, Townsville (19°19'14"S, 146°44'30"E); J48391 Townsville, James Cook University Campus (19°20'S, 146°46'E); QMJ90876-77 Alligator Ck, Mt Elliot (19°25'54"S, 146°56'37"E); J86515 Deadman's Creek, Proserpine (20°30'14"S, 148°33'23"E); J86516 Deadman's Ck, Proserpine (20°30'15"S, 148°33'22"E); J86449 Deadman's Creek, Proserpine (20°30'6"S, 148°33' 21"E); J63912 Cathu SF, Horse Ck (20°48' 51"S, 148°34'11"E); J74809 Brampton Is (20°49'S, 149°17'E); J74805 Cape Hillsborough NP (20°54'30"S, 149°00'30"E); J74807, J74812 Cape Hillsborough NP (20°55'30"S, 149°02' 30"E); J53395 Boulder Ck, campsite, via Mt Charlton (21°01'S, 148°43'E); J81405 East Point, Mackay (21°09'S, 149°13'E).

Additional material. J79829 Curacoa Island (18°40'S, 146°33'E); J42502, J42504 Bluewater, ca. 20 km N Townsville (19°11'30"S 146°33'30"E); J79565 Pallarenda (19°12'S, 146°46'E); J42497 Townsville (19°16'S, 146°49'E); J79270, J79297-98, J79375 Townsville Common (19°16'S, 146°49'E); J48393 Townsville, James Cook University Campus (19°20'S, 146°46'E); J89137 Whitehaven Whitsunday Is (20°17'47"S, 149°3'13"E); J86754 Mount Macartney, Eungella (20°47'58.4"S 148°32'31.2"E); J79888-89 Cape Hillsborough NP, Smalley's Beach (20°54'S, 149°00'E); J74806, J74808 Cape Hillsborough NP (20°55'30"S, 149°02'30"E); J53396 Boulder Ck, campsite, via Mt Charlton (21°01'S, 148°43'E); J59968 Walkerston, 3 km W of the Peak Downs Hwy (21°13'S, 149°0'30"E); J60072-73 Sarina Beach, 9 km E of Sarina (21°23' 10"S, 149°18'30"E).

Diagnosis. A moderate-sized *Carlia* (max SVL 49 mm) that can be distinguished from all its congeners by a combined suite of characters. Interparietal scale free. Dorsal scales tricarinate and hexagonally-shaped. Palpebral disc large. Ear aperture vertically elliptic (usually angled back) with a single large, rounded lobule on the anterior margin (Fig. 8A). Supraciliaries usually five. Prefrontals usually moderately separated (Fig. 9A). Upper preocular usually well developed and contacting posterior edge of 2nd loreal scale (if not contacting loreal, then broadly triangular in shape) (Figs. 10A–C). Breeding male with a pale blue throat and distinct orange upper lateral stripe that extends from forelimb to hindlimb; sometimes a less distinct orange lower lateral stripe is also present; black speckling present on neck and jawline but usually no, or limited, black-edging to scales on throat (Figs 1A, 2A, 4A, 5A). Adult female with a distinct, black-edged, white mid-lateral stripe that always extends to the groin (Figs 1B, 6A, 7A). Both sexes with an immaculate white or cream ventral surface.

Etymology. From the Latin *decora* (feminine), meaning 'beautiful'. In recognition of the beautiful form and colour pattern of this species. The species epithet is treated as a noun in apposition.

Description of holotype (Fig. 7A). QMJ90875, female. Measurements (mm): SVL 38.2; tail 71.6; interlimb 19.2; HLL 18.9; TL 5.9; HW 6.0; HL 8.6. Scalation: Dorsal scale keels 3; midbody scale rows 30; paravertebrals 47; supralabials 7; infralabials 6; supraciliaries 5, subdigital lamellae (4th toe) 24; subdigital lamellae (3rd finger) 19. Upper preocular in contact with posterior edge of 2nd loreal scale; palpebral disc large; ear smaller than palpebral disc, vertically elliptic with one large rounded lobule on anterior margin; postsupralabial divided; nasals widely spaced; prefrontals moderately spaced.

Colour pattern of holotype in preservative. Dorsum brown; top of head tawny brown. Indistinct, silvery dorso-lateral line, most prominent at the shoulders. Distinct, white mid-lateral line, bordered above and below by a thin black edging. Tawny brown upper flanks between mid-lateral and dorso-lateral lines. Lower flanks smudged greyish, merging to white belly. Ventral surfaces immaculate white. Tail brown with irregular fine black markings. Prominent white spot at posterior base of hindleg. Legs brown with dark mottling. Fine white line from nare, under eye, through tympanum, and continuous with mid-lateral line.

Description of type series. Body robust with keeled dorsal scales. Head barely distinct from neck. Snout rounded in profile. Limbs moderate; four fingers; five toes. Adult measurements and proportions: see Table 1. Scalation: Rostral in broad contact with frontonasal. Postsupralabial divided. Nasals widely spaced. Prefrontals large and usually in moderate separation (moderate separation 74%, narrow separation 26%) (Fig. 9A). Supraoculars 4; 1 and 2 in contact with frontal; 2, 3 and 4 in contact with frontoparietal. Frontoparietals fused, forming a single shield. Interparietal distinct. Enlarged nuchal scales 2. Loreals 2. Preoculars 2. Presubocular

single. Supraciliaries 5 (very rarely 6 or 7). Upper preocular well developed and contacting posterior edge of 2nd loreal scale (66%) or, if not contacting loreal, then broadly triangular in shape (33%) (Fig. 10A–C). Lower eyelid movable, with clear window; palpebral disc large, occupying more than half of lower eyelid. Ear aperture smaller than palpebral disc; usually vertically elliptical (68%) but sometimes rounded (32%); with 1 large rounded lobule on anterior margin (Fig. 8A). Supralabials 7, with the fifth positioned below the eye. Infralabials 6. Three scales between the nasal scale and the presubocular. Midbody scale rows 26–30 (mean = 29); dorsal scales with tricarinate keels. Paravertebral scale rows 46–50 (mean = 47). Subdigital lamellae under 3rd finger 17–22 (mean = 20). Subdigital lamellae under 4th toe 22–31 (mean = 27).

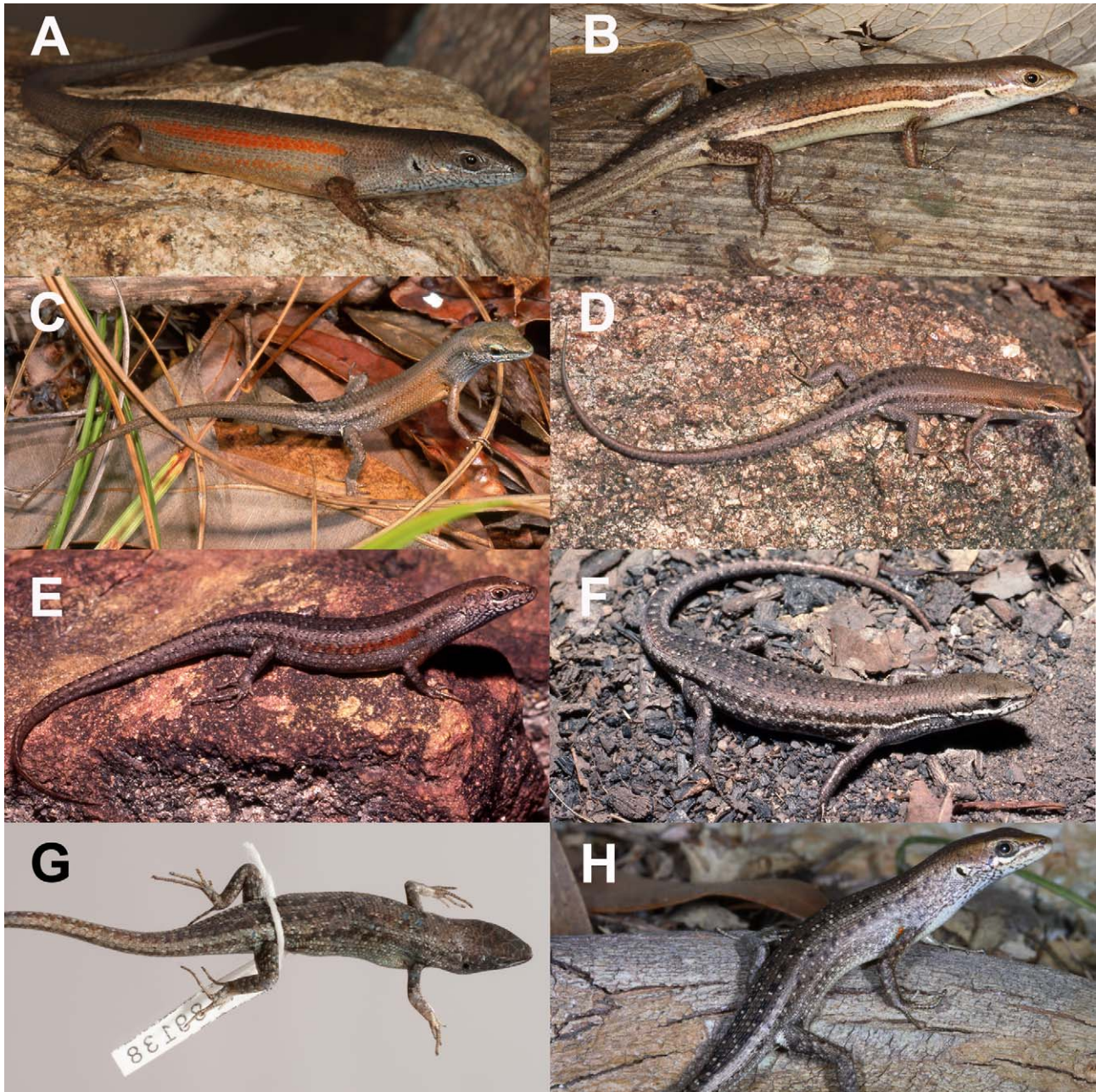


FIGURE 1. Photos of: (A) *C. decora* **sp. nov.**, male, Pallarenda; (B) *C. decora* **sp. nov.**, female, Townsville; (C) *C. rubigo* **sp. nov.**, male, Magnetic Island; (D) *C. rubigo* **sp. nov.**, female, Magnetic Island; (E) *C. pectoralis*, male, Murgon area; (F) *C. pectoralis*, female, Carnarvon Range; (G) *C. inconnexa*, QMJ89138, male, Whitsunday Island; (H) *C. inconnexa*, female, Whitsunday Island. No photo in life is available for a male *C. inconnexa*. The photo in (G) was flipped to match the orientation of the other panels. Photo credits: Conrad Hoskin (A, B), Steve Wilson (C–F, H), Jeff Wright (G).

TABLE 1. Morphology and diagnostic scale and pattern traits. Morphology is shown as mean (range). Measurements are in mm. Sample sizes for the majority of traits are listed after the species names. Original tail length was measured on fewer specimens (14, 11, 9 and 4, respectively). Upper preocular shape, ear lobe number, ear lobe shape and prefrontal spacing were scored on a larger number of specimens (42, 50, 38 and 15, respectively). Scale states and colour pattern represent the typical condition for each species (i.e. most common state in specimens examined). See descriptions for details of variation. F = female; M = male.

Trait	<i>C. decora</i> sp. nov. (N = 23)	<i>C. rubigo</i> sp. nov. (N = 21)	<i>C. pectoralis</i> (N = 21)	<i>C. incomixa</i> (N = 9)
Snout-vent length (SVL)	44.2 (38.2–48.6)	40.0 (33.9–44.2)	42.8 (37.3–47.0)	49.7 (46.6–52.4)
Original tail length	75.1 (64.1–89.6)	64.0 (56.3–73.6)	61.9 (53.5–68.4)	90.0 (82.0–103.2)
Interlimb length	22.6 (19.2–25.7)	19.1 (16.3–22.7)	19.7 (16.8–22.1)	23.2 (20.8–24.4)
Hindlimb length (HLL)	21.4 (18.9–23.2)	20.3 (18.9–21.8)	21.1 (19.6–23.6)	24.9 (20.2–27.2)
Tibia length (TL)	6.7 (5.9–7.4)	6.3 (5.5–7.0)	6.6 (5.2–7.6)	7.9 (7.2–8.6)
Head width (HW)	6.7 (6.0–7.8)	6.4 (5.7–7.2)	7.2 (6.0–8.3)	7.7 (7.1–8.6)
Head length (HL)	9.6 (8.6–10.9)	9.1 (7.8–10.0)	10.2 (8.7–11.1)	11.0 (10.1–12.3)
Tail/SVL	1.71 (1.35–2.12)	1.60 (1.39–1.91)	1.46 (1.19–1.54)	1.88 (1.68–2.22)
Interlimb/SVL	0.51 (0.48–0.55)	0.48 (0.43–0.53)	0.46 (0.42–0.53)	0.47 (0.45–0.50)
HLL/SVL	0.50 (0.47–0.55)	0.50 (0.46–0.57)	0.49 (0.46–0.54)	0.51 (0.45–0.58)
TL/SVL	0.15 (0.14–0.18)	0.16 (0.15–0.17)	0.15 (0.14–0.17)	0.16 (0.15–0.18)
HW/SVL	0.15 (0.14–0.17)	0.16 (0.14–0.18)	0.17 (0.15–0.19)	0.16 (0.15–0.17)
HL/SVL	0.22 (0.20–0.24)	0.23 (0.20–0.25)	0.24 (0.22–0.26)	0.22 (0.21–0.24)
HW/HL	0.71 (0.67–0.76)	0.70 (0.64–0.74)	0.71 (0.65–0.77)	0.70 (0.69–0.72)
Keels on mid-dorsal scales	3	3	3	2
Midbody scale rows	29 (26–30)	31 (30–32)	31 (28–32)	34 (32–34)
Paravertebral scales	47 (46–50)	47 (45–48)	47 (45–50)	51 (49–53)
Subdigital lamellae 4 th toe	27 (22–31)	27 (23–29)	25 (23–28)	29 (27–31)
Subdig. lamellae 3rd finger	20 (17–22)	19 (17–21)	19 (18–21)	22 (21–23)
Upper preocular shape	Broad triangular wedge	Narrow vertical sliver	Narrow vertical sliver	Narrow vertical sliver
Ear orientation	Elliptical, vertical	Elliptical, vertical	Round	Elliptical, vertical
Ear lobules	1, large, anterior	1 anterior or on all margins	On all margins	1–2, anterior
Ear lobe shape	Rounded	Low, rounded	Rounded-pointed	Rounded
Prefrontal spacing	Moderate	Narrow	Very narrow	Very narrow
White mid-lateral line (F)	Bold, to groin	To midbody, then speckled	To midbody, then speckled	Mottled, ragged
Orange on flanks (M)	Thin upper lateral line, weak lower lateral line	Extensive, diffuse	Upper lateral line, weak-mod. lower lateral line/chest	Faint wash
Throat & neck (M)	Pale or light blue, black flecking	Pale or light blue, black flecking	Blue, heavy black scalloping	Black
Ventral colour	White	Cream-grey	Cream-grey	Cream-grey

Colour pattern in preservative. Males (Figs 3A, 4A, 5A): Dorsal surfaces brown, with paired paravertebral dark markings (and occasionally white flecks) present on some individuals, particularly on the posterior half of the body and tail. Iridescent sheen to scales. Top of head generally lighter brown; often with fine black dots. Flank light brown with a thin orange upper lateral line from above forelimb to above hindlimb; sometimes a faint orange lower lateral line. Ventral surfaces immaculate white, cream or creamy yellow. Throat, neck and jawline blue or white. Throat generally unmarked but sometimes with grey or black flecking or fine edging to scales; occasionally grey or dark smudging. Neck and jawline generally marked with fine dark flecks or dark scale edging. Limbs brown on top, pale below. Prominent white spot at posterior base of hindleg. Females (Figs 6A, 7A): Dorsal surfaces brown, with paired paravertebral dark markings and white flecks present on some individuals. Iridescent sheen to scales of some individuals. Top of head generally lighter brown; often with fine black dots. Bold, white mid-lateral line, edged with black, always extends full length of flank to groin. Sometimes also a faint, silvery dorso-lateral line, particularly evident at shoulders. Upper flanks coppery, bronze or tawny. Lower flanks coppery or brown and merging with pale underside. White line from nare, under eye, through tympanum, and continuous with white mid-lateral line. Ventral surfaces immaculate white, cream or grey. Limbs brown on top, pale below. Prominent white spot at posterior base of hindleg.

Colour pattern in life (Figs 1A, 1B, 2A). Dorsum of both sexes brown with paravertebral row of black and pale dots, generally becoming more distinct posteriorly. Ventral surfaces immaculate white or cream. Breeding males with uniform pale blue or white throats and fine dark speckling along edge of jawline. A sharply defined orange or red upper lateral stripe encompasses two scale rows and extends from just in front of the forelimb to groin. At maximum breeding extent a ragged, orange lower lateral line is also present, the throat can be sky blue, and grey speckling on the neck and throat can be quite pronounced in some individuals. Occasionally, fine grey or black edging is present on scales of the throat. Adult females have a white mid-lateral stripe, with well-defined dark edges, extending from nostril or eye to groin. The upper flanks, above the white mid-lateral line, are usually tawny brown. In many females a narrow, coppery dorsolateral stripe is also discernable, particularly at the shoulders.



FIGURE 2. Comparison of males in full breeding condition: (A) *C. decora* **sp. nov.**, Townsville; (B) *C. rubigo* **sp. nov.**, Magnetic Island; (C) *C. pectoralis*, Woodgate National Park; (D) *C. inconnexa*, QMJ89134, Whitsunday Island. Photos: Conrad Hoskin (A, B), Steve Wilson (C), Jeff Wright (D).

Comparison. Only likely to be confused with *C. vivax* de Vis 1884, members of the *C. pectoralis* group (*C. pectoralis*, *C. rubigo* **sp. nov.** and *C. inconnexa*), and female *C. jarnoldae* Covacevich & Ingram 1975. *Carlia decora* **sp. nov.** is most closely related to *C. vivax* (C. Hoskin, unpublished data) and females of the two species are superficially similar. The two species also share some key traits, such as an upper preocular that contacts the 2nd

loreal or is a broad triangular wedge, and a vertically elliptical ear opening with a single large, rounded lobule on the anterior margin. However, *C. decora* **sp. nov.** can be readily distinguished from *C. vivax* by tricarinate versus bicarinate mid-dorsal scales, respectively. Tricarinate mid-dorsal scales also separates *C. decora* **sp. nov.** from *C. inconnexa* (predominately bicarinate), and the latter is also a larger skink with higher midbody, paravertebral and subdigital lamellae scale counts (Table 1). The male and female colour patterns also differ obviously between *C. decora* **sp. nov.** and *C. inconnexa* (Table 1, Figs 1–7; see *C. inconnexa* Comparison section). *Carlia decora* **sp. nov.** differs from *C. pectoralis* and *C. rubigo* **sp. nov.** in a variety of ways. The upper preocular scale in *C. decora* **sp. nov.** is broadly triangular (and usually contacts the loreal) versus a narrow vertical sliver in *C. pectoralis* and *C. rubigo* **sp. nov.** (Fig. 10). The prefrontals are generally moderately separated in *C. decora* **sp. nov.** versus narrowly separated or in point contact in *C. pectoralis* and *C. rubigo* **sp. nov.** (Fig. 9). *Carlia decora* **sp. nov.** generally has one large, rounded anterior ear lobule whereas *C. rubigo* **sp. nov.** often has low, rounded lobules present on other margins and *C. pectoralis* generally has lobules present on all margins of the ear (and these lobules are often pointed) (Fig. 8). Additionally, the ear opening of *C. pectoralis* is usually rounded, versus typically vertically elliptical in *C. decora* **sp. nov.** (Fig. 8). *Carlia decora* **sp. nov.** is a more elongate (> interlimb/SVL) skink than *C. pectoralis* and *C. rubigo* **sp. nov.**, and is larger (average and max SVL) than *C. rubigo* **sp. nov.** (Table 1). Female *C. decora* **sp. nov.** have a bold white, dark-edged mid-lateral line that always extends to the groin, whereas this stripe rarely extends as a distinct white line onto the posterior half of the flank in *C. pectoralis* and *C. rubigo* **sp. nov.** (Figs 1, 6). Additionally, in female *C. decora* **sp. nov.** the upper flanks are generally tawny brown and there is often some indication of a pale dorso-lateral line at the shoulders (Figs 1, 6). The colour pattern of breeding males differs between *Carlia decora* **sp. nov.**, *C. pectoralis* and *C. rubigo* **sp. nov.** (Figs 1–5). Breeding male *C. decora* **sp. nov.** have a thin orange upper lateral line and occasionally also a less distinct, ragged orange lower lateral line. The throat is pale or light blue and grey or black flecking is generally restricted to the jawline and side of the neck and rarely extends obviously onto the throat. In male *C. pectoralis*, the lower lateral orange line is often more obvious and the orange regularly extends onto the chest, and the scales of the neck and throat are typically heavily edged with black (i.e. black scalloping). The flanks of male *C. rubigo* **sp. nov.** are diffusely washed with orange or copper colouration, rather than the orange being restricted to upper and lower lateral lines. The ventral surfaces of male and female *C. decora* **sp. nov.** are typically immaculate white or cream, versus tinged with grey in *C. pectoralis* and *C. rubigo* **sp. nov.** Female *C. decora* **sp. nov.** and *C. jarnoldae* are superficially similar in that both have a white mid-lateral line that always extends to the groin. This line is broader on *C. jarnoldae* and bordered above by a more obvious dark band. Additionally, *C. decora* **sp. nov.** is larger (mean SVL 44 mm vs. 38 mm), generally has 5 supraciliaries (vs. usually 7), has vertically elliptical ear opening (vs. horizontally elongate) and with a large, rounded lobule on anterior margin (vs. a small pointed lobule on anterior margin and smaller pointed lobules on other margins).

Genetics. *Carlia decora* **sp. nov.** is approximately 16% divergent (900 bp ND4 mtDNA) from *C. rubigo* **sp. nov.**, *C. inconnexa* and *C. pectoralis*. *Carlia decora* **sp. nov.** is genetically most similar to *Carlia vivax* (approximately 13% divergence) (C. Hoskin, unpublished data). A representative ND4 mtDNA sequence for this species from the type locality is JX291972 (GenBank accession number).

Distribution. *Carlia decora* **sp. nov.** is found in high rainfall coastal areas of mid-east and north-east Queensland from approximately Sarina in the south to Mt Molloy in the north (Fig. 11). The distribution is centred on two areas: the Sarina-Mackay-Proserpine region and the Townsville region (Mt Elliot, Townsville city area, Bluewater Range). There are no records from the drier forests that separate these two regions. *Carlia decora* **sp. nov.** is also known from some offshore islands in these regions (e.g. Brampton Is., Whitsunday Is., and Curacoa Is. in the Palm Islands). The most northerly record of *C. decora* **sp. nov.** (Mt Molloy, north-west of Cairns) is a considerable distance from the records in the Townsville region. The lack of records in the intervening area is interesting because wet forests are fairly continuous through this region, and generally well surveyed. This may represent a genuine disjunction in the distribution (perhaps due to competing species in the Wet Tropics wet forests) or *C. decora* **sp. nov.** may be distributed through this area patchily or at low density.

Habitat and habits. *Carlia decora* **sp. nov.** is found in riparian forest, vine thickets, rainforest margins, seasonally moist open forests and town gardens. It generally occurs in thicker vegetation amongst a matrix of open woodland and is particularly abundant in vine thickets and in the ecotone between riparian rainforest and grassy *Eucalyptus* woodland (Fig. 12A). It occurs in areas with thick leaf litter and other ground cover (low vegetation, rocks, logs, etc.). It is a common garden skink in Townsville. *Carlia decora* **sp. nov.** is an active, ground-dwelling skink that retreats rapidly to thick leaf litter and dense vegetation when disturbed.

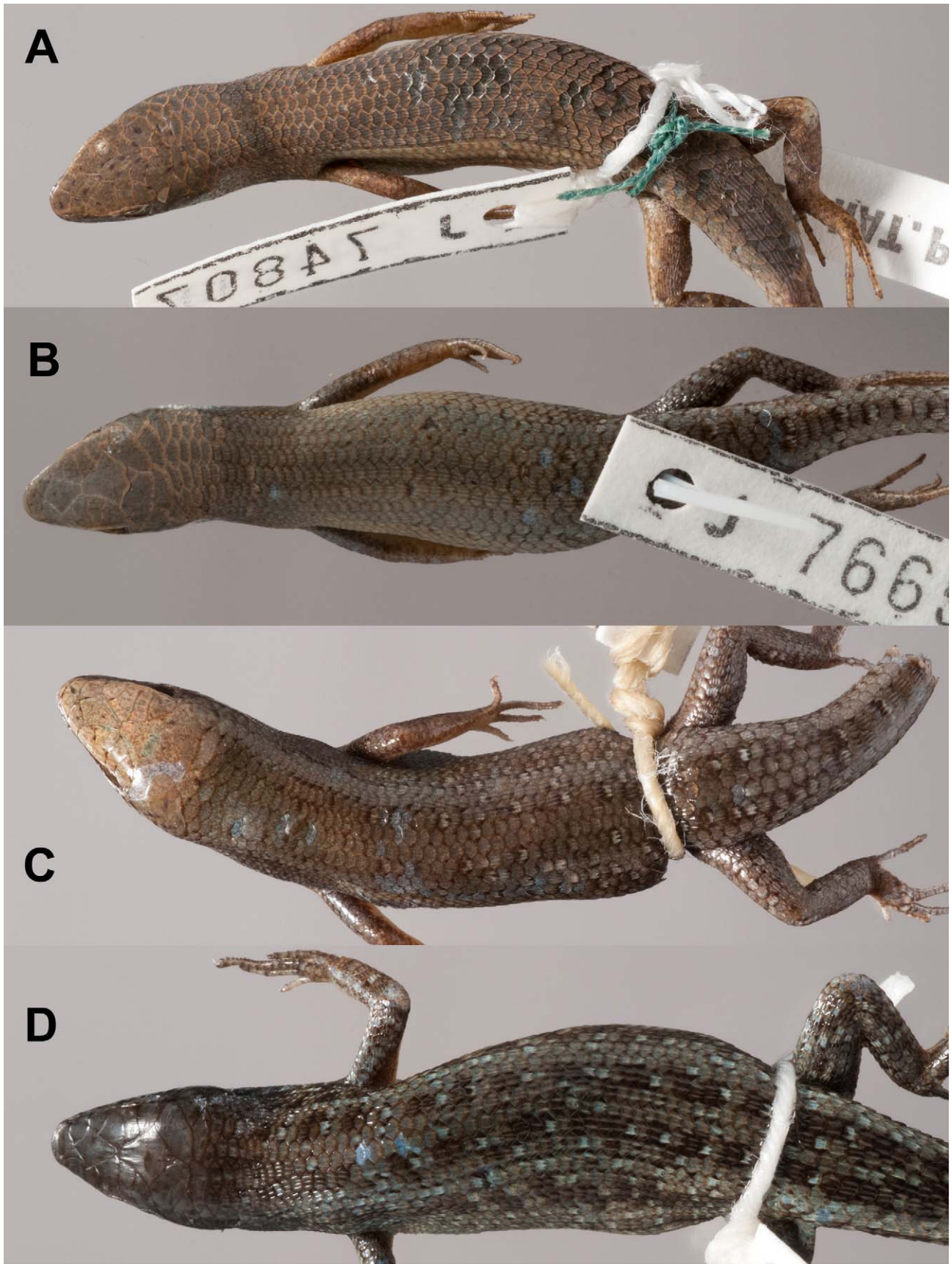


FIGURE 3. Comparison of typical dorsal pattern of males: (A) *C. decora* **sp. nov.**, QMJ74807, Cape Hillsborough National Park; (B) *C. rubigo* **sp. nov.**, QMJ76659, Magnetic Island; (C) *C. pectoralis*, QMJ63390, Wongi State Forest; (D) *C. inconnexa*, QMJ89138, Whitsunday Island. The photo in (A) was flipped to match the orientation of the other panels. Photos: Jeff Wright.

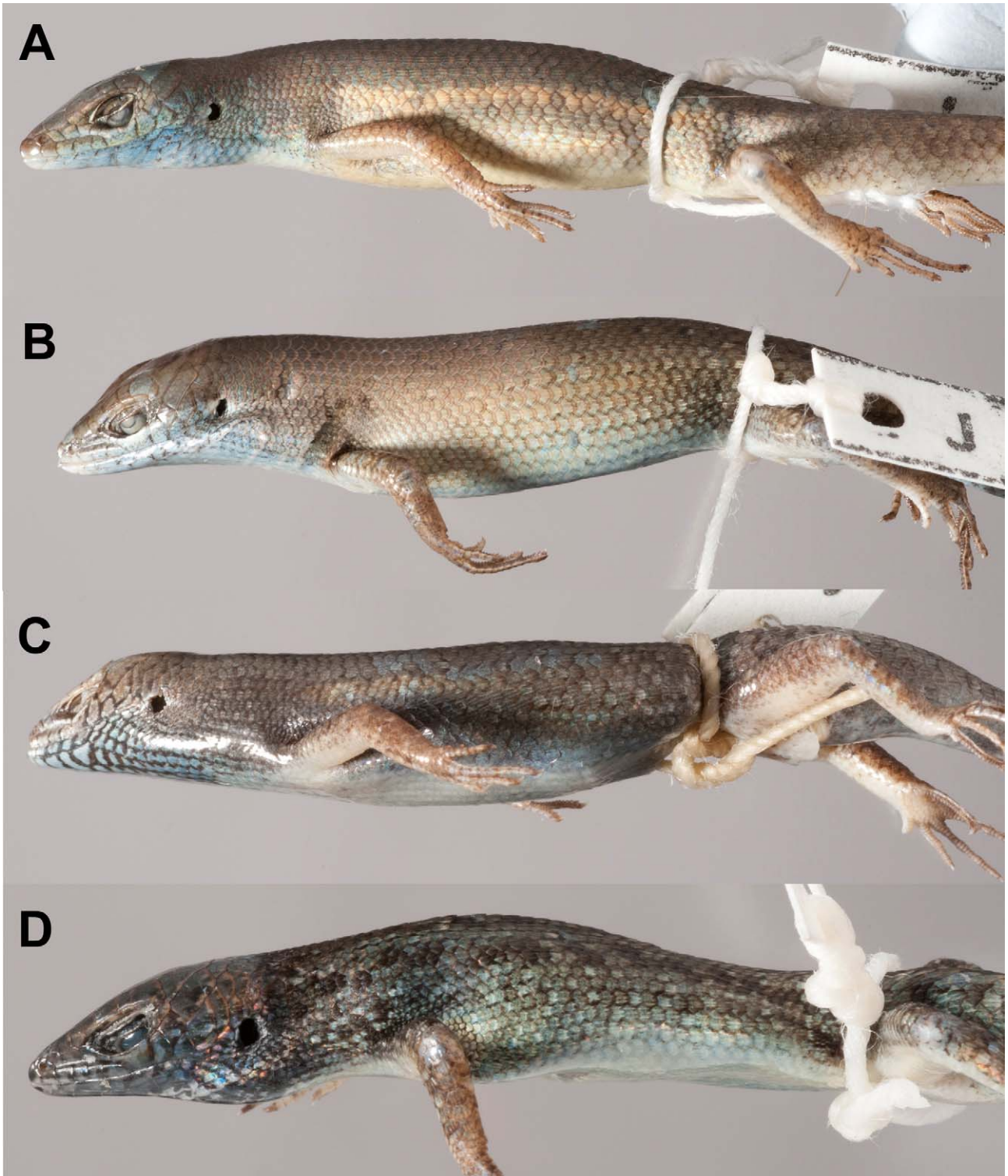


FIGURE 4. Comparison of typical lateral pattern of males: (A) *C. decora* **sp. nov.**, QMJ90878, Townsville; (B) *C. rubigo* **sp. nov.**, QMJ90885, Magnetic Island; (C) *C. pectoralis*, QMJ63390, Wongi State Forest; (D) *C. inconnexa*, QMJ89138, Whitsunday Island. Photos: Jeff Wright.

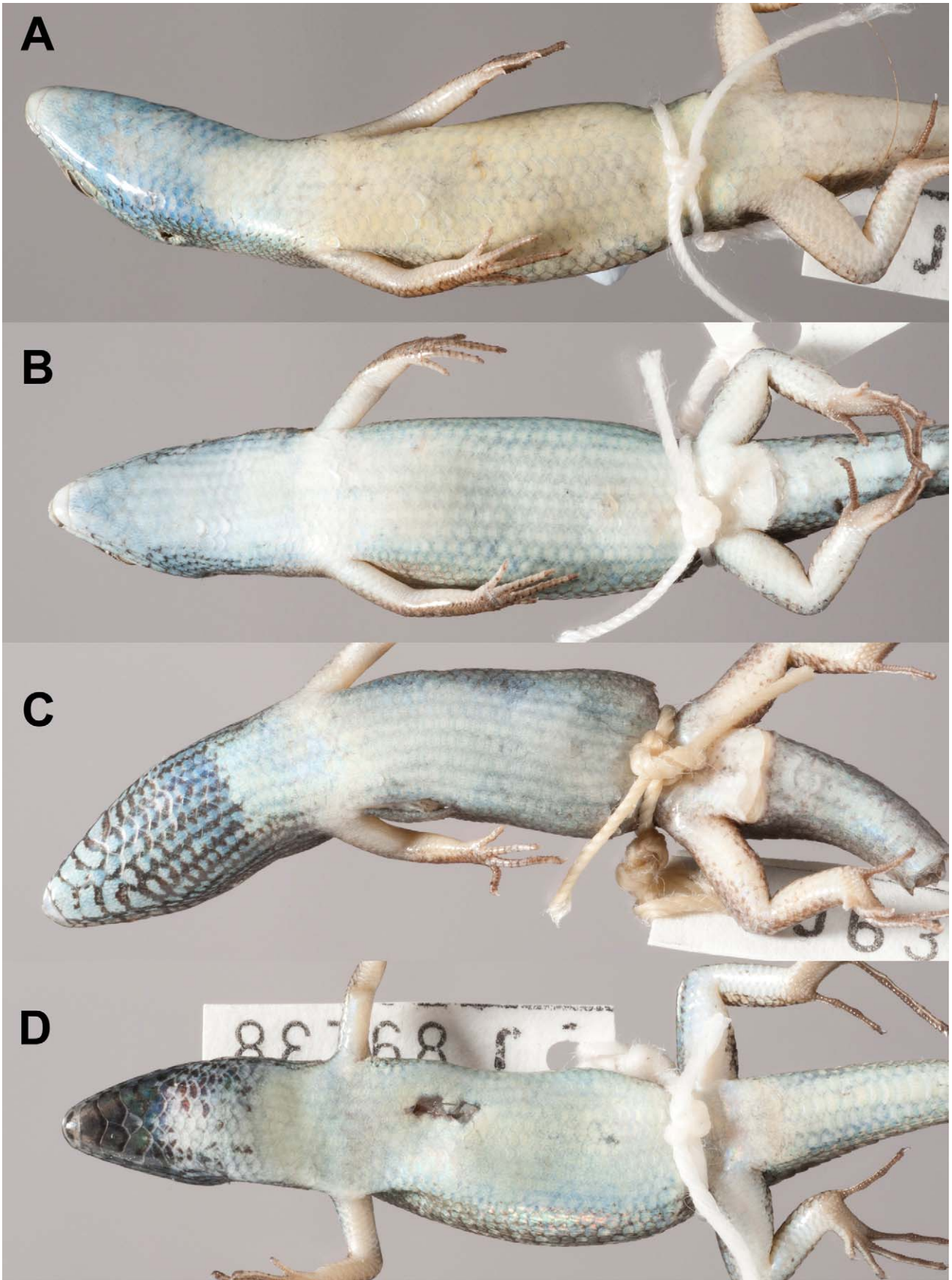


FIGURE 5. Comparison of typical ventral pattern of males: (A) *C. decora* **sp. nov.**, QMJ90878, Townsville; (B) *C. rubigo* **sp. nov.**, QMJ90885, Magnetic Island; (C) *C. pectoralis*, QMJ63390, Wongi State Forest; (D) *C. inconnexa*, QMJ89138, Whitsunday Island. Photos: Jeff Wright.

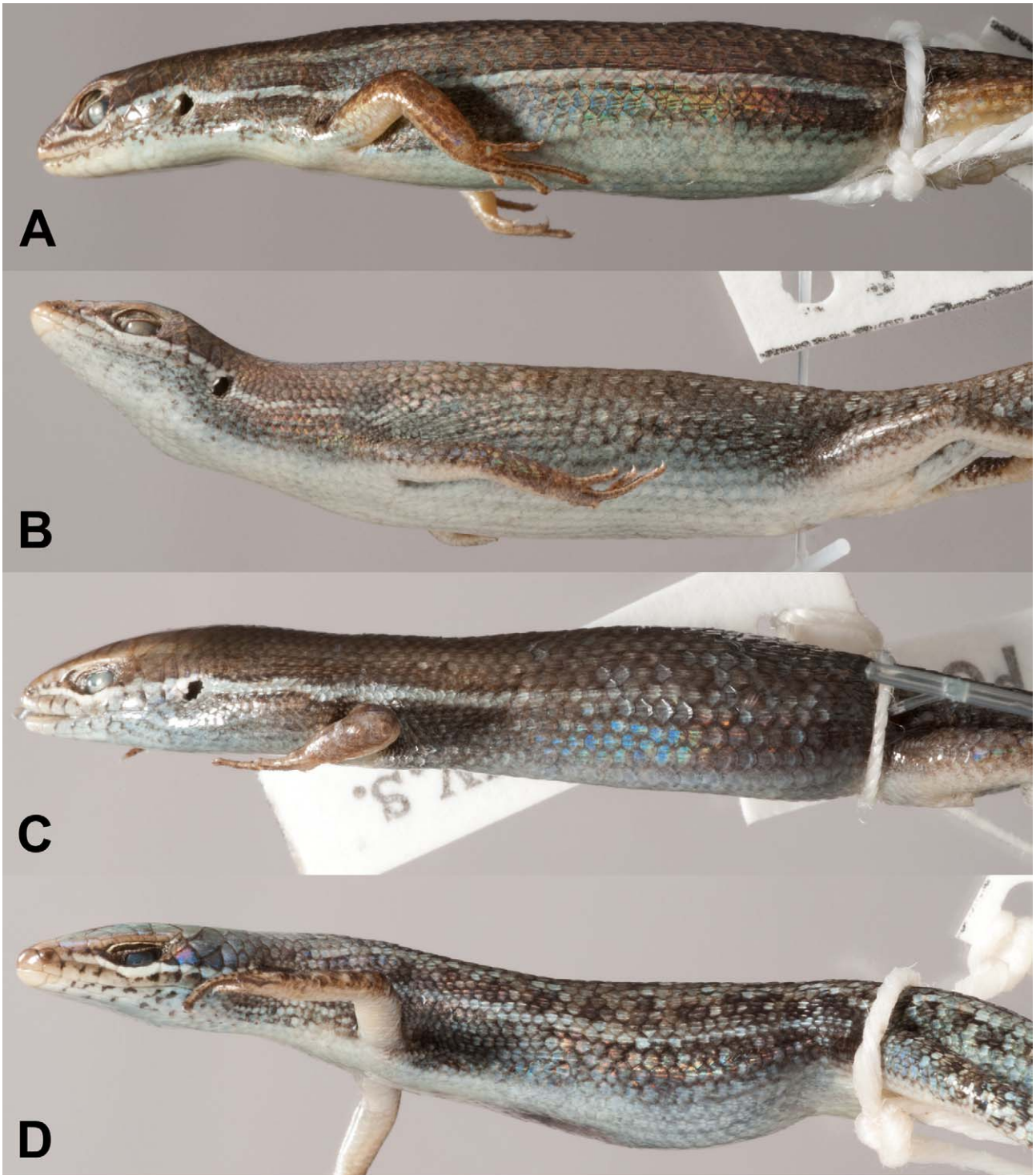


FIGURE 6. Comparison of typical lateral pattern of females: (A) *C. decora* **sp. nov.**, QMJ74805, Cape Hillsborough; (B) *C. rubigo* **sp. nov.**, QMJ76658, Magnetic Island; (C) *C. pectoralis*, QMJ41536, Pine Ck Timber Reserve, Eurimbula area; (D) *C. inconnexa*, QMJ89132, Whitsunday Island. Photos: Jeff Wright.

***Carlia rubigo* sp. nov.**

Orange-flanked Rainbow Skink

(Figs 1A & B, 2BN, 3B, 4B, 5B, 6B, 7B, 8B, 9B, 10D)

Holotype. QMJ90885, male, Magnetic Island, Gustav Ck (19°08'50"S, 146°50'41"E), north-east Queensland, C. Hoskin, 13 February 2011.

Paratypes. QMJ78516-17 Survey Dam, Princess Hills, Girringun NP (18°14' 14"S, 145°28' 34"E); J90883-84 Magnetic Island, Gustav Ck (19°08'50"S, 146°50'41"E); J76655, J76658-59 Nelly Bay, Magnetic Is (19°10'S, 146°51'E); J90890 Cape Cleveland (19°17'29"S, 147°01'22"E); J65166 Shark Bay, Cape Upstart (19°44'S, 147°45'E); J65165 Cape Upstart, on top (19°44'S, 147°49'E); J90886-87 Lolworth Ck, near Dalrymple National Park (19°51'37"S, 146°07'45"E); J75179 Gloucester Island (20°02' 30"S, 148°26' 30"E); J89141-42, J89145-47 Airlie Beach, Shute Harbour Rd, Mandalay (20°17'S, 148°44' 21"E); J83256 Clermont, 6.5 km NNW (22°46' 06"S, 147° 37' 39"E); J83279 Scotts Peak, Feez Creek Stn (22°51' 44"S, 148°13' 31"E); J88423 Valencia Station (22°56' 14"S, 147°46' 18"E).

Additional material. J60245, J60253 Mt Mulligan (16°48' 56"S, 144°46' 12"E); J75125 Forty Mile Scrub, 2.1 km S of park boundary (18°07' 58"S, 144°48' 50"E); J74273 Princess Hills, Girringun NP (18°19' 23"S, 145°22' 41"E); J74780 Shaft Cave, Fanning Caves (19°48'S, 146°28'E); J85004, J85006 Rochford Scrub (20°07' 05"S, 146°37' 43"E); J89148 Airlie Beach, Shute Harbour Rd, Mandalay (20°17'S, 148°44' 21"E); J44438, J44457, J44787 Warrawee Stn, 60km SE Charters Towers (20°20'S, 146°39'E); J44696-98 St Pauls Stn (20°24'S, 146°58'E); J44707-08 Mt Cooper Stn (20°30'S, 146°51'E); J44626 Natal Downs Stn (21°05'S, 146°10'E); J77971 Newlands Coal Mine (21°13'S, 147°53'E); J82977 Lord's Table summit (22°39' 17"S, 148°00' 55"E); J78677 Nairana NP (21°43' 28"S, 146°53' 31"E); J82997, J83006 Coomburragee Stn, nr (22°53' 59"S, 148°20' 04"E); J76759 Cudmore NP (22°56' 23"S, 146°17' 43"E); J76866 SF161 Condamine, 5.5km SE of Wilgo Downs Stn (26°57' 06"S, 150°15' 14"E); J78641 Yalebone Ck. 6km W Newington hstd, NW Surat (27°07' 22"S, 148°57' 47"E); J80137 Warrego Highway Stock Route, 27km W of Mitchell (26°28' 23"S, 147°39' 46"E).

Diagnosis. A moderate sized *Carlia* (max SVL 44 mm) that can be distinguished from all its congeners by a combined suite of characters. Interparietal scale free. Dorsal scales tricarinate and hexagonally-shaped. Palpebral disc large. Ear aperture round to vertically elliptic with one or two rounded lobules on the anterior margin and sometimes with smaller, rounded lobules on other margins (Fig. 8B). Supraciliaries usually five. Prefrontals usually narrowly separated or in point contact (Fig. 9B). Upper preocular minute or a narrow, vertical sliver (Fig. 10D). Breeding male with pale blue throat and broad orange or coppery flush on flanks; black speckling present on neck and jawline but no heavy black edging to scales on throat (Figs 1C, 2B, 4B, 5B). Adult female with a white mid-lateral stripe that usually breaks up posteriorly into white flecks (Figs 1D, 6B). Both sexes have a pale greyish tinge on the ventral surface.

Etymology. From the Latin *rustigo*, meaning 'rust'. In reference to the rusty orange colouration on this species, particularly on the flanks of males. The species epithet is treated as a noun in apposition.

Description of holotype (Fig. 7B). QMJ90885, male. Measurements (mm): SVL 39.3; tail (damaged); interlimb 18.7; HLL 20.1; TL 6.2; HW 6.7; HL 9.1. Scallation: Dorsal scale keels 3; midbody scale rows 30; paravertebrals 47; supralabials 7; infralabials 6; supraciliaries 5, subdigital lamellae (4th toe) 28; subdigital lamellae (3rd finger) 21. Upper preocular reduced to a narrow vertical sliver, well separated from posterior edge of 2nd loreal scale; palpebral disc large; ear < palpebral disc, vertically elliptic with one large rounded lobule on anterior margin; postsupralabial divided; nasals widely spaced; prefrontals very narrowly separated, almost in point contact.

Colour pattern of holotype in preservative. Dorsal surfaces brown, faint indication of some darker and lighter markings. Lateral surfaces flushed with a coppery and greenish colouration. Iridescent sheen to scales. Neck and jawline pale blue, with black flecking to scales forming thin longitudinal rows. Throat pale with a blue tinge, some dark flecks towards sides of neck and jawline. Pale markings from nare, under eye, and to tympanum. Ventral surfaces creamy white. Prominent white spot at posterior base of hindlimb. Tail greyish brown with dark and light markings.

Description of type series. Body robust with keeled dorsal scales. Head barely distinct from neck. Snout rounded in profile. Limbs moderate; four fingers; five toes. Adult measurements and proportions: see Table 1. Scallation: Rostral in broad contact with frontonasal. Postsupralabial divided. Nasals widely spaced. Prefrontals large and usually narrowly separated (narrow separation 77%, moderate separation 19%, contacting 4%) (Fig. 9B). Supraoculars 4, 1 and 2 in contact with frontal, 2, 3 and 4 in contact with frontoparietal. Frontoparietals fused, forming a single shield. Interparietal distinct. Enlarged nuchal scales 2. Loreals 2. Preoculars 2. Upper preocular very small, either a narrow vertical sliver (70%) or minute (30%) (Fig. 10D). Presubocular single. Supraciliaries 5, very rarely 4 or 6. Lower eyelid movable with clear window; palpebral disc large, occupying more than half of lower eyelid. Ear aperture smaller than palpebral disc. Ear opening vertically elliptic (86%) or round (14%), with a rounded lobule present on anterior margin (Fig. 8B); additionally often also small, low lobules present on the other margins of the ear (48% of specimens). Supralabials 7, with the fifth below the eye. Infralabials 6. Three scales between the nasal scale and the presubocular. Midbody scale rows 30–32 (mean = 31); dorsal scales with

tricarinate keels (very rarely 2). Paravertebral scale rows 45–48 (mean = 47). Subdigital lamellae under 3rd finger 17–21 (mean = 19). Subdigital lamellae under 4th toe 23–29 (mean = 27).

Colour pattern in preservative. Males (Figs 3B, 4B, 5B, 7B): dorsal surfaces rusty brown, generally with black and white dots on the back half of the dorsum and continuing along the tail. Top of head generally lighter brown; often with fine black dots. Lateral surfaces washed with orange or copper colouration, sometimes with a greenish tinge. Iridescent sheen to scales. Neck, throat and jawline pale blue or white. Black speckling and edging to scales of sides of neck and jawline, generally forming fine longitudinal rows. Usually no dark markings on throat. Often white line or markings from nare to beneath eye. Ventral surfaces cream-grey or cream. Prominent white spot at posterior base of hindlimb. Tail brown with black and white flecks. Females (Fig. 6B) dorsal surfaces brown, often rusty towards the anterior half and flecked or spotted with black and white towards the posterior half and tail. Top of head generally lighter brown; often with fine black dots. Thin white line from snout, under eye, through tympanum, and extending as a mid-lateral line to above forelimbs or mid flank before breaking up into white flecks or an indistinct ragged line. In a few specimens white mid-lateral line extends to groin. Flanks brown or grey and heavily flecked with white; upper flanks sometimes tawny brown. Ventral surfaces grey tinged or creamy grey. White spot at posterior base of hindlimb. Tail brown with black and white flecks.

Colour pattern in life (Figs 1C, 1D, 2B). Dorsum of both sexes coppery brown with black and white paravertebral dots or flecks on posterior half. Ventral surfaces greyish white. Breeding males with pale blue throats and black speckling on jawline and neck. The throat is generally clean but grey or black speckling sometimes extends onto the throat. Speckling of the neck and throat is sometimes arranged coarsely as thin transverse lines. A broad coppery/orange flush extends from forelimb along flank. At maximum breeding extent orange can extend onto the back and forelimbs, and blue can extend over entire head. Parts of the flanks and head can sometimes have a greenish tinge. Adult females have a white mid-lateral stripe that extends from nostril to forelimb or mid flank, before breaking up into a series of pale flecks.

Comparison. Only likely to be confused with *C. decora* **sp. nov.**, *C. pectoralis* and *C. inconnexa*. *Carlia rubigo* **sp. nov.** is readily distinguished from *C. inconnexa* by tricarinate versus mixed bicarinate/tricarinate mid-dorsal scales, smaller size, lower midbody, paravertebral and lamellae scale counts, and colour pattern (see *C. inconnexa* Comparison section; Table 1). From *C. decora* **sp. nov.** and *C. pectoralis*, *C. rubigo* **sp. nov.** is distinguished most easily by breeding male colouration (Figs 1–5). The flanks of male *C. rubigo* **sp. nov.** are broadly flushed with orange or copper colouration whereas orange is confined to upper and lower lateral lines on the flanks of male *C. decora* **sp. nov.** and *C. pectoralis*. The orange on the flanks of *C. rubigo* **sp. nov.** is sometimes concentrated towards the upper and lower flanks but it is nonetheless suffused over the entire flank to some extent. Breeding male *C. rubigo* **sp. nov.** are further distinguished from male *C. pectoralis* by the lack of heavy black edging (scalloping) on the scales of the throat. Female *C. rubigo* **sp. nov.** and *C. pectoralis* are of similar pattern but *C. decora* **sp. nov.** females have a bold white mid-lateral line that always extends to the groin (*vs.* less distinct white line that generally breaks up to white speckles on posterior flank in *C. rubigo* **sp. nov.** and *C. pectoralis*) (Figs 1, 6). *Carlia rubigo* **sp. nov.** is further distinguished from *C. decora* **sp. nov.** by higher midbody scale count (30 or more *vs.* 30 or less), generally smaller body size (75% of *C. rubigo* **sp. nov.** specimens measured < 42 mm *vs.* 75% of *C. decora* **sp. nov.** > 42 mm), upper preocular minute or a narrow vertical sliver (*vs.* broadly triangular) and prefrontal spacing generally narrow or very narrow (*vs.* moderate) (Table 1; Figs 9, 10). *Carlia rubigo* **sp. nov.** is further distinguished from *C. pectoralis* by usually having a vertically elliptical ear opening (*vs.* round), with one low, rounded anterior lobule and sometimes also low lobules on other margins (*vs.* more prominent rounded or bluntly pointed lobules on all margins) (Fig. 8). *Carlia rubigo* **sp. nov.** also tends to have more subdigital lamellae under the 4th toe (mean: 27 *vs.* 25; 75% of *C. rubigo* **sp. nov.** specimens examined have 26 or more, 75% of *C. pectoralis* have 26 or fewer) (Table 1).

Genetics. *Carlia rubigo* **sp. nov.** is approximately 10% divergent (ND4 mtDNA) from *C. inconnexa* and *C. pectoralis* and approximately 16% divergent from *Carlia decora* **sp. nov.** (C. Hoskin, unpublished data). A representative ND4 mtDNA sequence for this species from the type locality is JX291973 (GenBank accession number).

Distribution. *Carlia rubigo* **sp. nov.** is found in inland eastern Queensland, from close to the New South Wales border in the south (Texas, St George areas), to west of Cairns in the north, and throughout central eastern Queensland including coastal areas between approximately Mackay and Townsville and on associated offshore islands (e.g. Magnetic Island, Gloucester Island) (Fig. 11).

Habitat and habits. *Carlia rubigo* sp. nov. is found in dry open forests, grasslands and rocky habitats, particularly in areas with a complex ground cover of grass tussocks, leaf litter and rocks (Fig. 12B). It is an active, ground-dwelling skink.

***Carlia pectoralis* (de Vis 1884)**

Open-litter Rainbow Skink

(Figs 1E & F, 2C, 3C, 4C, 5C, 6C, 7C, 8C, 9C, 10E)

1884 *Heteropus pectoralis* de Vis. *Brisbane Courier*, November 15, p. 6. (Queensland). Holotype QM J1414.

1885 *Heteropus lateralis* de Vis. *Proc Roy. Soc. Qd* 1: 168. Pine River, Moreton Bay District, SE Queensland. Lectotype QM J234 designated by Ingram and Covacevich 1989. Name rejected by Boulenger as a secondary homonym of *Lygosoma lateralis* Duméril and Bibron. See Remarks section below.

1885 *Heteropus pectoralis* de Vis. *Proc. Roy. Soc. Qd* 1: 169. Warro, Port Curtis, south-east Queensland. Holotype QM J1414.

1890 *Lygosoma devisii* Boulenger. *Proc. Roy. Soc. Lond. P.* 79. Replacement name for *Heteropus lateralis* de Vis. See Remarks section below.

1989 *Carlia pectoralis pectoralis* Ingram & Covacevich. *Memoirs of the Queensland Museum* 27(2): 465. Holotype QM J1414.

Material examined. QM J1414 (holotype) male, Warro, Port Curtis, south of Miriam Vale (24°35'S, 151°45'E); J77644 Kunwarara Mine Site (22°55'S, 150°08'E); J73543 Awoonga Dam, from Boyne Valley to Miriam Vale (24°02'S, 151°19' 05"E); J42200 Worthington Ck, S of Turkey, via Miriam Vale (24°09'S, 151°42'E); J41536 Pine Ck Timber Reserve (102), S of Turkey Stn (24°10'S, 151°42'E); J40174 Eurimbulah NP, NE of Miriam Vale (24°13'S, 151°44'E); J42201 Eurimbulah NP, N of, via Miriam Vale (24°13'S, 151°42'E); J82445 Callide Mine, nr Biloela (24°17' 57"S, 150°36' 33"E); J76857 SF29, 5kms NW of Conomara Homestead (24°18'08"S, 149°07'37"E); J40169-70 Bindaree Stn, 10km ENE Miriam Vale (24°18'S, 151°39'E); J76857 SF29, 5kms NW of Conomara Homestead (24°18' 08"S, 149°07' 37"E); J42170-71 Kroombit Tops (24°22'S, 150°59'E); J42412 Kroombit Tops, via Calliope, Dry Ck Escarpment (24°22'S, 151°01'E); J40313 Deepwater, N of Miriam Vale, CSR Macadamia Farm (24°26'S, 151°59'E); J75823 Brigalow Res. Stn, Site 5 (24°48'S, 149°45'E); J83399 Brigalow Research Station (24°48' 01"S, 149°46' 13"E); J59575 Carnarvon NP, Ka Ka Mundi section (24°48' 36"S, 147°35' 34"E); J75636 Brigalow Res. Stn, Site 2 (24°49'S, 149°45'E); J83396 Carnarvon Station, 140km NW of Injune, Springs Road 24°49' 14"S, 147°44' 28"E); QMJ90888-89 Carnarvon Gorge (25°03'33"S, 148°14'04"E); J83126 Theodore, 38.8km SSW (25°15' 18"S, 149°53' 24"E); J63390 Wongi SF, N Section (25°21' 12"S, 152°25' 42"E); J72271 Boggomoss, via Taroom, Boggomoss 3 (25°26' 04"S, 150°01' 22"E); J90462 Lonesome Lookout, Lonesome NP (25°29'44"S, 148°48'43"E); J73316 Taroom District (25°33'S, 150°08'E); J73383, J73719 Wetheron, 3kms SW (25°34'S, 151°42'E); J73466 Wetheron, 3.5kms SW (25°34'S, 151°41'E); J73701 Mt Debatable, 1.5kms NE (25°37'S, 151°34'E); J77723 Stones Country Resources Reserve (26°23' 28"S, 149°52' 45"E); J76491 Yellow Gully, Gatton-Esk Rd (27°47'S, 152°21'E); J73349 Nipping Gully, Site 4 (25°40'S, 151°26'E); J73381 Nipping Gully, Site 5 (25°42'S, 151°26'E); J73472 Nipping Gully (25°42'S, 151°26'E); J41525 Mt Urah, 20km W Gundiah, nr Gympie (25°50'S, 152°21'E); J89392 Greenup SF (28°37'57"S, 151°14'31"E); QMJ234 (lectotype *Heteropus lateralis*) Pine River, Moreton Bay district, SE Queensland.

Diagnosis. A moderate sized *Carlia* (max SVL 47 mm) that can be distinguished from all congeners by a combined suite of characters. Interparietal scale free. Dorsal scales tricarinate and hexagonally-shaped. Palpebral disc large. Ear aperture usually round (may be vertically elongate) with a rounded lobule on the anterior margin and usually with sharp to bluntly pointed lobules on other margins (Fig. 8C). Supraciliaries usually five. Prefrontals usually narrowly separated or in point contact (Fig. 9C). Upper preocular minute or a narrow, vertical sliver (Fig. 10E). Breeding male with distinct orange upper lateral stripe and usually also an orange lower lateral stripe, with orange extending onto the chest; blue throat; throat, neck and chin scales strongly edged in black (Figs 1E, 2C, 4C, 5C). Female with white mid-lateral stripe that usually becomes ragged and indistinct or breaks up to flecks posteriorly along the flank (Fig. 1F, 6C). Both sexes have a pale greyish tinge on the ventral surface.

Etymology. The species name *pectoralis* translates as 'breasted'.

Description of holotype (Fig. 7C). QMJ1414, male. Measurements (mm): SVL 44.3; interlimb 19.2; HLL 21.3; TL 6.1; HW 7.7; HL 10.2. Dorsal scale keels 3; midbody scale rows 32; paravertebrals 44; supralabials 7; infralabials 6; supraciliaries 5, subdigital lamellae (4th toe) 25; subdigital lamellae (3rd finger) 21. Upper preocular reduced to a narrow vertical sliver, well separated from posterior edge of 2nd loreal scale; palpebral disc large; ear <

palpebral disc, round with lobules on all margins; postsupralabial divided; nasals widely spaced; prefrontals narrowly separated.

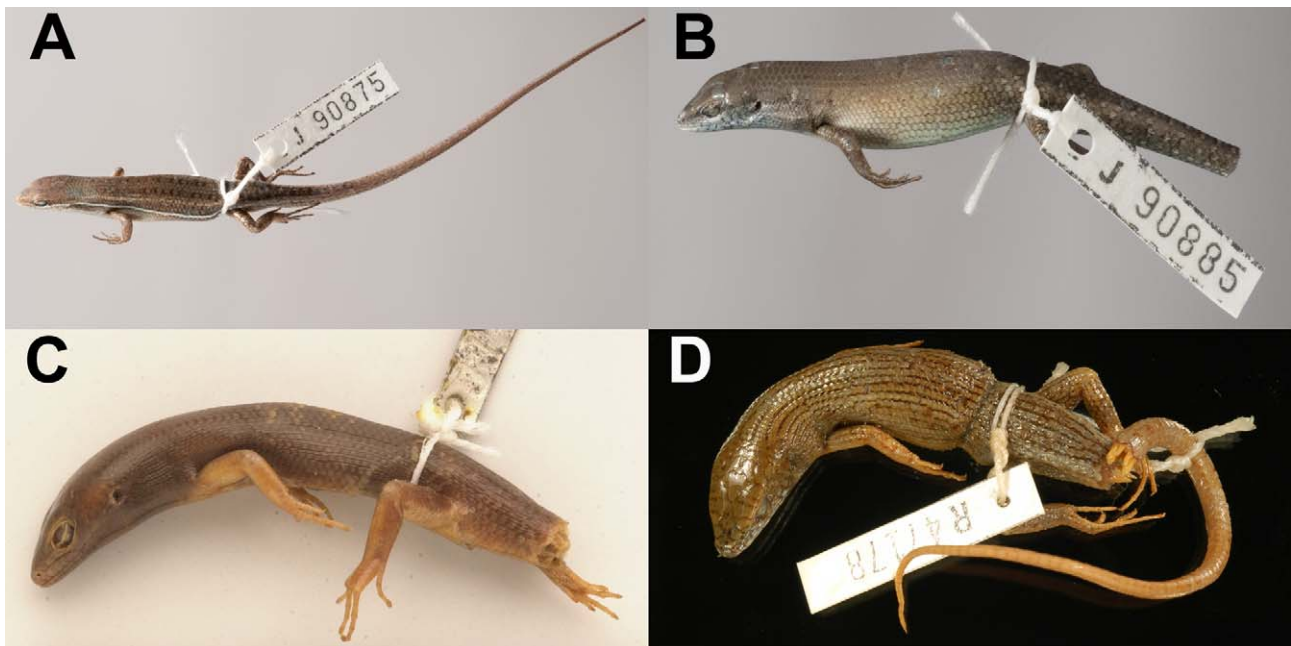


FIGURE 7. Photos of holotypes: (A) *C. decora* sp. nov., QMJ90875, female, Mt Elliot; (B) *C. rubigo* sp. nov., QMJ90885, male, Magnetic Island; (C) *C. pectoralis*, QMJ1414, male, Port Curtis; (D) *C. inconnexa*, R47178, male, Hayman Island. Photo credits: Jeff Wright (A–C), Ross Sadlier (D).

Colour pattern of holotype in preservative. Even dark brown colouration over dorsal and lateral surfaces. Sides of neck and throat dark brown to black. Chin and underside of throat pale brown, heavily marked or smudged with dark brown, particularly at scale edges. Ventral surfaces creamy yellow. Dorsal surfaces of limbs light brown; undersides creamy yellow.

Description of material examined. Body robust with keeled dorsal scales. Head barely distinct from neck. Snout rounded in profile. Limbs moderate; four fingers; five toes. Adult measurements and proportions: see Table 1. Scallation: Rostral in broad contact with frontonasal. Postsupralabial divided. Nasals widely spaced. Prefrontals large, usually narrowly separated (narrow separation 79%, point contact 13%, moderate separation 8%) (Fig. 9C). Supraoculars 4, 1 and 2 in contact with frontal, 2, 3 and 4 in contact with frontoparietal. Frontoparietals fused, forming a single shield. Interparietal distinct. Enlarged nuchal scales 2. Loreals 2. Preoculars 2. Upper preocular very small, typically a narrow vertical sliver (79%) or sometimes a minute granule (18%) (Fig. 10E); very rarely larger and in contact with posterior edge of 2nd loreal (3%). Presubocular single. Supraciliaries typically 5 (96%), but occasionally 6 (2%) or 7 (2%). Lower eyelid movable with clear window; palpebral disc large, occupying more than half of lower eyelid. Ear aperture smaller than palpebral disc. Ear opening round (or tending towards vertically elliptic) and usually with lobules on all margins; lobules may be rounded or pointed, or a mix of both (Fig. 8C). Supralabials 7, with the fifth below the eye. Infralabials 6. Three scales between the nasal scale and the presubocular. Midbody scale rows 28–32 (mean = 31), with tricarinate keels on dorsal scales. Paravertebral scale rows 45–50 (mean = 47). Forelimb tetradactyl, with 18–21 (mean = 19) lamellae beneath 3rd finger. Hindlimb pentadactyl, with 23–28 (mean = 25) lamellae beneath 4th toe.

Colour pattern in preservative. Males (Figs 3C, 4C, 5C): dorsal surfaces brown with black and white dots and flecks, usually increasing in intensity posteriorly. Iridescent sheen to scales of some individuals. Top of head generally lighter brown; often with fine black dots. Flanks brown with a faint to distinct orange upper lateral line and sometimes also some indication of an orange lower lateral line. Throat blue or pale; scales heavily edged with black to give a scalloped look. Scales of jawline and sides of neck also heavily edged with black. Ventral surfaces cream, grey tinged, creamy brown or yellowish. Dorsal surfaces of limbs brown; undersides pale. Prominent white spot at posterior base of hindleg. Tail brown with black and white spots and flecks. Females (Fig. 6C): dorsal surfaces brown with black and white dots and flecks. Top of head generally lighter brown; often with fine black

dots. Thin, white line from snout or beneath eye to tympanum and then continuous with mid-lateral line. Thin, white mid-lateral line generally extends past forelimb and along the anterior third or half of the flank before becoming indistinct and ragged or breaking up into white flecks. Flanks otherwise brown and speckled with white; upper flanks generally darker brown. Ventral surfaces grey, white or cream. Dorsal surfaces of limbs brown; undersides pale. White spot at posterior base of hindleg. Tail brown with black and white spots and flecks.

Colour pattern in life (Figs 1E, 1F, 2C). Dorsum of both sexes brown with a paravertebral row of widely spaced black and white dots, generally becoming more distinct posteriorly. Ventral surfaces with a pale grey wash. Breeding males have blue throats; scales of throat neck and chin heavily edged in black. An orange upper lateral stripe encompasses two scale rows and extends from just in front of the forelimb to groin. At maximum breeding extent a lower lateral orange stripe is also present, with the orange extending as a flush over the chest and underside of the forelimbs. Adult females have a white mid-lateral stripe, with diffuse dark edges, extending from nostril to anterior or mid flank, before breaking up into a series of flecks.

Comparison. Only likely to be confused with *C. decora* **sp. nov.**, *C. rubigo* **sp. nov.** and *C. inconnexa*. *Carlia pectoralis* is readily distinguished from *C. inconnexa* by tricarinate versus bicarinate dorsal scales, smaller size, lower midbody, paravertebral and lamellae scale counts, and colour pattern (see *C. inconnexa* Comparison section; Table 1). Most easily distinguished from *C. rubigo* **sp. nov.** by breeding male colouration (Figs 1–5). Male *C. pectoralis* have an upper lateral orange band and generally also a lower lateral orange band that is continuous with orange flushing on the chest and underside of the forelimbs. In contrast, the flanks of male *C. rubigo* **sp. nov.** are broadly flushed with copper or orange rather than it being restricted to upper and lower lateral bands. Additionally, breeding male *C. pectoralis* have heavy black edging (scalloping) to the scales of the throat, whereas the throat of male *C. rubigo* **sp. nov.** is clean or flecked with grey or black markings. *Carlia pectoralis* is further distinguished from *C. rubigo* **sp. nov.** by having a round ear opening (*vs.* usually vertically elliptical), with prominent rounded or bluntly pointed lobules on all margins (*vs.* one low, rounded anterior lobule and sometimes also low lobules on other margins) (Fig. 8). *Carlia pectoralis* also tends to have fewer subdigital lamellae under the 4th toe (means: 25 *vs.* 27; 75% of *C. pectoralis* specimens examined had 26 or fewer, 75% of *C. rubigo* **sp. nov.** had 26 or more) and tends to be a slightly larger skink with a proportionally larger head (> HL/SVL and > HW/SVL) than *C. rubigo* **sp. nov.** (Table 1). Breeding male *C. pectoralis* and *C. decora* **sp. nov.** both have upper and lower orange lateral stripes. However, in *C. pectoralis* the lower lateral stripe becomes more pronounced at maximum breeding extent and the chest and underside of the forelimbs become flushed with orange. More importantly, the throat of breeding male *C. pectoralis* is heavily scalloped with black whereas the throat of male *C. decora* **sp. nov.** is usually clean or speckled with grey or black (at most the scales are finely dark-edged) (Figs 1, 2, 4, 5). The white mid-lateral line on female *C. pectoralis* rarely extends as a clean line onto the posterior flank (usually becomes ragged-edged or breaks up into white flecks) whereas in female *C. decora* **sp. nov.** a neat white line always extends to the groin (Figs 1, 6). *Carlia pectoralis* is further distinguished from *C. decora* **sp. nov.** in that the upper preocular is minute or a narrow vertical wedge (*vs.* broadly triangular) (Fig. 10), prefrontal spacing is generally narrow or very narrow (*vs.* moderate) (Fig. 9), the ear opening is round (*vs.* vertically elliptical), and there are usually lobules present on all margins of the ear (*vs.* one large, rounded lobule on the anterior edge) (Fig. 8). *Carlia pectoralis* also tends to have more midbody scale rows than *C. decora* **sp. nov.** (generally 30 or more *vs.* 30 or less), fewer subdigital lamellae under the 4th toe (75% of *C. pectoralis* specimens had 26 or fewer *vs.* 26 or more for 75% of *C. decora* **sp. nov.**), a shorter relative interlimb length (interlimb/SVL of 0.48 separates most specimens) and a proportionally larger head (> HW/SVL and > HL/SVL) (Table 1).

Genetics. *Carlia pectoralis* is approximately 10% divergent (ND4 mtDNA) from *C. rubigo* **sp. nov.** and *C. inconnexa* and approximately 16% divergent from *Carlia decora* **sp. nov.** (C. Hoskin, unpublished data). A representative ND4 mtDNA sequence for this species from near the type locality is JX291975 (GenBank accession number).

Distribution. *Carlia pectoralis* is restricted to south-east Queensland (Fig. 11), from Brisbane in the far south-east, west to the Great Dividing Range, north-west to Carnarvon Gorge and north to at least Blackdown Tableland and Shoalwater Bay.

Habitat and habits. *Carlia pectoralis* is found in dry open forests, particularly in areas with grass tussocks, leaf litter and other ground cover (Fig. 12C). It is an active ground-dwelling skink.

Remarks. The holotype of *Carlia pectoralis* (QMJ1414) comes from Warro Station, Port Curtis, which is south-east of Miriam Vale (for clarification of type locality see Covacevich (1971), Pp. 56–58). The type specimen

fits the characters outlined herein for *C. pectoralis sensu stricto* and the type locality falls within the range of that species. The name *Heteropus lateralis* de Vis 1885, a synonym of *C. pectoralis*, requires assessment in light of the species descriptions herein.

Description of lectotype of *Heteropus lateralis* de Vis 1884 (Fig. 13). QMJ234, male. Measurements (mm): SVL 44.4; interlimb 21.4; TL 7.2; HW 7.7; HL 10.3. Scallation: dorsal scale keels 3; midbody scale rows 28; paravertebrals 47; supralabials 7; infralabials 6; supraciliaries 5, subdigital lamellae (4th toe) 25; subdigital lamellae (3rd finger) 18. Upper preocular in contact with posterior edge of 2nd loreal scale; palpebral disc large; ear aperture < palpebral disc; ear opening vertically elliptic with a single rounded lobule on anterior margin; postsupralabial divided; nasals widely spaced; prefrontals widely separated.

Colour pattern in preservative. Even mid brown colouration over dorsal and lateral surfaces. Ventral surfaces paler. The specimen is old and original colour pattern has been lost.

Comments on *Heteropus lateralis* de Vis 1884. There has been considerable confusion regarding *H. lateralis* due to the lack of a clearly designated holotype or syntypes and due to discrepancies in the original description. Ingram and Covacevich (1989) note that de Vis'1885 description of *H. lateralis* is more consistent with *C. vivax* than with *C. p. pectoralis* in that it has bicarinate dorsal scales (*vs* tricarinate in *C. p. pectoralis* and a single copper-red stripe on the flanks (*vs* two stripes in *C. p. pectoralis*). Despite such discrepancies, these authors designated QMJ234, a tricarinate specimen which was probably the last remaining syntype of *Heteropus lateralis*, as the lectotype of this taxon. Their action relegates *H. lateralis* to the synonymy of *C. p. pectoralis* (de Vis) and supports Mitchell's (1953) earlier assessment that this specimen was conspecific with *C. pectoralis* (as *Leiopisma pectoralis*). Ingram and Covacevich (1989) note that QMJ234 '...is a typical *C. p. pectoralis* in all respects' and, indeed, the specimen does conform to their concept of *C. p. pectoralis sensu lato*. However, with the recognition of the new taxa described herein, QMJ234 does not readily conform to our concept of *C. pectoralis sensu stricto*. The specimen exhibits a large upper preocular that contacts the posterior edge of the 2nd loreal scale (a character more consistent with *C. vivax* and *C. decora* **sp. nov.**). While such a state is atypical for *C. pectoralis sensu stricto*, one specimen in the *C. pectoralis* series we examined did have an upper preocular in contact with the 2nd loreal. QMJ234 also has a vertically elliptic ear aperture with a single rounded lobule on the anterior margin (again, characters that are more consistent with *C. vivax* and *C. decora* **sp. nov.**). Once again, while these states are atypical for *C. pectoralis sensu stricto*, individuals with vertically elliptical ear openings with just a rounded anterior lobule do occur (e.g. Fig. 1E). Other traits of QMJ234 (and the collection locality: Pine River, Moreton Bay District, south-east Queensland) conform to our description of *C. pectoralis sensu stricto* but the unusual state of two key traits make identification of this specimen problematic. It is unlikely to be *C. decora* **sp. nov.** because this species is not known to occur in south-east Queensland and because other traits on QMJ234 do not readily conform to *C. decora* **sp. nov.**. It is also not likely to be *C. vivax* because, to the best of our knowledge, *C. vivax* always has bicarinate dorsal scales. The most parsimonious explanation is that QMJ234 is a specimen of *C. pectoralis* with atypical morphology. Therefore, *Heteropus lateralis* remains a synonym of *C. pectoralis*.

***Carlia inconnexa* Ingram & Covacevich 1989**

Whitsunday Rainbow Skink

(Figs 1H, 2D, 3D, 4D, 5D, 6D, 7D, 8D, 9D, 10F)

1989 *Carlia pectoralis inconnexa* Ingram & Covacevich. *Memoirs of the Queensland Museum* 27(2): 468. Hayman Island, Queensland. Holotype AM R47178.

Holotype. AM R47178, male, Hayman Island (20°03'S, 148°53'E).

Paratypes. J25060 Hayman Is (20°03'S, 148°53'E); J42496 Whitsunday Is (20°15'S, 149°00'E).

Additional material. J48093-95 Hook Is, Nara Inlet (20°07' 30"S, 148°55' 30"E); J75251, Whitsunday Is (20°15' 30"S, 148°56' 30"E); J86535, J86539 Whitsunday Is (20°17' 46"S, 149°03' 13"E); J86538, Whitsunday Is (20°17' 46"S, 149°03' 14"E); J86549, Whitsunday Is (20°17' 46"S, 149°03' 22"E); J89132, J89134-35, J89138 Whitehaven Whitsunday Is (20°17' 47"S, 149°03' 13"E).

Diagnosis. A large, robust *Carlia* (max SVL 52 mm) that can be distinguished from all its congeners by a combined suite of characters. Interparietal scale free. Dorsal scales predominantly bicarinate (but often include a

mix of both bicarinate and tricarinate scales) and hexagonally-shaped. Palpebral disc large. Ear vertically elliptic or round, with one or two rounded lobules on the anterior margin (Fig. 8D). Supraciliaries usually five. Prefrontals narrowly separated (Fig. 9D). Upper preocular a narrow, vertical sliver (Fig. 10F). Breeding male with a black head, throat and neck (Figs 1G, 2D, 3D, 4D, 5D). Both sexes grey or brown and heavily mottled with black and white markings that are aligned in longitudinal rows (Figs 1–6).

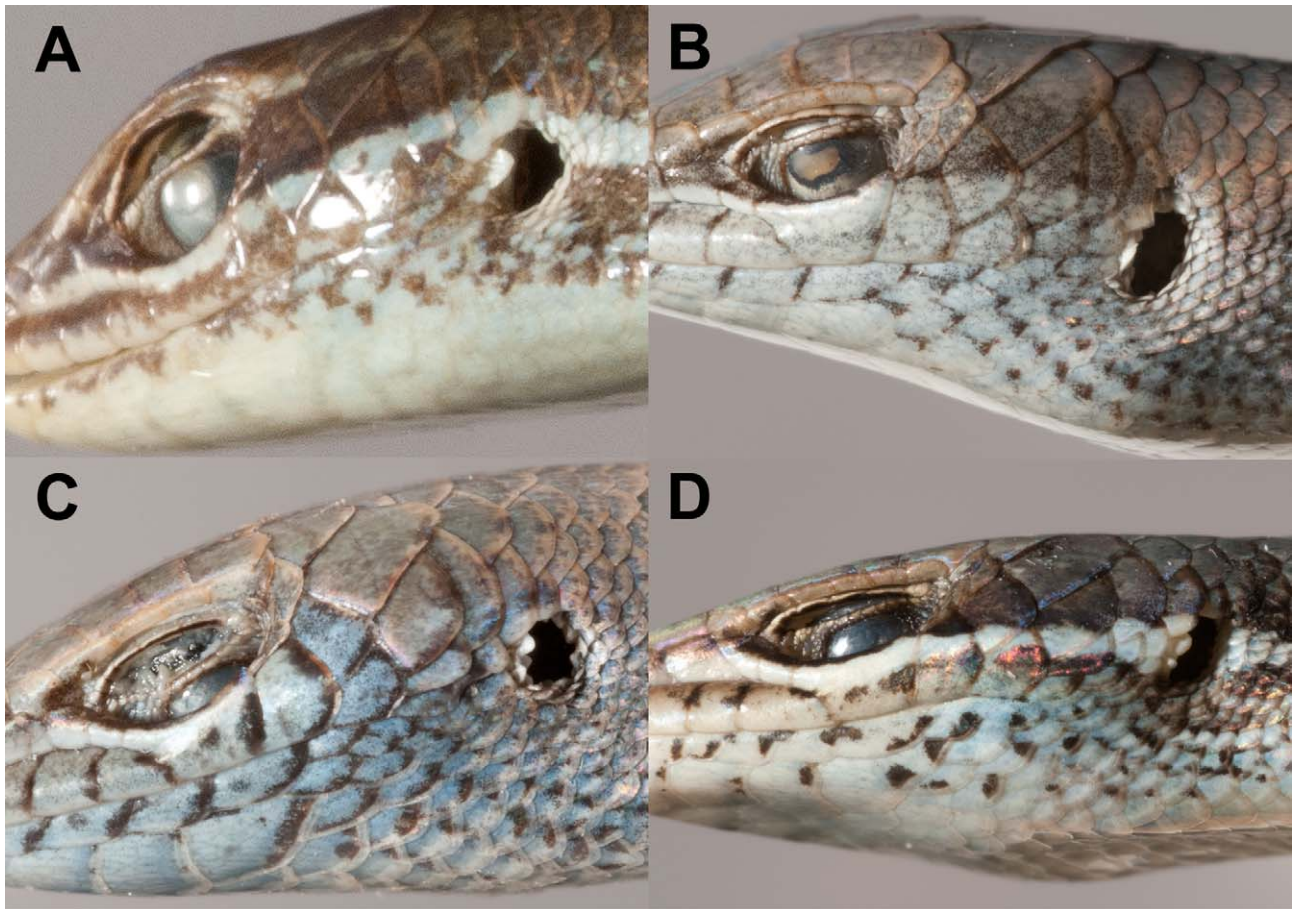


FIGURE 8. Typical ear openings of: (A) *C. decora* sp. nov., QMJ74805, Cape Hillsborough; (B) *C. rubigo* sp. nov., QMJ76655, Magnetic Island; (C) *C. pectoralis*, QMJ40170, Bindaree Station, Miriam Vale area; (D) *C. inconnexa*, QMJ89132, Whitsunday Island. Photos: Jeff Wright.

Etymology. Formerly the subspecies name for these populations. Derived from Latin and meaning ‘unjoined’; in reference to the fact the species is found on offshore islands (Ingram & Covacevich 1989). The species epithet is treated as a noun in apposition.

Description of holotype (Fig. 7D). R47178, male. Measurements (mm): SVL 51.7; tail 98.5 interlimb 22.8; HLL 27.2; TL 8.8; HW 9.0; HL 12.1. Scallation: dorsal scales with a mix of 2 or 3 keels (i.e. bicarinate/tricarinate); midbody scale rows 34; paravertebrals 49; supralabials 7; infralabials 6; supraciliaries 5, subdigital lamellae (4th toe) 27; subdigital lamellae (3rd finger) 20. Upper preocular reduced to a narrow vertical sliver, well separated from posterior edge of 2nd loreal scale; palpebral disc large; ear aperture < palpebral disc size; ear opening round to vertically elliptic with one large rounded lobule on anterior edge and smaller rounded lobules on other margins; postsupralabial divided; nasals widely spaced; prefrontals narrowly separated.

Colour pattern of holotype in preservative. Dorsum light brown with approximately 10 thin, black longitudinal lines. Top of head light brown with fine black dots. Lateral surfaces light brown with some indication of fine darker markings longitudinally. Sides of neck and jawline smudged dark grey, with heavy black edging to scales. Ventral surfaces creamy yellow. Dorsal surfaces of limbs light brown, flecked with darker markings; undersides creamy yellow. Tail creamy brown.

Description of type series. Body robust with keeled dorsal scales. Head barely distinct from neck. Snout rounded in profile. Limbs moderate; four fingers; five toes. Adult measurements and proportions: see Table 1.

Scalation: rostral in broad contact with frontonasal. Postsupralabial divided. Nasals widely spaced. Prefrontals large, usually narrowly separated (narrow separation 87%, moderate separation 13%) (Fig. 9D). Supraoculars 4, 1 and 2 in contact with frontal, 2, 3 and 4 in contact with frontoparietal. Frontoparietals fused, forming a single shield. Interparietal distinct. Enlarged nuchal scales 2. Loreals 2. Preoculars 2; upper preocular very small, generally a narrow vertical sliver or sometimes a minute granule (Fig. 10F). Presubocular single. Supraciliaries 5 (66%) or 6 (33%). Lower eyelid movable with clear window; palpebral disc large, occupying more than half of lower eyelid. Ear aperture smaller than palpebral disc. Ear opening vertically elliptic with one (44%) or two (56%) rounded lobules on the anterior margin (Fig. 8D). Supralabials 7 (89%) or 8 (11%), with the fifth below the eye. Infralabials 6 (85%) or 7 (15%). Three scales between the nasal scale and the presubocular. Midbody scale rows 32–34 (mean = 34). Dorsal midbody scales predominantly with bicarinate keels, but usually a mix of scales with bicarinate and tricarinate scales. Paravertebral scale rows 49–53 (mean = 51). Forelimb tetradactyl, with 21–23 (mean = 22) lamellae beneath 3rd finger. Hindlimb pentadactyl, with 27–31 (mean = 29) lamellae beneath 4th toe.

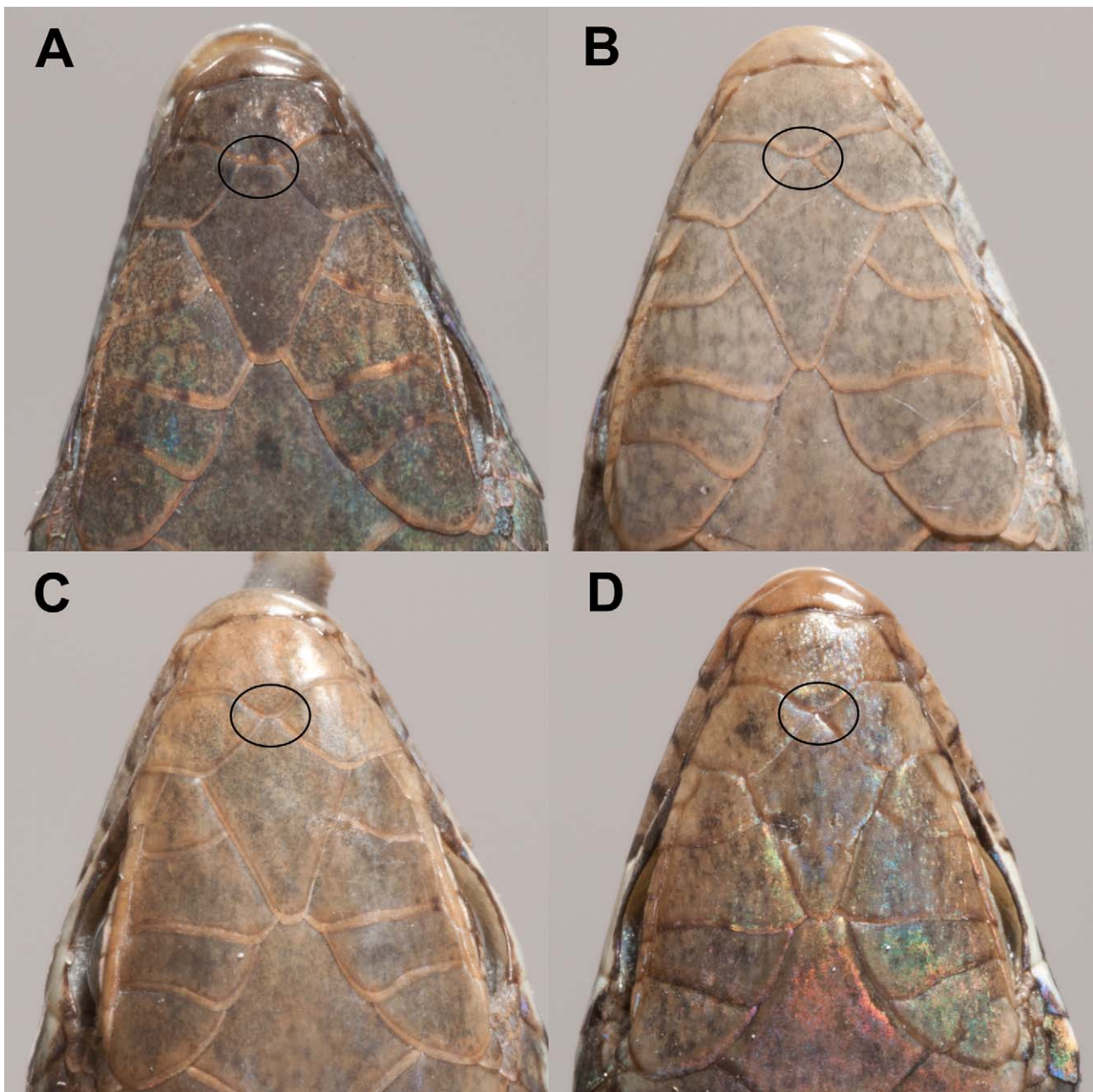


FIGURE 9. Typical prefrontal scale spacing in: (A) *C. decora* sp. nov., QMJ63912, Cathu State Forest; (B) *C. rubigo* sp. nov., QMJ76655, Magnetic Island; (C) *C. pectoralis*, QMJ41536, Pine Ck Timber Reserve, Eurimbula area; (D) *C. inconnexa*, QMJ89132, Whitsunday Island. Photos: Jeff Wright.

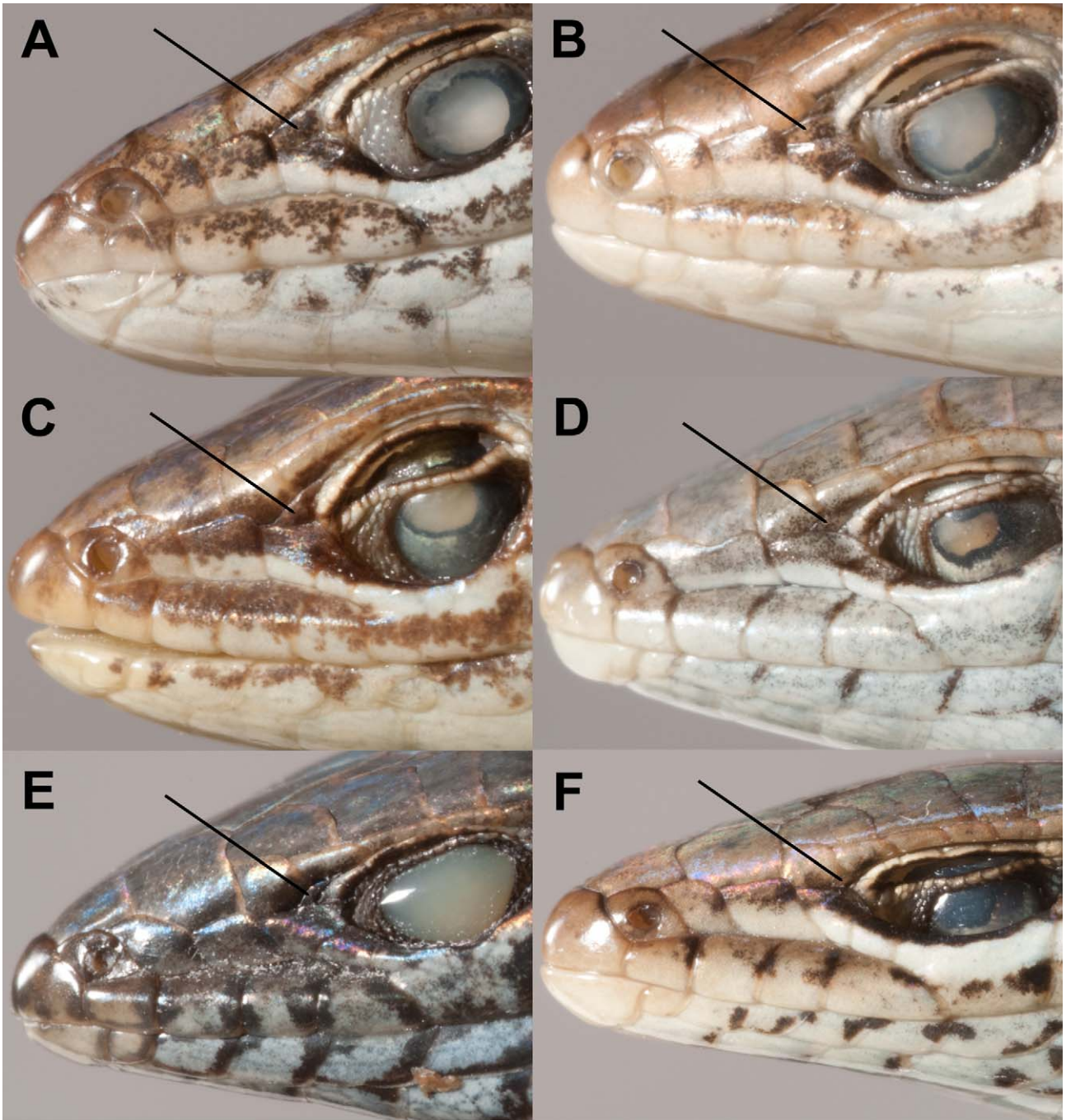


FIGURE 10. Upper preocular scale states. *Carlia decora* **sp. nov.** has an upper preocular that is well developed and either contacting the posterior edge of the 2nd loreal scale (A, B) or broadly triangular (C). The upper preocular of (D) *C. rubigo* **sp. nov.**, (E) *C. pectoralis*, and (F) *C. inconnexa* is typically a narrow vertical sliver. Photos details: (A) *C. decora* **sp. nov.**, QMJ90882, Mt Elliot; (B) *C. decora* **sp. nov.**, QMJ90875, Mt Elliot; (C) *C. decora* **sp. nov.**, QMJ74805, Cape Hillsborough; (D) *C. rubigo* **sp. nov.**, QMJ76655, Magnetic Island; (E) *C. pectoralis*, QMJ83396, Carnarvon Station; (F) *C. inconnexa*, QMJ89132, Whitsunday Island Photos: Jeff Wright.

Colour pattern in preservative. Males (Figs 3D, 4D, 5D, 7D): dorsal and lateral surfaces have a mottled grey, black and white appearance. Dorsum grey with an obvious paravertebral pair of black blotches interspersed with white flecks; more rarely, fine black dorsal stripes on a more even brown background. Scales iridescent. Top of head black or brown. Flanks grey and heavily mottled with black smudges and white flecks. Flanks of some individuals have a soft orange, copper or greenish wash. Sides of head, neck and throat either completely black or heavily smudged or mottled with black or bluish black. Top of limbs mottled grey, black and white; undersides

pale. Ventral surfaces cream or grey. Tail brown or grey, with heavy black and white blotching and flecking. Females (Fig. 6D): dorsal and lateral surfaces have a mottled brown, grey, black and white appearance. Dorsum brown or grey with an obvious paravertebral pair of black blotches interspersed with white flecks. Scales iridescent. Top of head brown or copper. Flanks heavily mottled brown, grey, black and white. Generally a row of black blotches along the upper flank. Thin white line from nare to tympanum, then extending as an indistinct ragged, mottled or flecked white line along at least the anterior portion of the flank. Top of limbs mottled grey, black and white; undersides pale. Ventral surfaces grey or cream. Tail brown or grey, with heavy black and white blotching and flecking.

Colour pattern in life (Fig. 1H). Both sexes grey or brownish and heavily blotched and flecked with black and white markings. Dorsum variable: usually a pair of paravertebral stripes consisting of black blotches and white flecks, or, more rarely, fine black dorsal stripes on a more even brown background. Flanks heavily blotched and flecked with black and white, particularly on the upper flanks. Adult females have an obscure, ragged, narrow, whitish mid-lateral stripe. Ventral surfaces greyish white. Colouration in life of breeding males is not known but the following can be interpreted from preserved specimens in breeding colour (Figs 1–5). The throat, head and neck are black. At maximum breeding extent the entire head of males is black. Some males in preservative have a copper wash to the flanks. Based on comparisons with males of other *Carlia* species covered herein that were examined in life then subsequently after preservation, it is unlikely that male *C. inconnexa* have bright orange lateral lines in life (as for *C. decora* **sp. nov.** and *C. pectoralis*). Rather, it is likely they have an orange/copper wash to the flanks when breeding.

Comparison. *Carlia inconnexa* is a highly distinct species that is readily distinguished from all congeners. The only species it is likely to be confused with are *C. vivax*, *C. decora* **sp. nov.**, *C. rubigo* **sp. nov.**, *C. pectoralis*. The similarity to *C. vivax* is that *C. inconnexa* has predominately bicarinate mid-dorsal scales; however, the two species are otherwise easily distinguished. *Carlia inconnexa* is larger (SVL 46–53 mm *vs.* < 47 mm) and more robust, has higher counts on several scale traits (e.g. mid body scale rows, mean 34 *vs.* mean 30; lamellae under 4th toe, mean 29 *vs.* mean 25) and male and female *C. inconnexa* are grey or brown with black and white mottling (*vs.* *C. vivax* not mottled). From *C. decora* **sp. nov.**, *C. rubigo* **sp. nov.** and *C. pectoralis*, *C. inconnexa* can be distinguished by larger size (mean SVL 50 mm *vs.* means of less than 45 mm for the other species), more midbody scales (32–34 *vs.* 32 or less), more paravertebral scales (mean 51 *vs.* means 47), generally higher counts for lamellae under the 4th toe and 3rd finger, heavily mottled colouration of males and females, and black head of breeding males (Table 1; Figs 1–6). *Carlia inconnexa* superficially resembles *Liburnascincus mundivensis* (Broom), which is also a robust, grey or brown, blotched, rock-dwelling species (but is not known to occur on the Whitsunday Islands). The two species are readily distinguished by predominately bicarinate dorsal scales on *C. inconnexa* (*vs.* predominately tricarinate in *L. mundivensis*), fewer supraciliaries in *C. inconnexa* (generally 5 *vs.* 7), ear opening of *C. inconnexa* vertically elliptical with 1–2 rounded, anterior lobules (*vs.* round ear opening surrounded by many acute lobules) and fewer midbody scale rows for *C. inconnexa* (32–34 *vs.* 34–42).

Genetics. *Carlia inconnexa* is approximately 10% divergent (ND4 mtDNA) from *C. rubigo* **sp. nov.** and *C. pectoralis* and approximately 16% divergent from *Carlia decora* **sp. nov.** (C. Hoskin, unpublished data). A representative ND4 mtDNA sequence for this species from Whitsunday Island is JX291974 (GenBank accession number).

Distribution. *Carlia inconnexa* is found on islands of ‘the Whitsundays’ off mid-eastern Queensland (Fig. 11). It is known from Whitsunday, Hook and Hayman islands of the Whitsunday Group, and Lindeman Island (Lindeman Group). All these islands are part of the Cumberland Islands.

Habitat and habits. *Carlia inconnexa* is found in rocky forests and scrubs (Fig. 12D). It appears to be primarily saxicoline.

Remarks. Ingram & Covacevich (1989) described *inconnexa* as a subspecies of *C. pectoralis* based on bicarinate (versus tricarinate) dorsal scales and dark lines on the dorsum of males. We have elevated *inconnexa* to species status due to substantial further differences from *C. pectoralis*, *C. rubigo* **sp. nov.** and *C. decora* **sp. nov.** *Carlia inconnexa* is a considerably larger skink and has more paravertebral and midbody scales than the other species, and generally has more subdigital lamellae under the 3rd finger and 4th toe. It also differs substantially in colour pattern compared to the other species. Both sexes of *C. inconnexa* are usually heavily mottled with black and white and the breeding colour of males at maximum extent is unique in that the head, throat and neck are black.

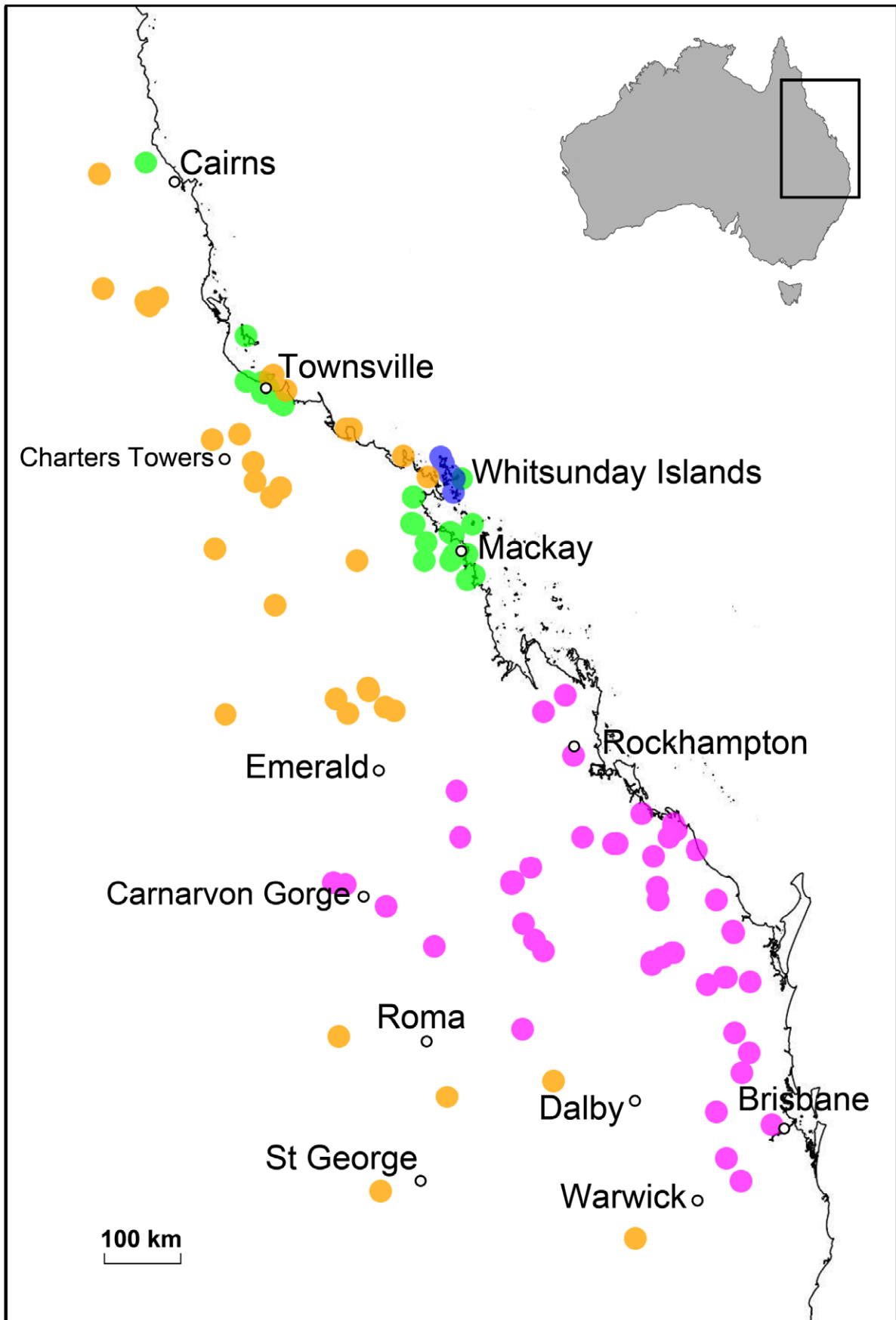


FIGURE 11. Map of eastern Queensland, north-east Australia, showing distributions of *C. decora* sp. nov. (green dots), *C. rubigo* sp. nov. (mustard dots), *C. pectoralis* (purple dots) and *C. inconnexa* (blue dots). Focal area is marked as a box on the inset map of Australia. Background layer source: Atlas of Living Australia.

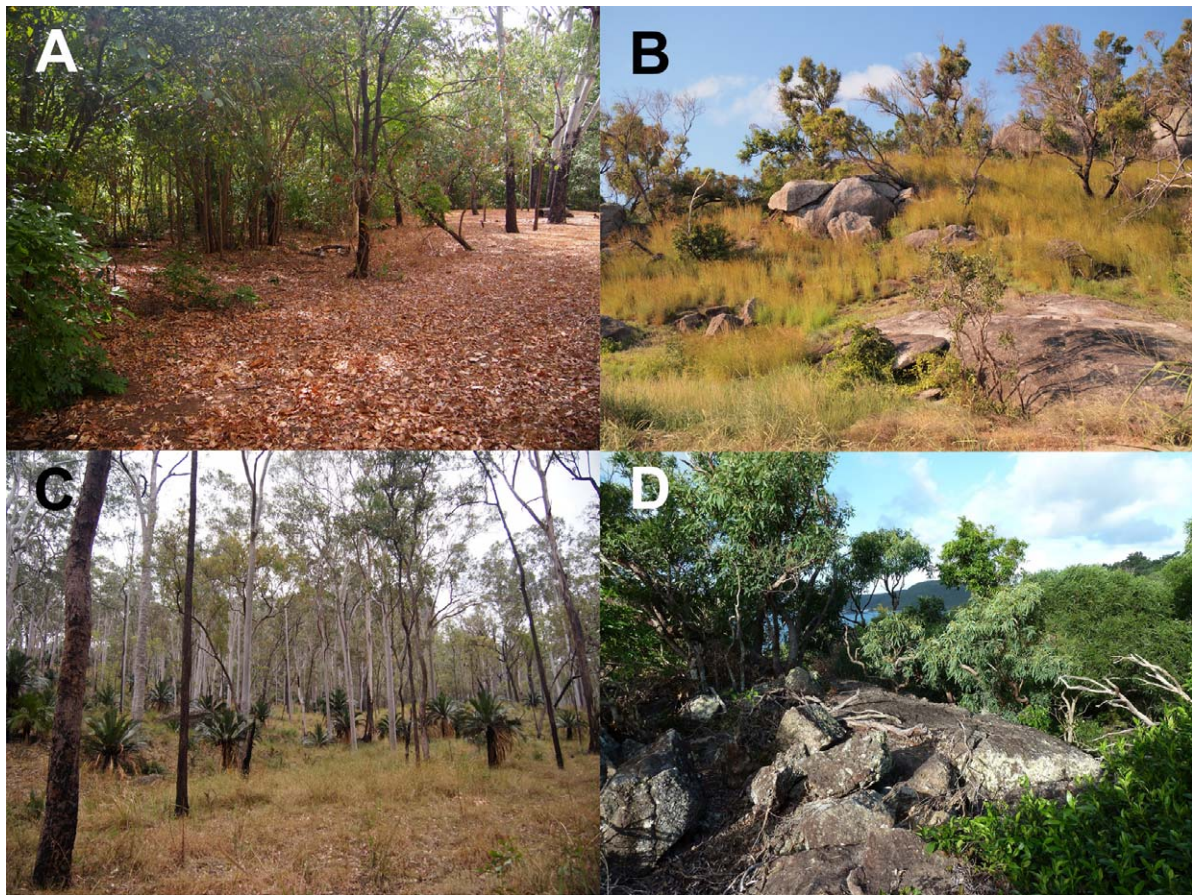


FIGURE 12. Photos of habitat of: (A) *C. decora* **sp. nov.**, Mt Elliot; (B) *C. rubigo* **sp. nov.**, Cape Cleveland; (C) *C. pectoralis*, Carnarvon Gorge; (D) *C. inconnexa*, Whitsunday Island. Photo credits: Conrad Hoskin (A–C), Andrew Amey (D).



FIGURE 13. The lectotype of *Heteropus lateralis* de Vis 1885, QMJ234, Pine River, north Brisbane area.

We regard the photo of a male *C. inconnexa* in Wilson & Swan (2010) as dubious. The individual is not heavily mottled and, although in breeding colours, it lacks any black on its head. The bright orange upper and lower lateral lines are also atypical compared to the colour pattern evident on the male *C. inconnexa* specimens we examined (generally a faint copper wash to the flanks). The colour pattern of the male in this photo is generally consistent with that of *C. decora* **sp. nov.**, a species that also occurs on Whitsunday Island. We are not aware of any photo in life of a male *C. inconnexa*. Photos of males in life are required.

Discussion

The species discussed herein belong to two species groups presented in Dolman & Hugall (2008, Fig. 1): *C. decora* **sp. nov.** belongs to the *C. vivax* clade [along with *C. vivax*, *C. dogare* Covacevich & Ingram 1975 and *C. rostralis* (de Vis 1885)], and *C. pectoralis*, *C. inconnexa* and *C. rubigo* **sp. nov.** belong to the *C. pectoralis* clade [along with *C. munda* (de Vis 1885)] (Hoskin, unpub. data). In all members of the *C. vivax* clade, the upper preocular is large and either in contact with the posterior margin of the second loreal scale or broadly triangular and narrowly separated from the posterior margin of the second loreal scale. In the *C. pectoralis* clade, this scale is very small (generally a narrow vertical sliver) and widely separated from the second loreal scale. We examined the upper preocular state in a selection of *Carlia* species and species in allied genera (*Liburnascincus* and *Lygisaurus*) (see Appendix for list of specimens and upper preocular state in each species). The large upper preocular scale state is the more common state across the *Carlia* tree (Fig. 1 in Dolman & Hugall 2008), being the condition for several clades and distantly related species. All *Lygisaurus* and *Liburnascincus* species examined also had this state. The small upper preocular scale state (a narrow vertical sliver) diagnoses the *C. pectoralis* clade, the clade comprising *C. johnstonei* Storr 1974, *C. triacantha* (Mitchell 1953) and *C. amax* Storr 1974, and *C. jarnoldae*. From this we conclude that a large upper preocular is the plesiomorphic state (occurring widely in *Carlia* spp. and in allied genera) and a reduced upper preocular is the derived state.

Field surveys are required to resolve the extent of the distributions of *C. pectoralis*, *C. decora* **sp. nov.**, *C. rubigo* **sp. nov.** and *C. inconnexa*. The distributions as currently known (Fig. 11) reveal regions where pairs of these species occur in close proximity, and it is likely that there are sites where species coexist. Regions of interest include: west of the Great Dividing Range in south-east Queensland for *C. pectoralis* and *C. rubigo* **sp. nov.**, and in the vicinity of the south-east Queensland outliers of Carnarvon Gorge and Blackdown Tableland for these two species; the Townsville to Mackay region for *C. decora* **sp. nov.** and *C. rubigo* **sp. nov.**; coastal mid-east Queensland for *C. decora* **sp. nov.**, *C. rubigo* **sp. nov.** and *C. pectoralis*; and islands of the Whitsunday group, where *C. inconnexa* and *C. decora* **sp. nov.** co-occur (and *C. rubigo* **sp. nov.** may also be present on closer inspection). Studies in areas of overlap between species would shed light on ecological differences and the mechanisms of reproductive isolation. Habitat differences are evident. In the Townsville region *C. decora* **sp. nov.** occurs in moister habitats (e.g. vine scrubs, gallery forests) than *C. rubigo* **sp. nov.**, which occurs in dry rocky areas (e.g. Cape Cleveland, Magnetic Island). In regards to mid-east Queensland, *C. decora* **sp. nov.** is once again associated with moister forests than *C. rubigo* **sp. nov.**, and *C. inconnexa* is a primarily rock-dwelling species. *Carlia pectoralis* occurs throughout the *Eucalyptus* forests of south-east Queensland but is replaced by *C. rubigo* **sp. nov.** in hotter, drier areas to the north of this region and west of the Great Dividing Range.

Carlia decora **sp. nov.** has a similar distribution to *C. rhomboidalis* (Peters) and *Lygisaurus zuma* Couper, two skinks that are also restricted to the Mackay region (Sarina, Eungella Range, Conway Range) and the Townsville region (Mt Elliot, Cape Cleveland, Magnetic Island for *C. rhomboidalis*; Mt Elliot, South Paluma Range, Bluewater Range for *L. zuma*). Specimens matching *C. decora* **sp. nov.** were also identified from Mt Molloy in the northern Wet Tropics, so this species may also be patchily distributed north from Townsville through the Wet Tropics region. *Carlia decora* **sp. nov.**, *C. rhomboidalis* and *L. zuma* are associated with mesic habitats (rainforest edge, vine scrubs, gallery forest, seasonally wet open forests) and, for all three species, the populations of the Mackay and Townsville regions appear to be disjunct across the intervening dry habitat barrier—the Burdekin Gap. This gap separates the distinctive rainforest faunas of mid-east Queensland and those of the Wet Tropics region (Moritz *et al.* 2005). These skinks and *Phyllurus* Schinz (leaf-tail) geckos are low vagility, mesic forest groups that span this gap (Couper *et al.* 2000; Hoskin *et al.* 2003); illustrating the legacy of historical moist forest connections between mid-east Queensland and the southern Wet Tropics.

The distribution of *C. pectoralis*, as redescribed herein, adds to the list of open forest species that are restricted to south-east Queensland (e.g. *Oedura jacovae* Couper, Keim & Hoskin, *Delma torquata* Kluge) or reach their northern extent in this region [e.g. *Oedura tryoni* de Vis, *Saiphos equalis* (Gray)]. As for *C. pectoralis*, the distribution of these species typically includes the topographic outliers (Kroombit Tops, Blackdown Tableland, Carnarvon Gorge) that sit in the north and north-west of the south-east Queensland region. The distribution of *C. inconnexa* is of interest in that it is the only vertebrate species known to be endemic to islands of ‘the Whitsundays’ region. These continental islands (Cumberland and Northumberland Islands) have been referred to as the peaks of ‘drowned’ mountain ranges and are separated from the adjacent mainland coast by the Hillsborough sea channel (Chappell & Thom 1977; Hopley 1983). This channel is shallow and these islands would have been connected to the mainland during periods of lowered sea-level. This would have included ephemeral connections throughout the Pleistocene, with the most recent connection estimated to have been about 8,000 years ago, when the main islands (including Hook and Whitsunday Islands) would have been joined to each other and the mainland as a peninsula (Chappell & Thom 1977; Hopley 1983). It is therefore interesting that *C. inconnexa* has not been recorded on the adjacent mainland and that *C. rubigo* **sp. nov.**, common in dry forests on the adjacent mainland, is not known to occur on islands of the Whitsundays. This may suggest a lack of suitable habitat connection between the Whitsundays and the mainland when land bridges were exposed or exclusion through competitive interactions between the species. Alternatively, one or both species may be found to occur on both sides of the channel with more thorough surveys.

The descriptions herein bring the number of Australian *Carlia* to 22 species, a large proportion of which (17 spp.) occur in Queensland. The addition of *C. decora* **sp. nov.**, *C. rubigo* **sp. nov.** and *C. inconnexa* adds to north-east Queensland's status as the centre of diversity and endemism for this genus (Ingram & Covacevich 1989; Couper *et al.* 2005; Donnellan *et al.* 2009). Preliminary genetic screening of *Carlia* populations in north Queensland (C. Hoskin, unpublished data), and more widely across northern regions of the Northern Territory and Western Australia (C. Moritz, unpublished data), reveals that significant cryptic diversity remains to be assessed across the monsoonal tropics of Australia. A number of species contain deeply divergent genetic lineages that may represent species on detailed assessment.

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APPENDIX

Additional Material Examined. All specimens listed are lodged in the Queensland Museum. The condition of the upper preocular scale is stated.

Carlia amax (upper preocular reduced and well separated from posterior margin of second loreal scale): QMJ36729, Radon Ck (12°40' S, 132°55' E); J36738, Kakadu NP, Twin Falls (13°22' S, 132°50' E); J77572, Selwyn Mine, SE of Mt Isa (21°34' 58"S, 140°29' 39"E); J83945, Maningrida beach (12°02' 42"S, 134°13' 22"E); J83967 Kolorbidahdah (12°39' 02"S, 134°17' 53"E); J84002, Tomkinson River, near (12°34' 53"S, 134°18' 29"E).

Carlia dogare (upper preocular large and contacting posterior margin of second loreal scale): J32415, Hopevale Community, 36km N (15°07' S, 145°15' E); J46157, Jungle Ck, tributary of Hann R (15°29' S, 143°43' E); J53136, Cape Flattery, Site 1 (14°59' S, 145°19' E); J61852, Cape Flattery, Airport Lake (14°59' 49"S, 145°19' 26"E); J61991, Cape Flattery (15°00' 19"S, 145°17' 7"E); J78254, Palmerville Rd (15°31' 14"S, 144°12' 16"E).

Carlia fusca (Duméril & Bibron) (upper preocular large and contacting posterior margin of second loreal scale): J32807, Kavieng, New Ireland Province (02 34' S, 150 48' 0"E); J32874, J32875, Brown R, 30km N, 9km E Port Moresby Cent Prov (09 22' S, 147 13' E); J32890, Itikinumu, Sogeri, Central Province (09 24' S, 147 30' E); J32949, Sogeri Rd, 3km E Rouna Falls, Central Province (09 25' S, 147 33' E); J64414, Wando Village, Bensbach R, SW PNG, (08 53' S, 141 15' E).

Carlia gracilis Storr (upper preocular large and contacting posterior margin of second loreal scale): J34847, J34853, J34854, J34856, J34862, Beatrice Hill Reserve Stn Beatrice Hill Reserve Stn (12°39' S, 131°20' E); J36711, Kemp Airstrip, Middle Pt, N side (12°34' S, 132°19' E).

Carlia jarnoldae (upper preocular reduced and well separated from posterior margin of second loreal scale): J58223, Rokeby NP, Eric Yard (13°37' S, 142°45' E); J61851, Cape Flattery (14°59' 39"S, 145°17' 1"E); J74230, Coal Seam Ck, S of Laura (15°37' 30"S, 144°29' 30"E); J78289, Windmill Ck, Artemis Stn (14°56' 48"S, 143°33' 29"E); J80400, Blackbraes NP, 180 km NE of Hughenden (19°27' 8"S, 144°09' 51"E); J80771, Blackbraes NP, Gilbert River track (19°31' 57"S, 144°03' 55"E).

Carlia johnstonei (upper preocular reduced and well separated from posterior margin of second loreal scale): diagram on page 16 (Storr *et. al.*, 1999).

Carlia longipes (Macleay) (upper preocular large and contacting posterior margin of second loreal scale): J32018, Kungathan (12°22' S, 143°12' E); J34479, Buthen Buthen, Nesbit R, E of Coen (13°21' S, 143°27' E); J34501, J34502, Steens Hut, ca.30km NE Coen (13°34' S, 143°13' E); J34539, Attack Ck, via Coen (13°33' S, 143°15' E); J39727, Hey Pt, 5km S Weipa Airport (12°44' S, 141°53' E); J50519, , Baird Ck, Chinaman Ck, Bloomfield area (16°03' S, 145°18' E); J60333, Starcke Homestead (15 02' 59"S, 145°7' 17"E); J87008, J87049, Black Mountain, via Cooktown (15°38' 54"S, 145°13' 08"E); J88572, J88581, Bridge Creek NP (15°08' 58"S, 144°55' 6"E).

Carlia munda (upper preocular reduced and well separated from posterior margin of second loreal scale): J71739, Mt Walsh NP (25°33' 38"S, 152°3' 20"E); J75944, Albinia Downs NP (24°26' S, 148°27' E); J78363, Laura (15°33' 28"S, 144°26' 28"E); J79092, Thrushton NP, NE of Bollon (27°43' 40"S, 147°43' 45"E); J84048, Healeys Yard, SE Mitchell R (16°11' 52"S, 142°51' 11"E).

Carlia rhomboidalis (upper preocular large and contacting posterior margin of second loreal scale): J82696, J82698, Diamond Cliffs (21°22' 50"S, 148°34' 25"E); J83733, Conway SF (20°24' 02"S, 148°51' 24"E); J89120, Cid Harbour, Whitsunday Is (20°15' 36"S, 148°57' 26"E); J89122, Cid Harbour, Whitsunday Is (20°15' 46"S, 148°57' 48"E).

Carlia rostralis (upper preocular large and contacting posterior margin of second loreal scale or not contacting but broadly triangular): J14147, Mitchell R Mission, Magnificent Ck, Ca 4.8km (15°28' S, 141°45' E); J27619, Hervey Ra, 10km S, 35km W Townsville (19°45' S, 146°36' E); J29372, Kowanyama (15°28' S 141°45' E); J38028, Glen Garland Stn 24km N, via Musgrave (14°50' S, 143°14' E); J45380, Mt Mulligan, summit (16°52' S, 144°52' E); J59768, J59769, Waterview Ck., 5 Km W Bruce Hwy (18°50' S, 146°12' E); J67204, Waterfall Ck, 50 km N Townsville (18°51' S, 146°13' E); J70991, Moon R Pk, Yorkey's Knob, N of Cairns (16°48' 30"S, 145°42' 30"E).

Carlia rubrigularis Ingram & Covacevich (upper preocular large and contacting posterior margin of second loreal scale): J41220, Cape Tribulation (16°05' S, 145°29' E); J45919, Malanda (17°21' S, 145°36' E); J47621, Mt Lewis, via Mt Molloy (16°35' S, 145°17' E); J48169, Walter Hill Ra, Charappa Ck drainage, Suttees Rd (17°42' 30"S, 145°41' 30"E); J48175, Laceys Ck SF, Mission Beach (17°51' 10"S, 146°3' 55"E); J48206, Billy Ck Bridge SF 758, vicinity of bridge (17°49' 25"S, 145°47' 5"E).

Carlia rufilatus Storr (upper preocular reduced and well separated from posterior margin of second loreal scale): J13687, Port Darwin (12°27' S, 130°42' E); J36713, Kemp Airstrip, Middle Pt, N Side (12°34' S, 131°19' E).

Carlia schmeltzii (Peters) (upper preocular large and contacting posterior margin of second loreal scale): J69182, Awoonga Dam, nr Gladstone (24°04' 30"S, 151°18' E); J69775, Isla Gorge, Lookout T'off (25°12' S, 149°58' E); J72704, Lakefield NP (14°46' 02"S; 144°04' 51"E); J73354, Camerons Scrub, top of knoll (27°30' S, 152°44' E); J74302 Boomer Range, Mongrel Scrub (23°12' S, 149°46' E); J75248, South Molle Is (20°15' 30"S, 148°50' 30"E).

Carlia sexdentata (Macleay) (upper preocular large and contacting posterior margin of second loreal scale): J32018, Kungathan (12°22' S, 143°12' E); J34479, Buthen Buthen, Nesbit R, E of Coen (13°21' S, 143°27' E); J34501, J34502, Steens Hut, ca.30km NE Coen (13°34' S, 143°13' E); J34539, Attack Ck, via Coen (13°33' S, 143°15' E); J39727, Hey Pt, 5km S Weipa Airport (12°44' S, 141°53' E).

Carlia storri (upper preocular large and contacting posterior margin of second loreal scale): J39439, Stange Bay, nr Township (22°10' S, 150°04' E); J46350, Nixons Hstd, 19km E Shelburne Stn, nr Harmer Ck, (11°58' S, 142°55' E); J54099, Bertie Ck (11°50' S, 142°30' E); J70351, Weipa Area (12°37' 16"S, 141°56' 27"E); J71579, Yabulu (19°10' 44"S, 146°37' 35"E).

Carlia tetradactyla (O'Shaughnessy) (upper preocular large and contacting posterior margin of second loreal scale): J21957, Jollys Falls, 24km N Stanthorpe, nr Thulimbah (28°33' S, 151°57' E); J26939, Darling Downs, Cecil Plains (27°32' S, 151°12' E); J34129, J34130, Oakey, Darling Downs (27°26' S, 151°43' E); J80812, Charker Street, Toowoomba (27°34' S, 151°57' E).

Carlia triacantha (upper preocular reduced and well separated from posterior margin of second loreal scale): J13686, J13691, Port Darwin (12°27' S, 130°42' E); Port Darwin (12°27' S, 130°42' E); J36742, Pine Ck (13°49' S, 131°50' E); J52983, March Fly Glen Gibb R Rd, (17°10' S, 125°19' E).

Carlia vivax (upper preocular large and contacting posterior margin of second loreal scale or not contacting but broadly triangular): J44286 Maranoa R, E branch, nr Warrong (25°11'S, 147°51'E); J46042 Tangalooma, Shipping Heads S Higher Head (27°12'S, 151°22'E); J46146-47, J46150-51 Mt Mulgrave (16°13'S, 144°02'E); J59243 Bauple SF (25°17'S, 152°34'E); J63860 Squirrel Ck SF, western boundary (26°40' 08"S, 152°16' 34"E); J64365 Targinie, via Gladstone (23°46'S, 151°08'E); J68001 Gladstone, Sthern Pacific Petroleum Site (23°44' 50"S, 151°06' 32"E); J69172 Awoonga Dam, nr Gladstone (24°04'30"S, 151°18' 30"E); J71021 Theodore, Brigalow Research Stn (24°49' 20"S, 149°45' 11"E); J79650 Mon Repos (24°47'S, 152°26'E); J80032 Massy Creek (13°55' 55"S, 143°33' 20"E); J80594, J84759 Gold Creek Reservoir 27°27' 54"S, 152°52' 30"E); J85825 Lake Broadwater (27°21'S, 151°06'E); J88721 Hann Tableland NP, Boyle Creek (16°56' 54"S, 145°19' 08"E); QM J89603 Coen R, Mungkan Kaanju NP (13°39'34"S, 142°40'02"E).

Liburnascincus coensis (Mitchell) (upper preocular large and contacting posterior margin of second loreal scale): J86919, Peach Creek, McIlwraith Range Kulla NP (13 45' 29"S, 143 19' 57"E); J86930, J86931, J86932, J86934, Tozers Gap, Iron Range NP (12 43' 43"S, 143 11' 14"E); J88869, Mount Tozer area (12 42' 50"S, 143 10' 26"E).

Liburnascincus mundivensis (upper preocular large and contacting posterior margin of second loreal scale or not contacting but broadly triangular): J26635, Moongobulla, 1km W, ca.65.3km NW Townsville (18°59' S, 146°19' E); J33866, J33924, J33930, Homevale, Oaky Ck bank, adjoining Site 10 (21°27' S, 148°32' E); J37967, Lolworth Ra, ca.50km N Pentland (20°16' S, 145°22' E); J42081, Chillagoe, 7km W (17°09' S, 144°28' E).

Lygisaurus aeratus (Garman) (upper preocular large and contacting posterior margin of second loreal scale): J26612, J26613, Ingham, 19.9km S, on Bruce Hway (18°50' S, 146°09' E); J57984, Meton Yard, Strathgordon Holding (14°41' S, 142 17' 0"E); J62400, Palmer R (16°09' S, 144°08' E); J65224, Clemant SF, 5km SE Rollingstone (19°03' 50"S, 146°25' 59"E); J84046, Healeys Yard, SE Mitchell R (16°11' 52"S, 142°51' 11"E).

Lygisaurus foliorum de Vis (upper preocular large and contacting posterior margin of second loreal scale or not contacting but broadly triangular): J69864, , Nth Theodolite Ck, SE of Bundaberg (25°4' 30"S, 152°28' 30"E); J69945, Goodedulla NP (23°16' 04"S, 149°45' 27"E); J71012, Theodore, Brigalow Research Stn (24°49' 20"S, 149°45' 11"E); J73329, Fraser Island, ridge behind Sterling Castle Dr (24°57' 45"S, 153°18' 29"E); J73734, Mt Rose, via Taroom, (25°25' S, 149°58' E); J76437, Coomingleh SF, nr Monto (24°54' 4"S, 151°1' 05"E).

Lygisaurus parrhasius (Couper, Covacevich & Lethbridge) (upper preocular large and contacting posterior margin of second loreal scale): J58680 – 82, Glennie Tableland (12°22' S, 142°57' E); J87002, J87004, Glennie Tableland (12°27' 38"S, 142°55' 40"E).

Lygisaurus sesbrauna Ingram & Covacevich (upper preocular large and contacting posterior margin of second loreal scale): J24793, Cape York, Lockerbie Scrub (10°48' S, 142°28' E); J54108, Captain Billy landing rd (11°39' S, 142°44' E); J58190, Peach Ck, 'top crossing' (13°43' S, 143°16' E); J58634, Schramm Ck, 9.5km SSW of Bramwell Hs (12°13' S, 142°35' E); J77447, McIlwraith Range, headwaters Peach Ck (13°44' 15"S, 143°20' 20"E); J78387, McIlwraith Ra, Station Creek, Klondyke Mine (13°57' 35"S, 143°19' 55"E).