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A new frog species (Myobatrachidae: *Uperoleia*) from the Northern Deserts region of Australia, with a redescription of *U. trachyderma*

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Abstract

The frog genus *Uperoleia* (Myobatrachidae) is species rich, with the greatest diversity in the northern monsoonal region of Australia. Due in part to their small body size, conservative morphology and distribution in diverse habitats, the genus is likely to harbor cryptic species. A recent study (Catullo *et al.* 2013) assessed region-wide genetic, acoustic and phenotypic variation within four species in northern Australia. Catullo *et al.* (2013) presented multiple lines of evidence that the widespread *U. trachyderma* comprises distinct allopatric western and eastern lineages within the Northern Deserts bioregion of Australia. Here we formally describe the western lineage as *U. stridera* **sp. nov.** and redescribe the eastern (type) clade as *U. trachyderma.* The new species can be distinguished from *U. trachyderma* by fewer pulses per call, a faster pulse rate, and the lack of scattered orange to red flecks on the dorsum. The description of *U. stridera* **sp. nov.** brings the number of *Uperoleia* species to 28, by far the largest genus in the Myobatrachidae, and further highlights the Australian monsoonal tropics as a region of high endemism.

Key words: Australian Monsoonal Tropics, advertisement call, cryptic species, *Uperoleia stridera* **sp. nov.**, *Uperoleia trachyderma*

Introduction

The frog genus *Uperoleia* (Myobatrachidae) is represented in Australia by 27 currently recognized species, with the majority of species discovery and description occurring in the last few decades. A significant review of *Uperoleia* by Tyler *et al.* (1981) described nine new species, followed by the description *U. aspera* Tyler, Davies & Martin 1981, *U. trachyderma* Tyler, Davies & Martin 1981b, and *U. glandulosa* Davies, Mahony, and Roberts 1985. Six more species were described in 1986 (Davies *et al.;* Davies & Littlejohn). Following almost two decades between the description of new species, the past few years have seen the description of a number of species from the poorly explored monsoonal tropics or arid regions of Australia, including *U. daviesae* Young, Tyler & Kent 2005 from the Top End, *U. micra* Doughty & Roberts 2008 from the north-west Kimberley, and *U. saxatilis* Catullo, Doughty, Roberts, & Keogh 2011 from the Pilbara. The northern monsoonal tropics region has 17 *Uperoleia* species, representing almost two-thirds of *Uperoleia* diversity. Another 10 species occur in the eastern mesic region and the arid zone. The monsoonal tropics are a geologically and climatically diverse region, characterized by a wet summer associated with cyclonic activity, and a dry winter season (Bowman *et al.* 2010). Due to a low population density, little infrastructure, and difficult access during the wet season, this region has been poorly explored.

Catullo *et al.* (2013) investigated genetic, phenotypic, and acoustic variation of the *U. lithomoda/U. trachyderma/U. minima/U. mimula* species complex from across monsoonal northern Australia. Frogs of this species complex represent a monophyletic group that also included five other species with a sharp "click" as a call (see also Catullo *et al.* 2011). This study concluded that multiple lines of evidence supported the existence of two distinct lineages that occur in the western and eastern Northern Deserts bioregion within currently described *U. trachyderma*. While there was some mitochondrial incongruence, the acoustic, nDNA, and morphological

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evidence support the western lineage (hereafter *U. trachyderma* W, described below) as a species distinct from typotypic *U. trachyderma* (hereafter *U. trachyderma* E, Catullo *et al.* 2013; see Fig. 2). Call data distinguished *U. trachyderma* E *versus U. trachyderma* W individuals by pulse rate, call rate and average number of pulses (Table 1, Fig. 2c). *Uperoleia trachyderma* W individuals called at a significantly higher pulse rate and call rate than the *U. trachyderma* E individuals. The *U. trachyderma* W individuals also produced mostly two pulse calls and *U. trachyderma* E individuals produced mostly three pulse calls (Fig. 1c). Despite some evidence of past hybridization, the individuals from the east and the individuals from the west are non-overlapping in discriminant function analyses (Fig. 2d in Catullo *et al.* 2013) of call traits, traits which are associated with mate choice and species recognition in frogs (Gerhart & Huber 2012; Hoskin *et al.* 2011). The clades differ in color patterns (Fig. 3) but are morphologically indistinguishable in multivariate analyses of body shape characters (Fig. 2c in Catullo *et al.* 2013). The eastern individuals have orange to red dorsal tubercles that are not present in the western clade (Fig. 3b *versus* 3c).

Catullo *et al.* (2013) concluded that multiple lines of evidence supported complete or near-complete reproductive isolation based on the 'substantial reproductive isolation' interpretation of the Biological Species Concept (Coyne & Orr 2004). Here we revise the taxonomy of *U. trachyderma* s.l., with the description of the western clade as a new species and the redescription of *U. trachyderma* from the eastern portion of the Northern Deserts.

Methods

Call data. Details of call recording and analysis are available in Catullo *et al.* (2013) and individual specimen results are in Table 2. The following call traits were recorded: call rate per minute, duration (beginning of the first pulse to the end of the last pulse of a call), number of pulses per call, pulse rate (number of pulses divided by call duration), and dominant frequency (the frequency at which the call is of greatest intensity). We selected representative calls for Fig. 1c as they were recorded at similar temperatures (between 23.5 and 25.5°C). A summary of call data for each species is presented in Table 1. Call rate data was normally distributed (Shapiro-Wilk test, $W = 0.9962$, $p = 0.575$) and temperature was not correlated with call rate ($p > 0.1$ for both species), therefore we only report raw call rate data.

TABLE 1. Call characteristics of *Uperoleia stridera* and *U. trachyderma* (mean [SD]). Ground temperature for all recordings was between 23.7 and 29.1°C. The difference in call rate between the two species was significant ($t = 17.0338$, $df = 23$, $p < 0.001$).

	Duration (ms)	Dominant Frequency (Hz)	Pulses/s	Pulses/call	Call Rate (calls/min)
U. trachyderma (N = 7)	0.046 [0.005]	3394.50 [159.62]	69.63 [4.54]	3.19 [0.33]	56.86 [10.91]
U. stridera (N = 17)	0.024 [0.004]	3236.70 [147.10]	90.41 [8.45]	2.16 [0.31]	90.74 [16.29]

Morphometics. Details of all morphological assessments and analysis are available in Catullo *et al.* (2013) and individual specimen results are in Table 2. We measured the following morphological characters: snout-urostyle length (SUL), eye-naris distance (EN—from anterior corner of the eye to midpoint of closest nostril), interorbital distance (IO—from anterior corners), internarial distance (IN—from medial margins of nares), eye length (EyeL—from corner of anterior and posterior edges), arm length (ArmL—from elbow to tip of 3rd finger), tibia length (TL), and foot + tarsus length (from knee to tip of 4th toe). All measurements were taken with electronic calipers to the nearest 0.01 mm. Statistics reported below are: Mean±S.D. [Range]. Institutional abbreviations where type material is deposited: Museum & Art Gallery of the Northern Territory, Darwin—NTM; South Australian Museum, Adelaide—SAMA; Western Australian Museum, Perth—WAM; Natural History Museum, University of Kansas—KU. A summary of the morphological variation in each species is presented in Table 3.

TABLE 2. Details of specimens included and data generated in this study. The 'nDNA- and mtDNA clade' columns indicate the clade assignment of the individual. The 'Call' column indicate the assignment of the individual in Discriminant Function Analyses (see Catullo *et al.* 2013), and the 'Morphology column indicates the individuals measured for Table 3. The column 'Museum ID' shows the museum and registration number as follows: Western Australian Museum (WAM), South Australian Museum (SAMA), and Northern Territory Museum (NTM). Final species designations are the same outlined in the nDNA column.

Lab#	Tissue No.	nDNA clade	mtDNA clade	Latitude	Longitude	Location	Call	Morphology
Up0410	NTM R35185	*U. trachyderma*	*U. stridera*	-16.30533	133.45567	Carpentaria Highway, NT	n/a	yes
Up0411	NTM R35184	*U. trachyderma*	*U. stridera*	-16.30533	133.45567	Carpentaria Highway, NT	n/a	yes
Up0412	NTM R35183	*U. trachyderma*	*U. stridera*	-16.30533	133.45567	Carpentaria Highway, NT	n/a	yes
Up1026	SAMA ABTC102544	*U. trachyderma*	*U. trachyderma*	-17.4825	135.651	Tableland Highway, NT	n/a	yes
Up1027	SAMA ABTC102545	*U. trachyderma*	*U. stridera*	-17.4825	135.651	Tableland Highway, NT	n/a	n/a
Up1029	SAMA ABTC102825	*U. trachyderma*	*U. stridera*	-19.7164	138.804	Thorntonia Yelvertoft Road, QLD	n/a	n/a
Up1030	SAMA ABTC102828	*U. trachyderma*	*U. trachyderma*	-19.7131	138.804	Thorntonia Yelvertoft Road, QLD	n/a	n/a
Up1032	SAMA ABTC102832	*U. trachyderma*	*U. trachyderma*	-19.7164	138.804	Thorntonia Yelvertoft Road, QLD	n/a	n/a
Up1090	NTM R36189	*U. trachyderma*	*U. stridera*	-16.45046	134.24469	Bullwaddy Conservation Reserve, NT	*U. trachyderma*	yes
Up1091	NTM R36190	*U. trachyderma*	*U. stridera*	-16.45046	134.24469	Bullwaddy Conservation Reserve, NT	*U. trachyderma*	yes
Up1092	NTM R36191	*U. trachyderma*	*U. stridera*	-16.45046	134.24469	Bullwaddy Conservation Reserve, NT	*U. trachyderma*	yes
Up1093	NTM R36192	*U. trachyderma*	*U. stridera*	-16.49017	134.31146	Bullwaddy Conservation Reserve, NT	*U. trachyderma*	yes
Up1094	NTM R36193	*U. trachyderma*	*U. stridera*	-16.49017	134.31146	Bullwaddy Conservation Reserve, NT	*U. trachyderma*	yes
Up1095	NTM R36194	*U. trachyderma*	*U. stridera*	-16.70481	135.39705	50 km W of Cape Crawford on Carpenteria Hwy, NT	*U. trachyderma*	yes
Up1103	NTM R36202	*U. trachyderma*	*U. stridera*	-17.48140	135.65167	Tablelands Hwy, NT	*U. trachyderma*	yes
Up0246	WAM R164690	*U. stridera*	*U. stridera*	-18.45408	125.76917	35 km S.E. of Fiztroy Crossing, WA	n/a	n/a
Up0248	WAM R164718	*U. stridera*	*U. stridera*	-18.70631	125.78086	75 km S.E. of Fitzroy Crossing, WA	*U. stridera*	yes
Up0249	WAM R164719	*U. stridera*	*U. stridera*	-18.70631	125.78086	75 km S.E. of Fitzroy Crossing, WA	*U. stridera*	yes
Up0250	WAM R164720	*U. stridera*	*U. stridera*	-18.70631	125.78086	75 km S.E. of Fitzroy Crossing, WA	*U. stridera*	yes
Up0251	WAM R164721	*U. stridera*	*U. stridera*	-18.70631	125.78086	75 km S.E. of Fitzroy Crossing, WA	*U. stridera*	n/a
Up0252	WAM R164722	*U. stridera*	*U. stridera*	-18.60914	125.78086	S.E. of Fitzroy Crossing WA	*U. stridera*	yes
Up0261	WAM R164738	*U. stridera*	*U. stridera*	-18.14047	125.49247	S.E. of Fitzroy Crossing WA	*U. stridera*	yes
Up0266	WAM R164747	*U. stridera*	*U. stridera*	-18.29319	127.59286	Mother O'Neal Creek, W Halls Creek, WA	n/a	n/a
Up0267	WAM R164748	*U. stridera*	*U. stridera*	-18.29319	127.59286	Mother O'Neal Creek, W Halls Creek, WA	n/a	n/a
Up0728	SAMA ABTC99706	*U. stridera*	*U. stridera*	-16.81000	131.21000	Pigeon Hole Station, NT	n/a	yes
Up0729	SAMA ABTC99707	*U. stridera*	*U. stridera*	-16.81000	131.21000	Pigeon Hole Station, NT	n/a	n/a
Up0730	SAMA ABTC99708	*U. stridera*	*U. stridera*	-16.81000	131.21000	Pigeon Hole Station, NT	n/a	yes
Up1067	WAM R164726	*U. stridera*	*U. stridera*	-18.12583	125.63194	13 km W of Fitzroy Crossing, WA	n/a	n/a
Up1106	NTM R36205	*U. stridera*	*U. stridera*	-16.73848	131.64482	30 km S of Top Springs on Buntine Hwy, NT	*U. stridera*	yes
Up1107	NTM R36206	*U. stridera*	*U. stridera*	-16.73848	131.64482	30 km S of Top Springs on Buntine Hwy, NT	*U. stridera*	yes
Up1108	NTM R36207	*U. stridera*	*U. stridera*	-16.69304	131.71834	20 km S of Top Springs on Buntine Hwy, NT	*U. stridera*	yes
Up1109	NTM R36208	*U. stridera*	*U. stridera*	-16.60492	131.78001	10 km S of Top Springs on Buntine Hwy, NT	*U. stridera*	yes
Up1110	NTM R36209	*U. stridera*	*U. stridera*	-16.54602	131.79544	in field just to south of Top Springs Roadhouse, NT	*U. stridera*	yes
Up1111	NTM R36210	*U. stridera*	*U. stridera*	-16.43353	131.63699	20km NW of Top Springs on Buchanen Hwy, NT	*U. stridera*	yes
Up1112	NTM R36211	*U. stridera*	*U. stridera*	-16.43353	131.63699	20km NW of Top Springs on Buchanen Hwy, NT	*U. stridera*	yes
Up1113	NTM R36212	*U. stridera*	*U. stridera*	-16.37529	131.53349	35 km NW of Top Springs on Buchanen Hwy, NT	*U. stridera*	n/a
Up1114	NTM R36213	*U. stridera*	*U. stridera*	-16.40333	131.59315	27 NW of Top Springs on Buchanen Hwy, NT	*U. stridera*	yes
Up1115	NTM R36214	*U. stridera*	*U. stridera*	-16.48911	131.72807	10 km NW of Top Springs on Buchanen Hwy, NT	*U. stridera*	yes
Up1116	NTM R36215	*U. stridera*	*U. stridera*	-16.48911	131.72807	10km NW of Top Springs on Buchanen Hwy, NT	*U. stridera*	yes

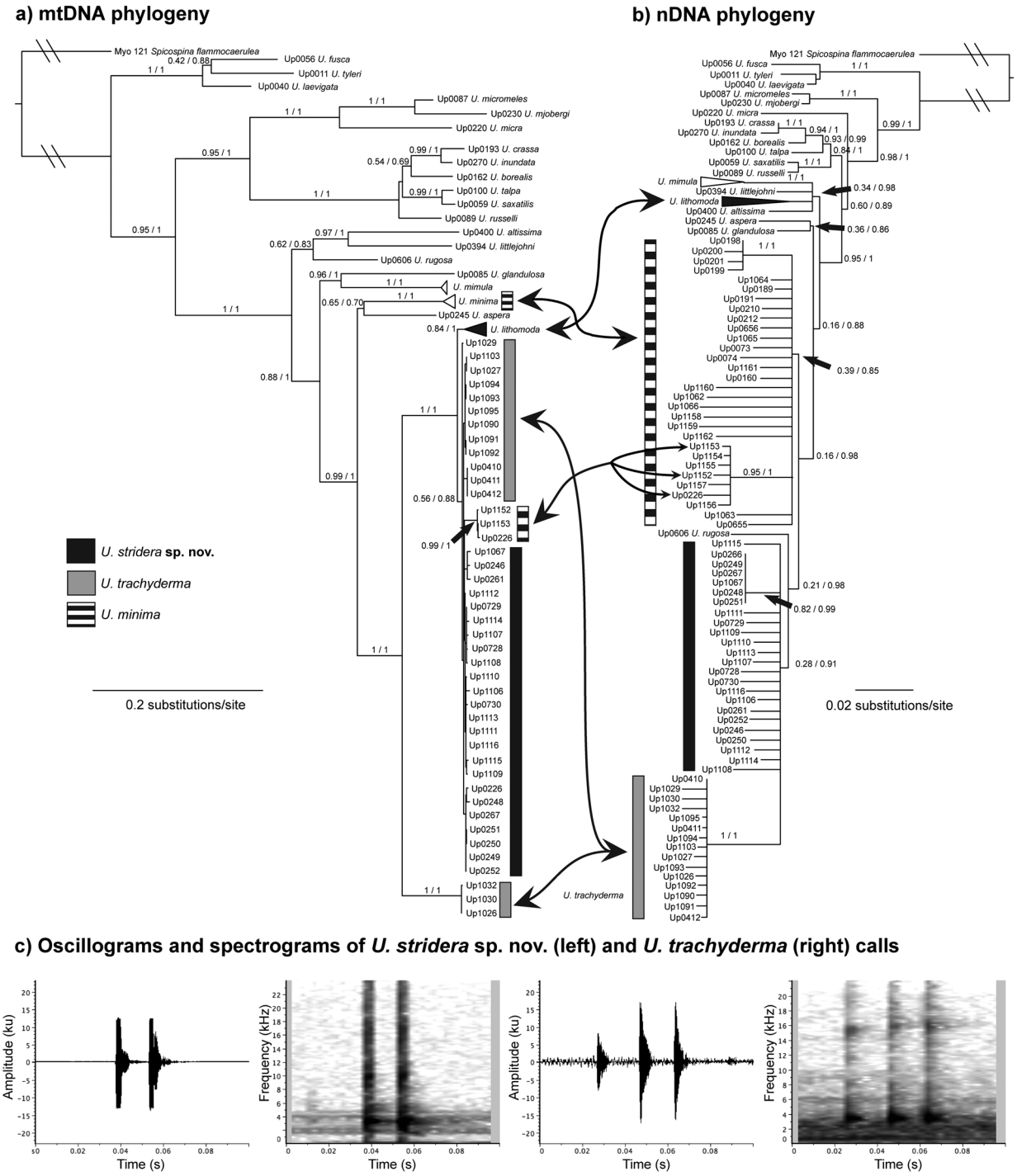

FIGURE 1. Mitochondrial (a) and nuclear (b) phylogenies of *U. stridera* **sp. nov.** and *U. trachyderma* (modified from Catullo *et al.* 2013). Patterned bars indicate final species allocation based on genetics, morphology, and acoustics. Individuals with differing mitochondrial *versus* nuclear haplotypes are indicated by arrows. Oscillogram and spectrograms for the holotype of *U. stridera* **sp. nov.** (Up0261, WAM R164738, from near Fitzroy Crossing, WA) and *U. trachyderma* (Up1091, NTM R36190, from Bullwaddy Conservation Reserve, NT) are pictured in (c). Oscillograms display amplitude (y-axis) against time (x-axis), and spectrograms display frequency (y-axis) against time (x-axis). Time for each graph is one second.

Systematics

The new species is clearly assignable to *Uperoleia* based on genetic data (Catullo *et al.* 2013) and external characters such as the combination of flash coloration and extensive glands that cover the tympanum. *Uperoleia*

trachyderma has been previously assigned to *Uperoleia* based on morphological characters (Davies *et al.* 1986), as well as genetic data (Catullo *et al.* 2011, 2013). It is important to note that due to hybridization, mtDNA cannot be used to accurately identify these species.

Genus *Uperoleia* Gray, 1841

Uperoleia Gray, 1841, Ann. Mag. Nat. Hist., Ser. 1, 7: 90.
Hyperoleia Agassiz, 1846, Nomencl. Zool., Fasc. 12: 384. Unjustified emendation.
Glauertia Loveridge, 1933, Occas. Pap. Boston Soc. Nat. Hist., 8: 89. Type species: *Glauertia russelli* Loveridge, 1933, by monotypy. Synonymy by Tyler *et. al.* 1981, Aust. J. Zool., Suppl. Ser., 29 (79): 9. *Hosmeria* Wells & Wellington, 1985, Aust. J. Herpetol., Suppl. Ser., 1: 2. Type species: *Uperoleia marmorata laevigata* Keferstein, 1867, by original designation. Synonymy by Catullo *et al.* 2011, Zootaxa, 2902; 1–43.
Prohartia Wells & Wellington, 1985, Aust. J. Herpetol., Suppl. Ser., 1: 3. Type species: *Pseudophryne fimbrianus* Parker, 1926, by original designation. Synonymy by Catullo *et al.* 2011, Zootaxa, 2902; 1–43.

Type species—*U. marmorata* Gray, 1841, by monotypy.

Uperoleia trachyderma
Blacksoil Toadlet
Fig. 2 & 3c

Uperoleia trachyderma Tyler, Davies & Martin 1981, Trans. R. Soc. S. Aust. 105, p. 49.
Uperoleia trachyderma Davies, McDonald & Corben 1986, Proc. R. S. Vict. 98(4), p. 160.

Holotype. SAMA R20374 (male), collected on the Newcastle Creek floodplain at the George Redman Causeway, Northern Territory (17°14′S, 133°28′E) by M. Davies, A.A. Martin and M.J. Tyler on 16 December 1980.

Paratypes. KU 189561, NTM 9865, SAMA 20375–6. The series was collected with the holotype.

Type locality for *Uperoleia trachyderma*. The holotype for *U. trachyderma* (SAMA R20374) was collected at Newcastle Creek, NT (17°14′S, 133°28′E) (Fig. 2). This area corresponds with the distribution of the eastern Northern Deserts clade. In addition, the holotype was reported by Tyler *et al.* (1981b) to have a harsh 'creak' of four pulses as a call as well as orange tubercles on the dorsal surface, characteristics that have only been found in the *U. trachyderma* E nDNA clade individuals. Thus, based on available data, we have determined that the *U. trachyderma* holotype belongs to the *U. trachyderma* E nDNA clade.

Comment on previous descriptions. In the Davies *et al.* (1986) redescription of this species, a number of specimens were examined from the western side of the Northern Deserts. These localities do not fall into the range of *U. trachyderma*, and are likely to represent *U. stridera* **sp. nov.** These individuals and their locations were: SAMA R25952–61 from 113.9 km S Victoria Hwy/Delamere Hwy junction; SAMA R24017 from 415.1 km W Katherine on Victoria Hwy; and SAMA R24018–28 from 4.4 km W Keep River on Victoria Hwy.

Diagnosis. Distinguished from all other *Uperoleia* by a combination of small body size (males 18.1–22.1 mm SUL), flattened head (HD/SUL 0.15±0.01 [0.12–0.17]) broad snout (EN/IN 1.24±0.08 [1.14–1.36]), absence of maxillary teeth, finely tubercular skin, large red groin and femoral patches, large round parotoid glands reaching only to arms, well developed oval inguinal glands and large obvious coccygeal glands. Toes and fingers unwebbed, and highly reduced inner and outer metatarsal tubercles. Scattered light orange to red dorsal tubercles. A sharp click consisting of three to four pulses as an advertisement call.

Material examined. See Table 2 for specimens labeled as "*U. trachyderma*" under the nDNA clade column.

Description of series. Body size small, square and flattened in shape. Head is small, dorso-laterally compressed and shallow in depth. When viewed laterally, snout does not slope, tip is distinct and flattened; when viewed from above, the sides of the snout slope gradually to a sharp corner forming a flattened tip. Canthus rostralis prominent, slightly protruding and well defined; loreal region slopes to jaw and is only slightly convex. Moderate rounded medial projection (synthesis of mentomeckelian bones) that matches notch on upper jaw. Nostrils directed upward and slightly outward; nares have no visible rim. Anterior corner of eye covered by slight

flap of skin. Posterior edge of brow does not project over side of head. Tympana covered by skin and parotoid glands. Tongue oval and elongate. Maxillary and vomerine teeth absent. EN larger than IN.

Arms and hands gracile. Arms are of moderate length and the fingers are moderately fringed and unwebbed. Finger length 3>4>2>1. Tubercles under fingers well developed; one on first and second, two on third and fourth. Well developed outer palmar tubercle on distal portion of wrist; well developed inner palmer tubercle on medial portion of wrist. Nuptial pad of males on outer portion of first finger (beginning 2/3 from attachment of finger), extending to base of wrist and encroaching on inner palmar tubercle.

Legs of moderate length and thin build. Toe length 4>3>5>2>1. Tubercles under toes well developed and conical; one on first and second, two on third and fifth, three on fourth. Toes moderately long, unwebbed, and strongly fringed. Small spade-shaped inner metatarsal tubercle along first toe. Outer metatarsal tubercle conical and highly reduced along fifth toe.

Dorsum covered in fine tubercles which extend down arms, legs, and across the ventral surface. Cloacal flap present, moderately fimbriated in males and status is unknown in females. Parotoid gland round, extremely well developed and obvious, starting from just behind eye and extending posteriorly to arms and to below the angle of the jaw. Inguinal glands well developed, oblong, situated on the side of the body, extending from approximately halfway between arm and leg to the groin coloration; posterior half of gland covered when leg is normally situated. Coccygeal glands large, round and obvious; situated on the torso above the legs. No glands evident between inguinal and parotoid glands. Mandibular gland moderately developed, disrupted, and situated alongside the parotoid gland at the corner of the jaw.

Coloration. Dorsal ground color frequently a rich medium brown, but a few individuals tended towards a grayish brown. Some individuals displayed solid dorsal coloration, while in others the dorsal pigment was mottled with darker spots of a similar color. All individuals displayed scattered dorsal tubercles that ranged from light orange to red. In most individuals the glands were slightly paler than the remaining dorsal surface. A slightly darker V, pointing posteriorly, was present between the eyes of most individuals. Groin and femoral coloration, usually extending down to top of the crus, was universally red. All males had darkly pigmented chins, with the dark pigment extending just posterior to the arms. The belly of all individuals is a cream color with scattered darker spots, which becomes blotchy as it nears the legs, then ceases abruptly. Ventral background pigment, except for a faint scattering of cream tubercles in some individuals, is not present on the thigh region any individuals examined.

Advertisement call. Figure 1c and Table 1 summarize the main features of the call. This species produces a short sharp sound, audible as a slow click. All individuals of *U. trachyderma* gave calls consisting of three pulses (Fig. 1c), although some individuals also gave intermittently gave four-pulse calls. The four-pulse calls had a similar pulse rate to the three-pulse calls. Call rate of *U. trachyderma* was significantly lower than the call rate for *U. stridera* **sp. nov.**

Habitat. High population densities in protected claypan swamps, in chorus with *Cyclorana maculosa*, *Litoria rubella*, and *L. caerulea*. Individuals in low-density populations were found in boggy portions of pastures and ditches. This species appears to prefer fine soils such as blacksoil, which become extremely soft when wet. This may be associated with the extremely small size and highly reduced metatarsal tubercles, which would limit burrowing capabilities in other soil types.

Distribution. Found in the eastern portion of the Northern Deserts region: from approximately Cloncurry, Queensland, to east of Daly Waters, Northern Territory (Fig. 2d, Table 2). Like *U. stridera* **sp. nov.**, ecological niche modeling suggests that the sandstone escarpments of the Top End biogeographic region represent the northern barrier to this species, and that the southern barrier corresponds with the 18th parallel, which is the approximate transition to extreme aridity and highly variable rainfall (Catullo *et al.* 2013) . These models also suggest that the Carpentarian Gap (MacDonald 1969) represents a major barrier for the eastern side of the distribution.

Comparisons with other species. *Uperoleia trachyderma* can be distinguished from all species of *Uperoleia* except *U. stridera* **sp. nov.** by the combination of small size (SUL = 19.77 [1.34]), dorsal-lateral compression (HD/SUL = 0.15 [0.01]) giving the frog a distinct flat aspect, extremely reduced metatarsal tubercles, and by the presence of fine dorsal tubercles. This species is distinguished from *U. stridera* **sp. nov.** by a lower pulse rate, a lower call rate, the presence of three or four pulses in the call *versus* two or three pulses (Fig. 1c, Table 1), and field location (Fig. 2d). This species is also distinguished by the presence of light orange to red dorsal tubercles, which are absent in *U. stridera* **sp. nov.**

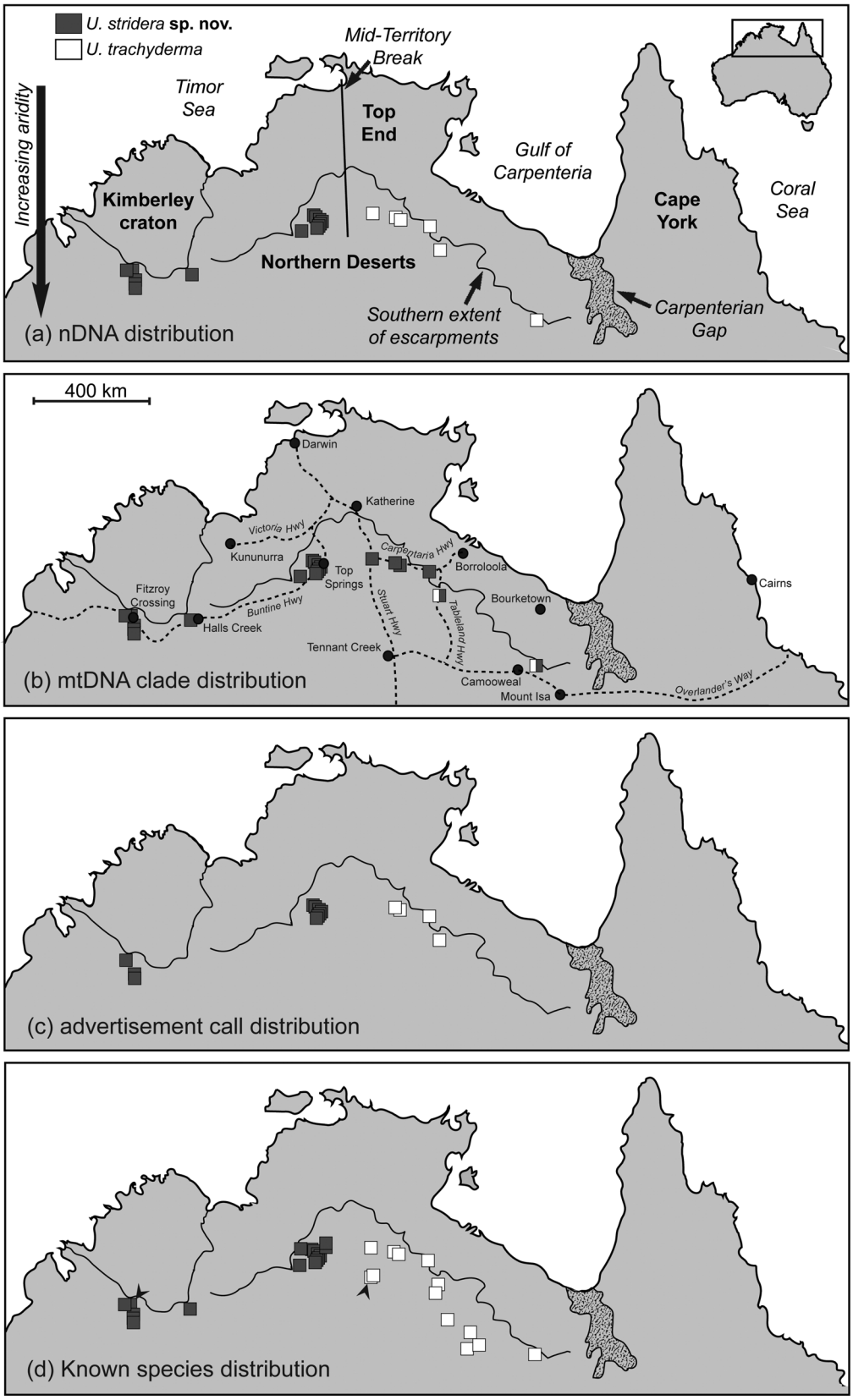

FIGURE 2. Map of the Australian Monsoonal Tropics showing the distribution of (a) nDNA groups, (b) mtDNA clades, (c) acoustic variation, and (d) total known distribution of *U. stridera* **sp. nov** (green) and *U. trachyderma* (yellow) based on our data and previous taxonomic descriptions. Half coloured shapes in (b) indicate locations with multiple mtDNA clades present. Arrowheads in (d) indicate type localities. In (a), major bioregions are in bold, and biogeographical barriers are in italics. In (b), dashed lines indicate major roads and dots indicate locations. Modified from Catullo *et al.* 2013.

a) *U. stridera* **sp. nov.** holotype (WAM R164738)

b) *U. trachyderma* variation, in life

c) *U. stridera* **sp.nov.** variation, in life

FIGURE 3. (a) Dorsal, dorsolateral, and ventral photos of the holotype of *Uperoleia stridera* sp. nov. (WAM R164738); (b) Photos of *U. trachyderma* in life (NTM R36190, R36194, & R36202); and (c) Photos of *U. stridera* **sp. nov.** (NTM R36209, R36212, & R36213). Photos by M. Whitehead & R. Catullo.

***Uperoleia stridera* sp. nov.**
Ratcheting Toadlet
Fig. 3

Holotype. WAM R164738 (male), collected 13 km W of Fitzroy Crossing, WA (18°8′25.7″S, 125°29′32.9″E) by P. Doughty, P. Oliver, and D. Moore on 15 January 2008.

Paratypes. WAM R164691 (male), collected 35 km SE of Fitzroy Crossing, WA (18°27′14.7″S, 125°45′69″E); WAM R164718 (male), collected 75 km SE of Fitzroy Crossing, WA (18°42′22.7″S, 125°46′51.1″E); WAM 164722 (male), collected 75 km SE of Fitzroy Crossing, WA (18°36′32.9″S, 125°46′51.1″E); NTM R27425 (male), collected at Pigeon Hole station (16°48′36″S, 131°12′36″E); NTM R36205 (male), collected 30 km S of Top Springs, NT (16°44′18.5″S, 131°38′41.4″E); NTM R36207 (male), collected 20 km S of Top Springs, NT (16°41′35.0″S, 131°43′6.0″E); NTM R36209 (male), collected at Top Springs, NT (16°32′45.7″S, 131°47′43.6″E); NTM R36213 (male), collected 27 km N of Top Springs on Buchanan Hwy, NT (16°24′12.0″S, 131°35′35.3″E); NTM R36214 (male), collected 10 km N of Top Springs on Buchanan Hwy, NT (16°29′20.8″S, 131°43′41.1″E).

Additional Material. See Table 2 for specimens labeled as "*U. stridera* **sp. nov.**" under the nDNA clade column.

Diagnosis. Distinguished from all other *Uperoleia* by a combination of small body size (males 19.0–25.0 mm) with flattened head (HD/SUL 0.14±0.01 [0.12–0.15]), broad snout (EN/IN 1.13±0.05 [1.05–1.21]), absence of maxillary teeth, finely tubercular skin, large red groin and femoral patches, large round parotoid glands reaching only to arms, well developed oval inguinal glands and large conspicuous coccygeal glands, toes and fingers unwebbed, and highly reduced inner and outer metatarsal tubercles. Further distinguished from *U. trachyderma* by lack of orange to red flecks on dorsum. A sharp click consisting of two to three pulses as an advertisement call repeated, on average, 90 times per minute at a faster rate than *U. trachyderma* (Table 1).

Holotype measurements. Measurements (in mm): SUL–24.3; ArmL–10.5; TL–8.6; FL–14.9; HD–3.5; IO–4.3; EyeL–2.5; EN–2.3; IN–1.9.

Description of holotype. Body size small, square and flattened in shape. Head is small, dorso-laterally compressed and shallow in depth (HD/SUL = 0.14, IO/HD = 1.24). When viewed laterally, snout is horizontal, tip is distinct and flattened; when viewed from above, the sides of the snout slope gradually up to a sharp angle that forms a flattened tip (EN/IN = 1.21). Canthus rostralis prominent, slightly protruding and well defined; loreal region slopes to jaw and is only slightly convex. Moderately rounded medial projection (synthesis of mentomeckelian bones) that matches notch on upper jaw. Nostrils directed upward and slightly outward; nares have no visible rim. Anterior corner of eye covered by slight flap of skin. Posterior edge of brow does not project over side of head side of head. Tympana covered by skin and parotoid glands. Tongue oval and elongate. Maxillary and vomerine teeth absent. EN larger than IN.

Arms and hands gracile. Arms are of moderate length (ArmL/SUL = 0.43) and the fingers are moderately fringed and unwebbed. Finger length 3>4>2>1. Tubercles under fingers well developed; one on first and second, two on third and fourth. Well-developed outer palmar tubercle on distal portion of wrist; well developed inner palmer tubercle on medial portion of wrist. Nuptial pad of males on outer portion of first finger (beginning 2/3 from attachment of finger), extending to base of wrist and encroaching on inner palmar tubercle.

Legs of moderate length (TL/SUL = 0.35, FTL/SUL = 1.74), thin. Toe length 4>3>5>2>1. Tubercles under toes well developed and conical; one on first and second, two on third and fifth, three on fourth. Toes moderately long, unwebbed, and strongly fringed. Small spade-shaped inner metatarsal tubercle, oriented along first toe. Outer metatarsal tubercle conical and highly reduced, oriented along fifth toe.

Dorsum covered in fine tubercles which extend down arms, legs, and across the ventral surface. Cloacal flap present, moderately fimbriated. Parotoid gland round, extremely well developed and obvious, starting from just behind eye and extending posteriorly to arms and to below the angle of the jaw. Inguinal glands well developed, oblong, situated on the side of the body, extending from approximately halfway between arm and leg to the groin coloration; posterior half of gland covered when leg is normally situated. Coccygeal glands large, round and obvious; situated on the torso above the legs. No glands evident between inguinal and parotoid glands. Mandibular gland moderately developed, disrupted, and situated alongside the parotoid gland at the corner of the jaw.

Coloration. In preservative (Fig. 3a), dorsum is a pale grey with large irregular dark patches. The parotoid and coccygeal glands are a light salmon pink. Ventrum is a dull yellow, and the outside edge of the chin is stippled with pigment. The anterior and posterior flash coloration patches are large and come in to close proximity on the dorsal surface of the thigh, separated by a thin strip of dark dorsal coloration.

Variation In life, dorsal ground color frequently a light to rich medium brown, although individuals varied from reddish-orange to brownish-gray; some individuals displayed solid coloration, while in others the dorsal pigment was mottled with darker spots of a similar color. In mottled individuals, dorsum scattered with small to large irregular blotches of dark brown, especially near parotoid glands (forming a dark border around them) and coccygeal region; upper limbs also with dark brown markings, often forming bars on the legs. Some individuals displayed uniform coloration, while in others the dorsal pigment was mottled with darker spots of a similar colour. In most individuals the paratoid and coccygeal glands were slightly paler than the rest of the dorsal surface, sometimes suffused with orange. A slightly darker 'V' (pointing posteriorly) was present between the eyes of most individuals. Groin and femoral coloration, usually extending down to top of the crus, was always a bright red. All males had darkly pigmented chins, with the dark pigment extending just posterior to the arms. The venter of all individuals was a pale white with scattered darker flecks; ventral background pigment, except for a faint scattering of cream tubercles in some individuals, was not present on the thigh region.

Advertisement call. Table 1 and Fig. 1c summarize the main features of the call. This species produces a short sharp sound, audible as a grinding click. All individuals of *U. stridera* primarily gave calls consisting of two pulses (Fig. 1c), although some individuals also periodically produced three-pulse calls. The three-pulse calls had a similar pulse rate as the two-pulse calls, as can be noted by the small standard deviation in pulse rate in Table 1. Individuals producing 3 pulse calls in our analyses were found both the far west (Up0248, Up0250 & Up0261) and east (Up1111) of the *U. stridera* distribution.

Habitat. Usually encountered calling from flooded grasslands, streams, ponds, or roadside ditches.

Distribution. Found in the western portion of the Northern Deserts region: from approximately Fitzroy Crossing, Western Australia, to west of Daly Waters, Northern Territory (Fig. 2). Ecological niche modeling suggests that the sandstone escarpments of the Top End biogeographic region represent the northern barrier to this species, and that the southern barrier (~18°S) is the approximate transition to extreme aridity and highly variable rainfall (Catullo *et al.* 2013).

Etymology. The name is a euphonious random combination of letters suggestive of the Latin word *strido*, meaning a creaking or grating sound. This refers to the grating nature of the call.

Comparisons with other species. *Uperoleia stridera* can be distinguished from all species of *Uperoleia* except *U. trachyderma* by the combination of small size (SUL = 21.9 [1.7]), pronounced dorsolateral compression (HD/SUL = 0.14 [0.01]), extremely reduced metatarsal tubercles, and presence of fine dorsal tubercles. It is further distinguished from *U. trachyderma* by higher pulse rate (Table 1; Fig. 1c), two or three pulses per call (*vs.* three or four), by location (Fig. 2d), and by the lack of scattered light orange to red tubercles on the dorsum.

Discussion

The description of *U. stridera* brings the total number of *Uperoleia* to 28, by far the largest genus in the family Myobatrachidae. We note, however, that much of the ecology of both *U. stridera* and *U. trachyderma* remain unknown. It is apparent from examination of Fig. 2 that significant geographic gaps remain to be sampled, a difficult task in this region due to access problems during the wet season. Further work on other species complexes within *Uperoleia* from the monsoonal tropics are likely to result in additional new species and better understanding of morphological, acoustic, and genetic variation in the genus.

Our work contributes to a growing suite of data suggesting that the Northern Deserts region contains a unique assemblage of fauna and may in fact be two distinct bioregions (Catullo *et al.* 2013). Genetic research into the distributions of *Heteronotia* geckos (Fujita *et al.* 2010) and agamid lizards (Melville *et al.* 2011; Smith *et al.* 2011) support the presence of distinct species associated with the Northern Deserts. As defined by Catullo *et al.* (2013), the Northern Deserts is comprised of four Interim Biogeographic Regions of Australia (IBRA, Commonwealth of Australia 2005): the Sturt Plateau, the Mount Isa Inlier, the western arm of the Mitchell Grass Downs, and the Ord Victoria Plain. The first three areas encompass the entire distribution of *U. trachyderma* and are poorly conserved, with less than 3% of each included in the National Reserve system of Australia (Commonwealth of Australia 2008a, 2010). The Ord Victoria Plain, which comprises the distribution of *U. stridera*, has greater than 10% overall protection. This figure, however, includes Purnululu National Park, a large area with distinct geology that is probably unsuitable for savannah species, as well as a large area designated 'minimal use' but is still utilized for grazing (Commonwealth of Australia 2005, 2008b).

For each of these IBRA regions, land use is almost entirely grazing (Bastin & ACRIS Management Committee 2008). For example, 96% of the Mitchell Grass Downs bioregion is under pastoral lease (Bastin & ACRIS Management Committee 2008). Studies of grazing impact on Australian amphibians are still in their infancy, and the few studies that include amphibians either focused on floodplain species (Jansen & Healey 2003) or found too few individuals to clearly assess any trends (Woinarski & Ash 2002). None of these studies have been able to locate any individuals of the *Uperoleia* genus. However, the negative impact of pastoralism on biodiversity in northern Australia is well established (reviewed in Woinarski & Fisher 2003), and includes evidence from birds (Woinarski & Catterall 2004), reptiles (Price *et al.* 2010), mammals (Read & Cunningham 2010) and invertebrates (Woinarski *et al.* 2002). This fits with the trend we found in the field, where large multi-species choruses were only found in the few fenced reserve areas in the region, with smaller scattered low-density populations in areas with strong pastoral use. Thus, these species may be of conservation concern but without further data this cannot be fully assessed.

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