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A New Species of Treefrog (Hylidae, *Litoria*) from the Southern Lowlands of New Guinea

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Abstract: A new species of small green treefrog in the genus *Litoria* is described from the Lakekamu Basin, Gulf Province, southern Papua New Guinea. This species is associated with the *Litoria gracilenta* group on the basis of its pale canthal stripe and predominantly green dorsum, but can be differentiated from other species in the group by its more robust build (head width/snout-vent length [SVL] 0.37–0.38) and small body size (SVL of three adult males 28.3–28.7 mm). Dorsal colouration is either plain green or green with numerous small dark spots, suggesting colour polymorphism. This dark-spotted colouration is also unique amongst the *L. gracilenta* complex.

Key words: Hylidae; *Litoria*; New species; Papua New Guinea; Lakekamu Basin

INTRODUCTION

Small green treefrogs of the *Litoria gracilenta* group (Tyler and Davies, 1978) are widespread across north-eastern Australia, New Guinea and surrounding islands. They can be readily distinguished from all other *Litoria* by their distinct pale canthal stripe, small to moderate body size, and predominantly green dorsal colouration (Menzies and Tyler, 2004). In a recent revision of the *L. gracilenta* group, Menzies and Tyler (2004) confined true *L. gracilenta* to Australia, and described two new species from Papua New Guinea: *Litoria auae* from low elevations in the Gulf and Western Provinces and *Litoria kumae* from higher elevations along the central cordillera. Two other members of the group are known primarily from Papua Province, Indonesian New Guinea: *Litoria aruensis* from scattered localities across the Papuan region, and *Litoria elkeae* from the Nabire and Wapoga River area in northern Papua Province, Indonesia (Günther and Richards, 2000).

During a biological survey in the Lakekamu Basin of Gulf Province, Papua New Guinea, one of us (DS-F) collected three specimens of the hylid genus *Litoria* that resemble the *L. gracilenta* group in being small and predominantly green, and in possessing a distinct canthal stripe and partially webbed hands. However they differ from all recognized members of the group in the combination of relatively small body size, more robust build and unique and distinctive colouration. Herein we describe them as a new species.

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Materials and Methods

Freshly collected specimens were fixed in 10% formalin and stored in 70% ethanol. Vouchers are deposited in the South Australian Museum, Australia (SAMA). The following measurements were taken to the nearest 0.1 mm with dial calipers and a stereomicroscope fitted with an ocular micrometer: SVL (snout-vent length), TL (tibia length), HW (head width at tympanum), HL (head length, from tip of snout to posterior edge of tympanum), EYE (horizontal eye diameter), TYM (horizontal tympanum diameter), IN (internarial distance), EN (distance between anterior edge of eye and posterior edge of naris), 3FD (transverse diameter of third finger disc), 3FP (narrowest transverse width of penultimate phalanx), 4TD (transverse diameter of fourth toe disc), and 4TP (penultimate phalanx, as for third finger). We examined comparative material in the Museum Zoologicum Bogoriense (MZB), National Museum of Natural History, Leiden (RMNH), Papua New Guinea National Museum (PNGNM), South Australian Museum (SAMA), Queensland Museum (QM), and Zoological Museum, Berlin (ZMB). Additional data for comparisons were taken from Menzies and Tyler (2004). Specimens with JCU numbers are currently at the South Australian Museum and will be shared between that institution and the Natural Sciences Resource Centre of the University of Papua New Guinea (UPNG).

Litoria robinsonae sp. nov.
(Figs. 1–5)

Holotype

SAMA R55527, adult male with vocal slits and nuptial pads, Ivimka Camp (07 44 05S, 146 29 45E), 10 km south west of Tekadu on an unnamed tributary of the Avi Avi River, Lakekamu Basin, Gulf Province, Papua New Guinea, collected by Devi Stuart-Fox, on 12 January 2001.

Paratypes

SAMA R55528-529, two adult males, with same locality and collector information as the

Fig. 1. Lateral view of head of holotype of *Litoria robinsonae* sp. nov. (SAMA R55527). Scalebar= 5 mm.

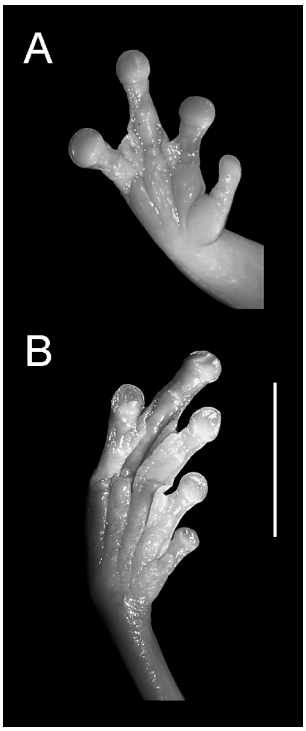

Fig. 2. Palmar (A) and Plantar (B) views of holotype of *Litoria robinsonae* sp. nov. (SAMA R55527). Scalebar=5 mm.

holotype. Collected between 5 and 25 January 2001.

Diagnosis

Litoria robinsonae sp. nov. can be distinguished from all *Litoria* in New Guinea by the following combination of characters: moderately small size (SVL of three males 28.3–28.6 mm); dorsum green, with or without extensive dark and some white spotting; hands and feet partially webbed; weak pale canthal stripe; and relatively robust build (HW/SVL 0.37–0.38).

Description of holotype

Measurements are given in Table 1. Body robust, head moderately broad, limbs relatively long. Head wider than long, relatively short; snout truncate in dorsal and lateral views. Canthus rostralis straight, weakly defined; loreal region slightly concave; labial region not markedly flared. Nares close to tip of snout, visible only in lateral and anterior views; internarial distance equal to distance between eye and naris, distance from eye to naris less than eye diameter. Eye large and prominent, protruding in both lateral and dorsal views; pupil horizontal. Vomerine teeth in two small clumps between the choanae; vocal slits moderately long, positioned laterally, extending to just anterior of jaw angle. Tongue round with slight posterior indentation. Tympanic annulus moderately visible, bordered at dorsal edge by weak, straight supratympanic fold.

TABLE 1. Measurements (in mm) and ratios for the type series of *Litoria robinsonae* sp nov.

	SAMAR55527	SAMAR55528	SAMAR55529
	Holotype	paratype	paratype
SVL	28.7	28.6	28.3
TL	16.6	16.0	15.6
EN	3.0	2.9	2.9
IN	3.0	2.9	2.6
HL	10.4	10.2	10.3
HW	10.9	10.6	10.8
EYE	4.1	4.0	3.8
EAR	2.0	1.6	2.0
TD4	1.5	1.6	1.2
TP4	1.1	0.9	1.0
FD3	1.5	1.8	1.7
FP3	1.0	1.0	1.0

Fingers moderately short, relative lengths III>IV>II>I, with enlarged terminal discs with circum-marginal grooves; thick fleshy webbing between all fingers, restricted to a thin basal strip between fingers I and II, extending to tubercle 2 (tubercle 1 being distalmost) on both fingers between II and III, to approximately tubercle 2 on finger III and between tubercles 1 and 2 on finger IV between III and IV. Subarticular tubercles conspicuous, two on fingers I and II, three on fingers III and IV; tubercle 2 on fingers III and IV faintly bilobed, remainder small and round. Large nuptial excrescence on finger I covering proximal lateral surface and most of dorsal surface between disc and base. Toes moderately long, relative lengths IV>V>III>II>I with enlarged discs and circum-marginal grooves; thick fleshy webbing, in a thin strip between toes I and II, extending to tubercle 2 on toe II and to tubercle 3 on toe III between II and III, to disc on toe III and just proximal to tubercle 2 on toe IV between III and IV, and to just proximal of tubercle 2 on toe IV and almost to disc on toe V between IV and V. Each toe with distinct dermal flanges extending from distal edge of webbing to disc. Subarticular tubercles round, indistinct on all toes; very indistinct small, ovoid metatarsal tubercle at proximal edge of base of thumb. Skin on snout, head and dorsal surfaces of body smooth with minute pores visible microscopically; throat finely granular; belly, lateral surfaces of body and area around vent coarsely granular; all surfaces of arms and legs smooth.

In preservative dorsal surfaces of body and head light slate blue with many dark grey spots. Colour of upper arm, tibia, and posterior edge of tarsus similar but with extensive off-white flecking especially on distal surfaces; tarsus with single row of grey spots. Lateral

and ventral surfaces of body and limbs pale off-white without markings. Area of gradation between green dorsal colouration and off-white lateral colour is narrow and sharply defined with relatively little mixture between the two colours.

Variation

Body measurements of the two paratypes are presented in Table 1. All types are relatively small robust frogs with very similar proportions (Table 2). One paratype (SAMA R55528) lacks the extensive spotting on the dorsal and dorso-lateral surfaces; the only markings on the dorsum of this specimen are two small white spots (Fig. 3B). The other paratype (SAMA R55529) has many small white spots scattered in the middle and posterio-lateral regions of the body, in addition to the extensive dark spotting seen on the holotype.

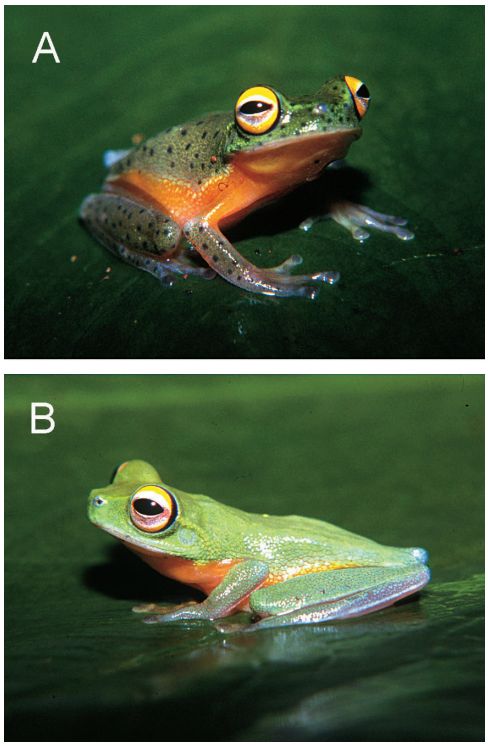

FIG. 3. *Litoria robinsonae* sp. nov. in life showing variation in dorsal colouration (A) spotted holotype (SAMA R55527) (B) plain paratype (SAMA R55528), both specimens from the Lakekamu Basin, Gulf Province Papua New Guinea. Photographs D. Stuart-Fox.

Colouration in life

Colour photographs of the holotype and one paratype in life are shown in Fig. 3. These individuals illustrate the two distinct dorsal colour patterns shown in the type series. The holotype (SAMA R55527, photo A) has a pattern consisting of a bluish green dorsum with extensive dark spotting. The paratype (SAMA R55528, photo B) has an almost completely unmarked pale green dorsum. In other features these two animals share similar colouration: ventral and ventrolateral surfaces bright orange; a distinct pale bluish tinge on the lateral surfaces of the arms and thighs; and discs and anterior-most digits of both the hands and feet bluish-grey tending towards translucent. In both specimens photographed a distinct yellowish-green canthal stripe is clearly visible, the outer iris is bright orange, and the inner iris is off white.

Comparison with other species

Litoria robinsonae can be readily distinguished from all recognized species of the genus except for members of the *Litoria gracilenta* group by a combination of small body size (SVL<30 mm), predominantly green dorsal colouration, and a pale canthal stripe. We compared the types of the new species with New Guinean members of the *L. gracilenta* group including paratypes of *L. auae*, *L. elkeae* and *L. kumae*. Table 2 summarises data for the type series of *L. robinsonae* and several geographically proximate populations of the *L. gracilenta* group. *Litoria robinsonae* can be distinguished from previously described members of the group by its more robust build (HW/SVL 0.37–0.38 vs 0.31–0.35 [range across all populations examined]; Fig. 4). Because we noticed consistent differences in colouration between highland and lowland populations of the geographically most proximate species *L. auae* (see discussion), these populations were compared with the new

TABLE 2. Average and range (in parenthese) of key measurements (in mm) and proportions of male frogs from populations refered to the *Litoria gracilenta* group from Papua New Guinea.

	L. robinsonae sp. nov. n=3	*L. auae* n=7	*L.* cf *auae* n=11	*L. kumae* n=3	*L.* cf *kumae* n=4
SVL	28.5 (28.3–28.7)	33.8 (32.8–34.9)	32.3 (32.3–34.9)	27.5 (27.5–27.5)	30.6 (29.6–31.8)
TL	16.1 (15.6–16.6)	19.0 (18.3–19.7)	17.65 (16.9–18.8)	15.0 (13.8–15.6)	16.4 (15.4–17.1)
HL	10.3 (10.2–10.4)	11.1 (10.8–11.8)	10.7 (9.8–11.4)	8.7 (8.7–8.8)	9.8 (9.1–10.8)
HW	10.8 (10.6–10.9)	11.3 (10.4–11.9)	10.1 (10.0–12.1)	9.1 (9.0–9.1)	9.88 (9.17–10.33)
EYE	3.9 (3.7–4.1)	4.5 (4.1–5.0)	4.2 (3.7–4.7)	3.4 (3.2–3.6)	3.73 (3.50–4.00)
HW/SVL	0.38 (0.37–0.38)	0.33 (0.31–0.35)	0.33 (0.31–0.35)	0.33 (0.33–0.33)	0.32 (0.31–0.33)
HL/SVL	0.36 (0.35–0.36)	0.33 (0.32–0.34)	0.32 (0.30–0.34)	0.32 (0.31–0.32)	0.32 (0.31–0.34)
TL/SVL	0.56 (0.55–0.58)	0.56 (0.55–0.58)	0.53 (0.49–0.57)	0.54 (0.50–0.57)	0.54 (0.52–0.55)
HW/HL	1.05 (1.04–1.05)	1.02 (0.95–1.09)	1.03 (1.00–1.06)	1.04 (1.04–1.05)	1.01 (0.96–1.07)
EYE/SVL	0.13 (0.13–0.14)	0.13 (0.12–0.14)	0.13 (0.12–0.14)	0.13 (0.12–0.13)	0.12 (0.12–0.13)

species separately. *Litoria robinsonae* is smaller than all specimens referred to *L. auae* (28.3–28.6 mm vs 32.3–34.9 mm; see also data in Menzies and Tyler [2004]) and has a shorter head (HL/SVL 0.35–0.36 vs 0.32–0.34). The geographically most proximate lowland populations of *L. auae* tend to have extensive large white spots in preservative (vs few or no white spots); photographs in life also show that *L. auae* has orange thighs (Menzies, 2006) while *L. robinsonae* has blue thighs. The highland species *L. kumae* is approximately the same size as *L. robinsonae* (27.4–27.5 mm vs 28.3–28.6 mm; see also Menzies and Tyler [2004]), but in addition to its more robust build, *Litoria robinsonae* can be distinguished by its proportionally longer head (HL/SVL 0.35–0.36 vs 0.31–0.32), slightly larger eyes (EYE/SVL 0.13–0.14 vs 0.12–0.13) and distinct dorsal spotting. In preservative the types of *L. robinsonae* are also light slate green, while all high altitude populations of *L. auae* and all *L. kumae* are dark green. *Litoria robinsonae* can be distinguished from populations of *L. aruensis* by its smaller body size and less extensive webbing on the hands (webbing does not extend beyond subarticular tubercle 2 on either side of finger III [Tyler, 1968]). The geographically distant *L. elkeae* is similar in body size (SVL 25.5–30.4 mm) but possesses extensive whitish (never dark brown) dorsal spotting and yellow inner thighs (Günther and Richards, 2000). *Litoria gracilenta*, known only from Australia, is much larger (SVL of adult males>30 mm), and never exhibits dark spotting on the dorsum (Cogger, 2000; S. Richards pers. obs.).

Distribution and ecology

Litoria robinsonae is known only from the Lakekamu Basin in Gulf Province, Papua New Guinea (Fig. 5), where it formed calling aggre-

FIG. 4. Dorsal views of holotype of *Litoria robinsonae* sp. nov. (SAMA R55527, right), and paratypes of *L. auae* (SAMA R57262, middle) and *L. kumae* (SAMA R57261, left) showing differences in colouration, body size and proportions.

gations around stream pools and swampy areas in the primary lowland forest along a tributary of the Avi Avi River (further descriptions of collecting localities are given in Mack 1998). Males were found calling from low vegetation (<1 m above the ground). Surrounding forested areas in Gulf Province have not been well surveyed, so the new species may actually be more widespread. Until its distribution is better documented we recommend that the conservation status of the new species be considered Data Deficient according to the criteria used for the Global Amphibian Assessment (IUCN et al., 2006).

Etymology

For the late Honourable Justice Margaret Ann Clare Robinson, judge of the Family Court of Australia, in whose memory a donation for research into Melanesian herpetofauna was made to the South Australian Museum.

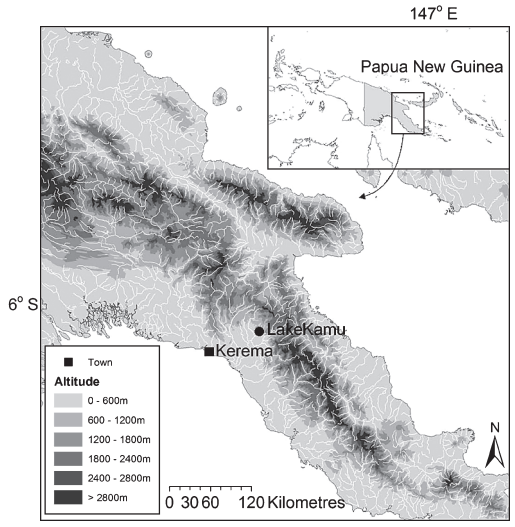

FIG. 5. Map of southern Papua New Guinea showing the position of the Lakekamu Basin, type and only known locality of *Litoria robinsonae* sp. nov.

DISCUSSION

The combination of morphological features exhibited by *L. robinsonae* suggests that its evolutionary relationships lie with the *L. gracilenta* group. In particular, a distinct canthal stripe is not present in any other Papuan hylids and this feature may be a synapomorphy for the *L. gracilenta* group (Tyler and Davies, 1978). An adequate assessment of the phylogenetic placement of *L. robinsonae* must await collection of additional specimens with associated recordings of advertisement calls and tissues for molecular phylogenetic analysis.

Although our sample size is small, our data suggest that *L. robinsonae* may be polymorphic for dorsal colour pattern. The small series of available specimens show a striking difference in dorsal colouration, with one form heavily spotted with dark grey, while the other form has a uniformly light green dorsum. Polymorphism of dorsal colour is common in *Litoria*, and some species, such as *Litoria multicolor*, are extremely polymorphic (Günther, 2004). Specimens of the normally uniformly green species *Litoria infrafrenata* have also been found heavily speckled with dark grey spots (S. Richards, D. Stuart-Fox, pers. obs.), similar to the variation observed in *L. robinsonae*. More specimens are required to assess the level of colour pattern variation shown by *L. robinsonae*, but our data already indicate that *L. robinsonae* may exhibit the most variable dorsal colour pattern of the *L. gracilienta* group.

In the course of this study it became clear that there is extensive variation within the frogs that are currently referred to *Litoria auae*. Most notably, widely separated lowland populations of *L. auae* in Western Province and Gulf Province consistently have a pale dorsum with large, white spots in preservative. By contrast, highland populations of *L. auae* in closer proximity to the lowland Gulf Province population (e.g. Herowana Village, Eastern Highlands Province [~1500 m asl] and Moro, Gulf Province [800 m asl]) than that population is to the Western Province population are darker and less extensively spotted (but substantially more spotted than Menzies and Tyler's [2004] highland species *L. kumae*). Resolving the taxonomic significance of this apparent altitudinal variation will require further morphological analysis in addition to acoustic and genetic analysis. Regardless of this variation, the small body size, robust build, and dark spotting of *L. robinsonae* readily distinguishes this species from all other frogs in the *L. gracilenta* group that we examined, emphasizing the distinctness of this new taxon.

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Appendix I

Specimens examined

See text for institutional acronyms.

Litoria aruensis, RMNH 4416A-B (syntypes) Aru Islands, Indonesia.

Litoria auae, SAMA R57262-623 (paratypes) Daru, Western Province, Papua New Guinea (PNG); SAMA R6309, Hoeiba nr Tari, Southern Highlands Province, PNG; JCU 4013, 4875, 209028, Tabubil, Western Province, PNG; JCU 4939, 4986, Dark-end Lumber, Gulf Province, PNG; SAMA R11799-800, Nr Purari River, Gulf Province, PNG.

Litoria cf. *auae*, JCU, 2555-558, 2560-561, 2563, 4347, 4349, 4827, Herowana Village, Crater Mountain Wildlife Management area, Eastern Highlands Province, PNG; JCU 2118, 2369, Moro, Southern Highlands Province, PNG.

Litoria elkeae, QMJ 70491-492, MZB 3866, 3869 (paratypes) Siewa, Papua Province, Indonesia.

Litoria kumae, SAMA R57260-261 (paratypes) Tari, Southern Highlands Province, PNG; SAMA R6307-308, Hoieba, Southern Highlands Province, PNG.

Litoria cf. *kumae*, SAMA R34352 Bobole, Southern Highlands Province, PNG; SAMA R34661-663, Namosado, Southern Highlands Province, PNG.

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