



A new species of *Uperoleia* (Anura: Myobatrachidae) from the northwest Kimberley, Western Australia

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Abstract

Uperoleia is a large genus of small-bodied terrestrial frogs that occur in Australia and southern New Guinea. With nine species, the Kimberley region in northern Western Australia is the most diverse. Recent surveys of the northwest coast of the Kimberley have revealed a tenth species of *Uperoleia*. The new species is characterized by a combination of small body size, dark and slightly tubercular dorsal skin, basal webbing between the toes, outer metatarsal tubercle spatulate and oriented perpendicular to the foot, possession of maxillary teeth, a broadly exposed frontoparietal fontanelle and the advertisement call is a high-pitched rasp. All specimens collected have been associated with sandstone boulders or escarpments with flowing water or rock pools. The northwest Kimberley is an isolated region of high rainfall and rugged terrain that possesses high biodiversity for many plant and animal groups and is therefore worthy of special conservation attention.

Key words: frog, *Uperoleia*, call analysis

Introduction

The Myobatrachidae is a diverse family of small-bodied frogs from Australia and southern New Guinea (Littlejohn *et al.* 1993; Tyler & Doughty (in press)). Within the Myobatrachidae, the genus *Uperoleia* Gray, 1841 is the most speciose with 25 currently recognized species. *Uperoleia* species are small (2–4 cm), squat and short-limbed frogs that are typically drably coloured and terrestrial. They have moderately developed parotoid, dorsolateral/inguinal and coccygeal glands which may be marked with orange or gold. There is usually a red or orange femoral and tibial patch that may function as ‘flash’ colouration when the legs are extended. Advertisement calls are simple, consisting of rasps or clicks.

Until the revision of *Uperoleia* by Tyler *et al.* (1981a), confusion surrounded the distribution of the type species (*U. marmorata* Gray, 1841), the status of *Glauertia* and the number of species. Tyler *et al.* (1981a) restricted the distribution of *U. marmorata* to the vague collection location of the holotype, synonymized *Glauertia* with *Uperoleia* and described nine new species (one of which, *U. variegata* Tyler, Davies & Martin, 1981, was later synonymized by Tyler *et al.* 1986). Tyler *et al.* (1981b,c) described two more species and Davies and colleagues (Davies *et al.* 1985; Davies & Littlejohn 1986; Davies *et al.* 1986; Davies *et al.* 1993) described eight more species. Recently, Young *et al.* (2005) described a small-bodied *Uperoleia* from just outside the Darwin metropolitan area, underscoring the potential for further unrecognized diversity within the genus.

Uperoleia are distributed chiefly in the wetter northern and eastern regions of Australia, but can penetrate more arid regions, i.e. *U. russelli* Loveridge, 1933 and *U. glandulosa* Davies, Mahony & Roberts, 1985 in the Pilbara region, *U. micromeles* Tyler, Davies & Martin, 1981 in the northwestern deserts, *U. trachyderma* Tyler, Davies & Martin, 1981 in the Northern Territory and *U. capitulata* Davies, McDonald & Corben, 1986

and *U. rugosa* Andersson, 1916 in arid Queensland, New South Wales and South Australia. The region with the highest diversity of species is the Kimberley in northern Western Australia. The Kimberley is a diverse and rugged landscape that is isolated to the south by deserts and to the east by the geographic constriction of the Cambridge Gulf. This region receives reliable and heavy tropical rainfall in the summer (December–March). The southwestern Kimberley has three endemic species: *U. aspera* Tyler, Davies & Martin, 1981, *U. mjobergii* Andersson, 1913 and *U. talpa* Tyler, Davies & Martin, 1981. To the east are *U. borealis* Tyler, Davies & Martin, 1981, *U. lithomoda* Tyler, Davies & Martin, 1981, and *U. trachyderma*, all three of which extend into the Northern Territory and *U. lithomoda* extends to Queensland and southern New Guinea. In the northwest Kimberley, *U. borealis*, *U. crassa* Tyler, Davies & Martin, 1981, *U. lithomoda*, *U. marmorata* and *U. minima* Tyler, Davies & Martin, 1981 occur.

Surveys specifically targeting frogs were conducted during summer wet seasons from 2005–2008 in the Kimberley (Fig. 1). In January 2007, we went to the Prince Regent River area to look for *U. marmorata* and new species of frogs. During the survey, the new species was recognized as such because its call differed from congeners. In February 2008, more individuals were heard and collected on Katers Island in the far north Kimberley. We describe the new taxon here based on its distinctive appearance and call.

Methods

Morphology

We examined and measured all nine available specimens of the new taxon in the Western Australian Museum (WAM). All the specimens were male, except for one female and one metamorph of indeterminate sex. We measured the following characters: snout-urostyle length (SUL), head depth (HD – from top of head to jaw at level of the eyes), eye-naris distance (EN – from anterior corner of eye to posterior margin of naris), interorbital distance (IO – from anterior corners), internarial distance (IN – from medial margins of nares), eye length (EyeL), arm length (ArmL – from elbow to tip of 3rd finger), tibia length (TL) and foot + tarsus length (FTL – from knee to tip of 4th toe). Morphological characters of the head are limited in *Uperoleia* owing to extensive glands covering the tympana. One specimen (WAM R168040) was dissected to determine the extent of the frontoparietal fontanelle.

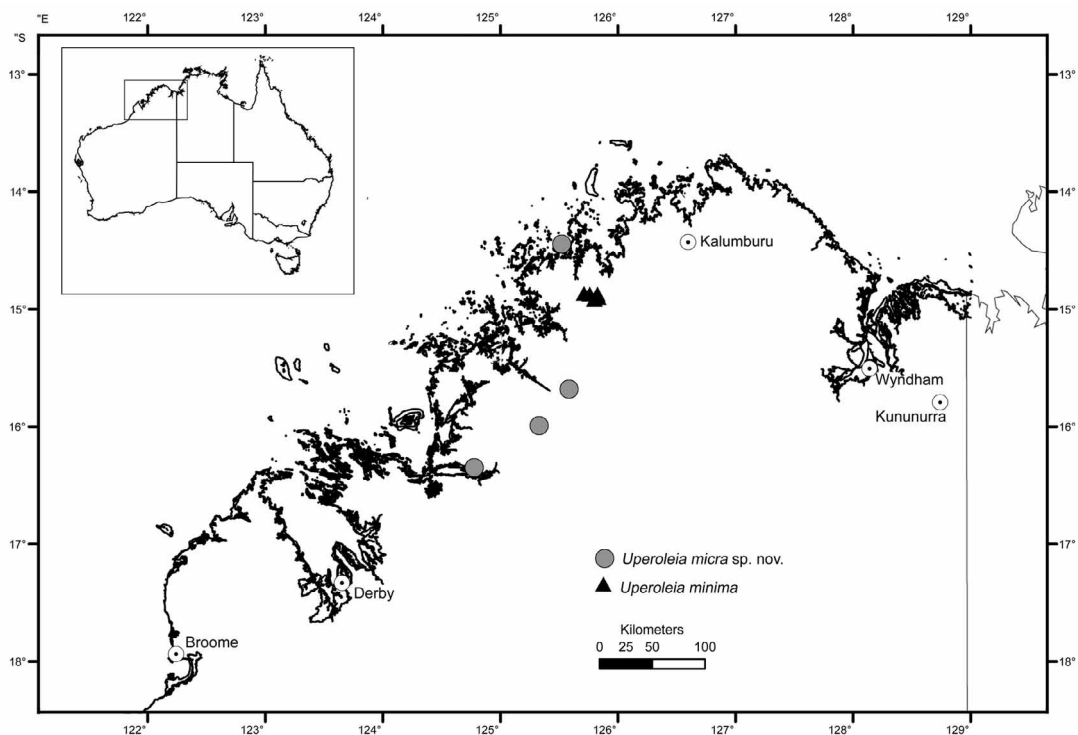


FIGURE 1. Distribution of *Uperoleia micra* sp. nov. and *U. minima* in the northwest Kimberley, Western Australia.

Call recording and analysis

We obtained high quality recordings of four males for analysis. Digital recordings were made using Marantz PMD 660 digital recorders with either Beyer M88 or AKG D880^M microphones. Calls were analysed using Raven Pro 1.3. We measured duration for various call components to the nearest ms. Frequency was analysed using a Hann window, 1024 samples and we selected the peak frequency from a spectrum display averaged 10 times over an entire call.

Frogs called in discrete bouts and we measured calls per bout and call rate (from the first to the last call in the longest complete bout). For all other variables, we measured three consecutive calls from the middle of a bout and averaged values from all three calls for a single frog. For each call we measured duration, pulse number, pulse rate (averaged over whole call) and peak frequency also averaged over the whole call. We have reported a whole call average for ease of comparison. Temperature was measured as air temperature at the calling site.

In one of the four recordings, high background noises and/or reverberation obscured pulse structure as the male was calling in a rock crevice sitting just above flowing water so pulse rate and pulse number were not measured. In one other recording, the male called intermittently and we could not define a bout structure so there were no call rate data.

Taxonomy

Uperoleia Gray, 1841

Type species: *U. marmorata*, by monotypy.

Diagnosis. A group of small-bodied (to 4 cm) terrestrial frogs with short limbs, no webbing on fingers, first finger shorter than second, inner metatarsal tubercle not compressed, lacking vomerine teeth, covered tympana, pupil rhomboidal, parotoid, dorsolateral and coccygeal glands usually present, aquatic reproduction with small pigmented eggs and free-swimming larvae.

Uperoleia micra sp. nov.

Tiny Toadlet

Figs. 2–4

Holotype. WAM R168043, an adult male collected near Bachsten Creek near the southwest corner of the Prince Regent River Nature Reserve, Western Australia (15°59'29" S; 125°19'54"E) on 22 January 2007 by J. D. Roberts, R. Barrett, P. Doughty and M. Barrett. Call recorded; liver stored at –70°C at WAM.

Paratypes. WAM R168039–40 and WAM R168042, adult males, location and date as for holotype (15°59'26"S; 125°19'50"E); WAM R168044, adult male, location and date as for holotype; WAM R167989, adult female, collected from the Prince Regent River Nature Reserve (15°40'58"S; 125°34'59"E) on 21 January 2007; WAM R166476, a metamorphosing individual, collected near the Walcott Inlet, Western Australia (16°20'51" S; 124°46'24" E) on 21 January 2008; WAM R164897–8, adult males collected from Katers Island, Western Australia (14°26'56"S; 125°31'22"E) on 14 February 2008.

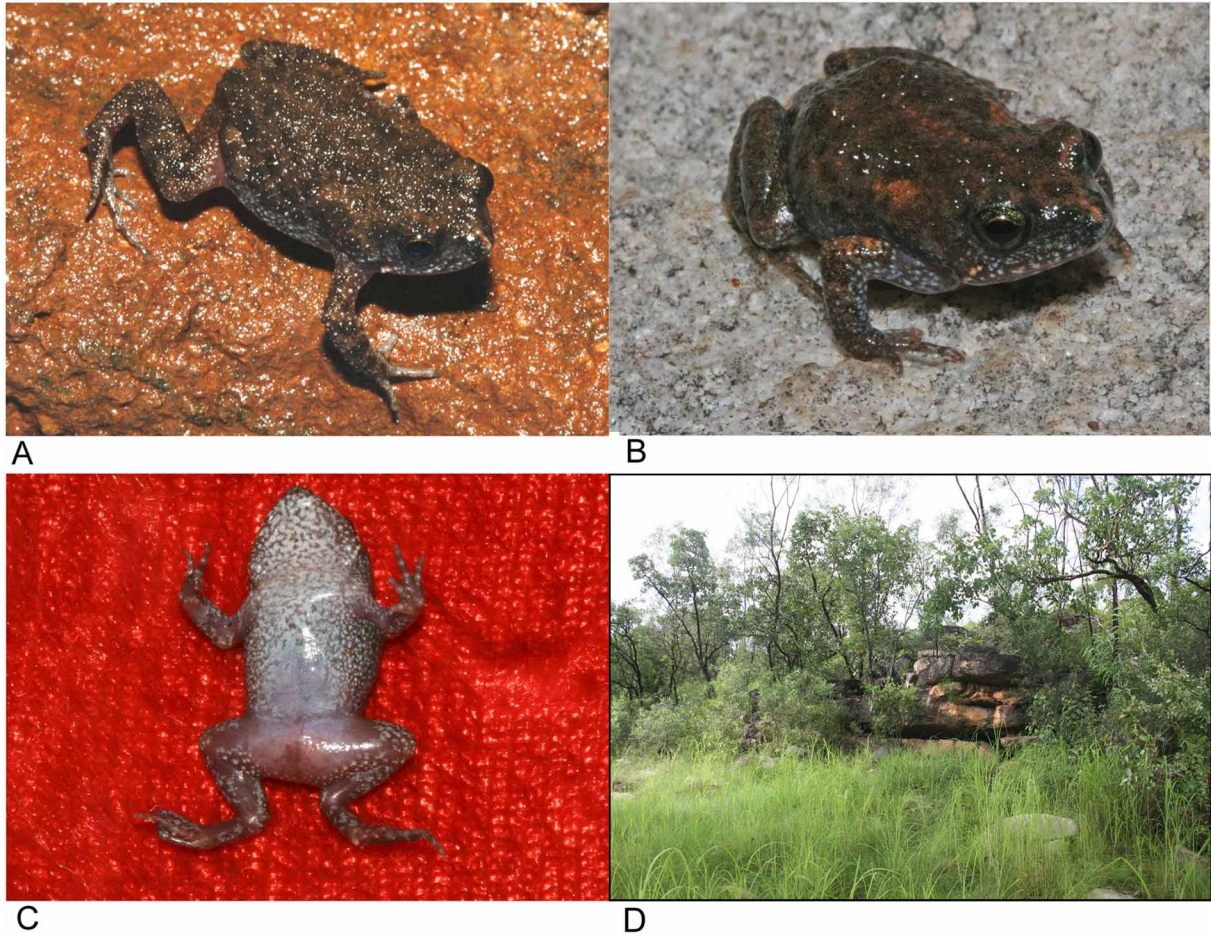


FIGURE 2. *Uperoleia micra* sp. nov.: A) WAM R164988 from Katers Island, Western Australia; B) WAM R168042; C) WAM R168044 from near Bachsten Creek, Western Australia; D) collection location of calling males (WAM R168039–40) near Bachsten Creek; males were calling from the low crevice within which had flowing water, and *U. borealis* and *U. crassa* were calling from the flooded grassy areas in the foreground (height of boulders ~ 2.5 m).

Diagnosis. Distinguished from congeners by a combination of small body size, presence of maxillary teeth, broadly exposed frontoparietal fontanelle, slightly tubercular skin on dorsum and upper limbs, moderately conspicuous parotoid and inguinal glands and less developed coccygeal glands, toes basally webbed, elongate inner metatarsal tubercle perpendicular to foot, dark brown dorsal surfaces with small darker spots, loreal and lateral zone stippled with bluish-white dots, pale orange-red femoral patches, speckled and slightly granular ventral surface and high-pitched rasp as an advertisement call.

Description. Body small, squat and rotund. Head small with slightly protruding eyes. When viewed laterally, evenly sloping snout with a rounded or truncated tip; when viewed from above, the sides of the snout gradually come to a rounded point. Canthus rostralis rounded; loreal region moderately steep and slightly concave. Sharp medial projection (symphysis of mentomeckelian bones) on lower jaw that matches notch on upper jaw. Nostrils directed upwards; nares with only a slight rim. Anterior corner of eye covered by flap of skin; at dorsal terminus the skin overlaps the skin of the brow above the eye. Posterior edge of brow projects slightly over skin on the side of the head. Tympana covered by skin and parotoid glands. One-three small infralabial glands present below angle of jaw. Tongue oval and elongate. Maxillary teeth present; vomerine teeth absent. Frontoparietal fontanelle broadly exposed. EN slightly larger than IN (EN/IN = 1.15).

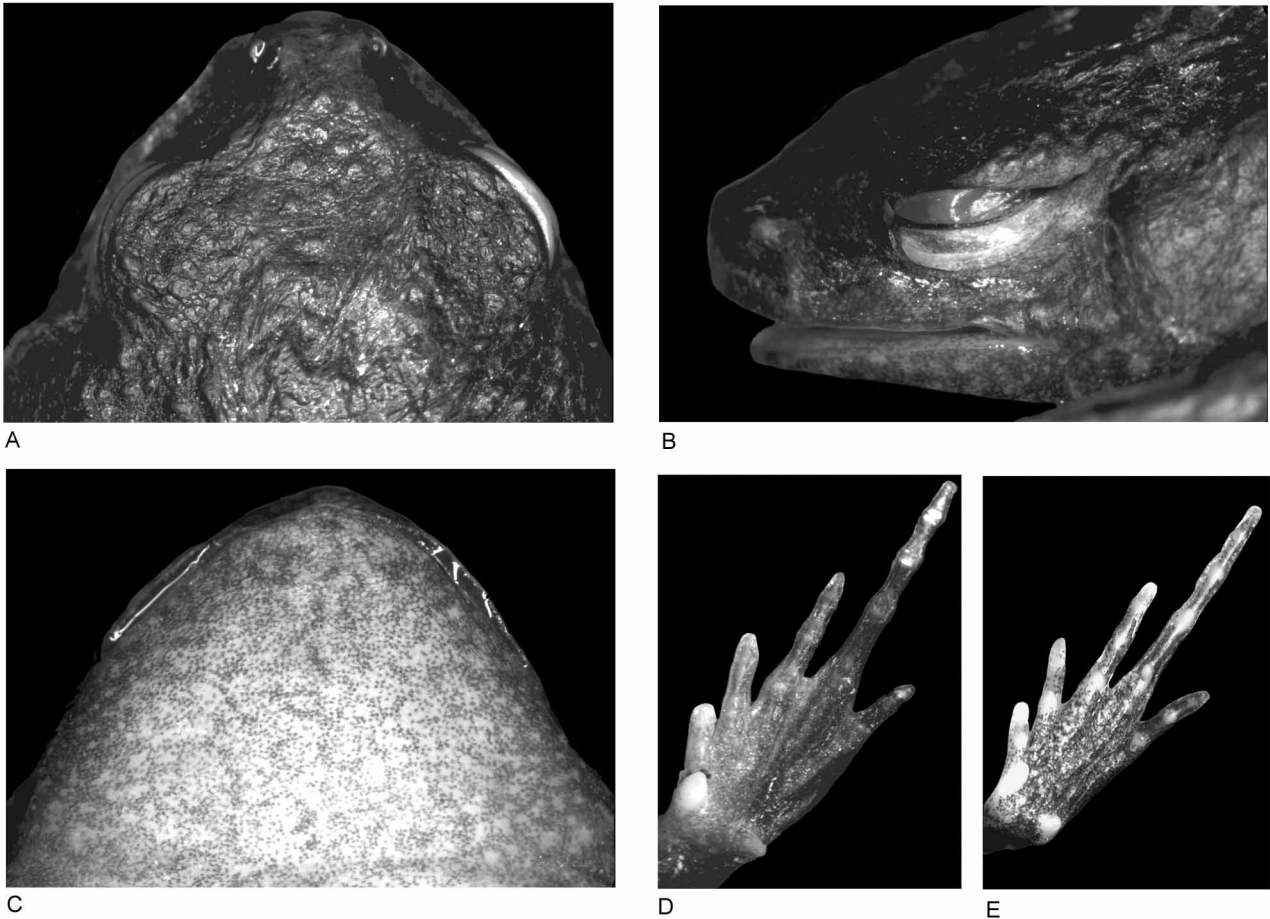


FIGURE 3. Holotype (WAM R168043) of *Uperoleia micra* sp.nov.: A) dorsal, B) lateral and C) ventral views of head; D) plantar surface of left foot; E) plantar surface of left foot of *U. minima* (WAM R167878).

Arms and hands slightly built. Arms are of moderate length ($\text{ArmL/SUL} = 0.44$) and the fingers unwebbed. Finger length: $3 > 4 > 2 > 1$. Tubercles under fingers moderately developed; one on 1st and 2nd; two on 3rd and 4th. Large outer palmer tubercle on distal portion of wrist. Nuptial pad of males on inner portion of 1st finger (beginning halfway down finger), extending to base of wrist ($1/4$ along forearm) and slightly encroaching on palmer surface.

Legs short ($\text{TL/SVL} = 0.36$) and of moderate build. Toe length: $4 > 3 > 5 > 2 > 1$. Tubercles under toes moderately developed; one on 1st and 2nd; two on 3rd and 5th; three on 4th. Toes basally webbed. A weakly-developed flange runs along the length of the toes. Inner metatarsal tubercle moderately developed, $1/2$ – $1/3$ the length of the 1st toe; projecting anteriorly (towards toe tips). Outer metatarsal tubercle is moderately developed and larger than inner, usually spatulate (sometimes round) and oriented perpendicular to the foot with the medial edge adrupt and the distal edge gradually sloped.

Skin with scattered low tubercles on dorsum, head and limbs. The ventral surface is slightly granular. Cloacal flap present. Parotoid and inguinal glands moderately developed; coccygeal gland discernible but poorly developed.

Measurements. Adult males ($N = 7$): SUL (mean and range in mm)—19.6 (18.0–21.5); HD—3.9 (3.5–4.4); EN—1.5 (1.3–1.8); IO—3.5 (3.2–3.8); IN—1.3 (1.2–1.4); EyeL—2.2 (2.1–2.4); ArmL—8.5 (8.1–9.0); TibL—7.0 (6.8–7.5); FTL—11.4 (10.3–12.1); EN/IN—1.17 (1.00–1.50); ArmL/SUL—0.44 (0.39–0.46); TL/SUL—0.36 (0.34–0.38).

Adult female (N = 1): SUL—20.5; HD—4.2; EN—1.4; IO—3.7; IN—1.4; EyeL—2.3; ArmL—9.0; TibL—7.3; FTL—12.0; EN/IN—1.00; ArmL/SUL—0.44; TL/SUL—0.36.

Metamorph (N = 1): SUL—19.0.

Colouration. In life, specimens from the mainland had a dorsum with background shade ranging from a charcoal black to dark brown, with scattered small darker blotches and faint barring on the limbs. There is a zone stippled with pale bluish-white from the tip of the snout, posterior through the loreal region and extending along the sides; also on the undersurfaces of the limbs. There is a subtle wash of orange-red on the dorsum, including more conspicuous blotches on the parotoid glands, the anterior tip of the snout, submandibular glands, vertebral zone of dorsum and upper arms. The fingers and toes are a creamy white. The ventral surface is a dull white peppered with small dark spots; the abdomen lacks the dark spots or white pigment altogether. The margin of chin is only slightly more pigmented than the rest of the chin and ventral surface. Femoral patch a pale orange-red, only moderately contrasting with background colour. The iris is a chestnut brown with a hint of green. Specimens from Katers Island were similar, but differed in having slightly lighter colouration and with inguinal glands with orange-red colouration.

In preservative, the colouration is almost completely black, with the orange-red highlights only faintly visible; the paler loreal and lateral zone is still visible.

Advertisement call. Table 1 summarises the main features of the call. The call is a long high-pitched rasp that has an obvious regular pulse structure and a moderate pulse rate (Fig. 4). The call also shows some evidence of frequency modulation with frequency rising later in the call.

TABLE 1. Call structure characteristics in *Uperoleia*. A) *Uperoleia micra* **sp. nov.** from near Bachsten Creek, Prince Regent River Nature Reserve; B) comparison with other *Uperoleia* species from the Kimberley region, Western Australia, and *U. daviesae* from near Darwin, Northern Territory.

A)

	Duration (ms)	Frequency (Hz)	Pulses/s	Pulses/call	Calls/s	Calls/bout	Temp (°C)
Mean	105.5	3347	325	30.3	0.9	18.1	27.9
s.e.	3.6	140	7	1.7	2.4	5.2	0.5
N	4	4	3	3	4	3	4

B)

Species	Frequency (Hz)	Duration (ms)	Pulses/s	Pulses/call	Temp (°C)	N	Reference
<i>U. aspera</i>	2778	33	170	5.7	25.6	3	Tyler <i>et al.</i> , 1981b
<i>U. borealis</i>	2600	191	109	20.9	26.9	7	Tyler <i>et al.</i> , 1981a
<i>U. crassa</i>	2356	173	42	7.3	24	7	Tyler <i>et al.</i> , 1981a
<i>U. daviesae</i>	-	97	244	22	25	3	Young <i>et al.</i> , 2005
<i>U. lithomoda</i>	3420	12	401	4.6	26	5	Tyler <i>et al.</i> , 1981a
<i>U. micra</i> sp. nov.	3347	106	325	30.3	27.9	4	This study
<i>U. minima</i>	3517	20	118	2.3	25.7	3	Tyler <i>et al.</i> , 1981a
<i>U. mjobergii</i>	3272	225	98	22.1	25.6	3	Tyler <i>et al.</i> , 1981a
<i>U. talpa</i>	2450	130	315	41.0	25.8	3	Davies & Martin, 1988
<i>U. trachyderma</i>	3600	51	79	4.0	25.6	2	Tyler <i>et al.</i> , 1981c

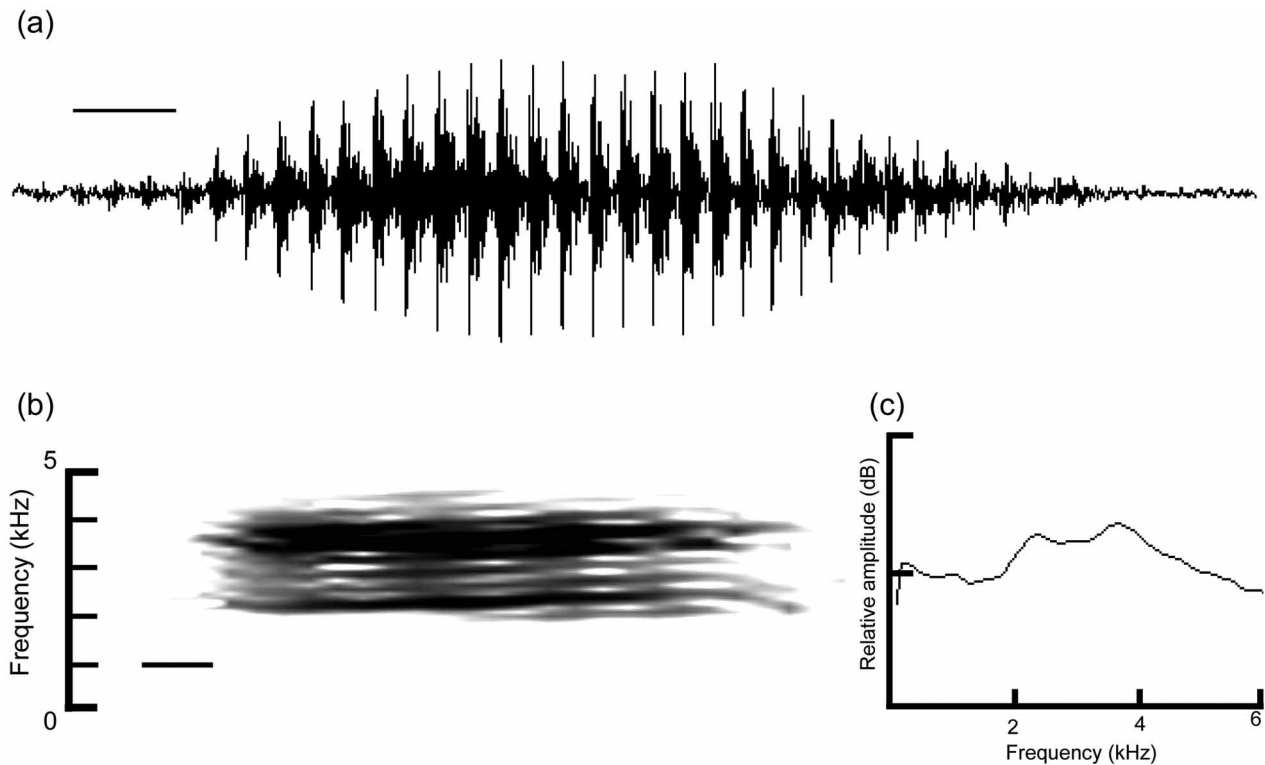


FIGURE 4. Oscillogram (a), sound spectrograms (b) and spectrum display (c) for a call of *U. micra* **sp. nov.** (WAM R168042). The bar in (a) and (b) represents 20 ms. In (b) we manipulated contrast, brightness and spectrum window display to maximise the loudest frequency components over pulse structure and side-bands arising from pulse rate (see Gerhardt & Huber, 2002).

Habitat. At Bachsten Creek, *U. micra* were calling in moist crevices in sandstone rock faces high on a ridge. One male was seen calling at the back of a narrow crevice sitting just above a broad sheet of shallow, flowing water (Fig. 2D). Other calling males were collected in crevices and cracks in rock faces with slowly flowing water from seepages among vegetation and litter. Other species calling within a few meters were *U. borealis* and *U. crassa* in a flooded grassy area and *Limnodynastes lignarius* (Tyler, Martin & Davies, 1979) along a rocky creek. On Katers Island, *U. micra* was encountered in a low valley near the top of an extensive sandstone plateau. Males were calling from a hard-capped sandstone surface with slow-flowing water forming small pools among *Triodia* clumps. Other species that were calling at the same sites were *U. borealis* and *L. lignarius*. At both sites, males were encountered after heavy early evening showers which may have stimulated calling. The individual collected from near the Walcott Inlet was found on a high flat sandstone rock platform (M. Barrett, pers. comm.).

Distribution. Only known to occur in the high rainfall zone (> 1000 mm/year) of the northwest Kimberley, Western Australia (Fig. 1). On the mainland, from the Prince Regent River Nature Reserve south to Walcott Inlet. Also on Katers Island.

Etymology. Derived from the Greek *mikros*, alluding to this species' small size and to the nearby *U. minima* which is similar in size and external appearance. Used as an adjective.

Comparisons with other species. *Uperoleia* is a genus characterized by low morphological diversity. Nevertheless, *U. micra* is distinguished from congeners from a combination of internal and external characters as well as call structure. The small (~ 2 cm) body size rules out *U. marmorata* (30.1 mm; Tyler *et al.* 1981a). Within the genus, only *U. daviesae* Young, Tyler and Kent, 2005 has both the presence of maxillary teeth and a broadly exposed frontoparietal fontanelle like *U. micra*. This species also shares tubercular skin and basal webbing, but can be distinguished from *U. micra* by light grey dorsum with faint purple tone,

absence of pale loreal and lateral zone and less developed outer metatarsal tubercle. In addition, *U. daviesae* has only been found in flooded grasslands (versus sandstone boulders and escarpments) and although its call is similar to *U. micra*, it has fewer pulses and a lower pulse rate (Table 1).

The most similar Kimberley species in external appearance to *U. micra* is *U. minima* which occurs at Mitchell Plateau and may prove to be sympatric with *U. micra* (see Fig. 1). Both species have small body size, dark mottled coloration, pale speckled venter and tubercular skin. They can be distinguished, however, by the following external traits. In *U. minima*, the dorsal tubercles are denser and often form short scapular folds in some specimens; in *U. micra* the tubercles are less dense and lower. In *U. micra*, the outer metatarsal tubercle is elongate and orientated perpendicular to the foot (Fig. 3D); in *U. minima* this tubercle is round (Fig. 3E). In *U. micra*, males have few markings on the chin; in *U. minima* there is a conspicuous dark pigmentation bordering the edge of the jaw. Internally, *U. micra* has maxillary teeth and a broadly exposed frontoparietal fontanelle, whereas *U. minima* lacks teeth and has well-developed frontal bones.

Calls of *U. micra* can be readily distinguished from other Kimberley species. *Uperoleia aspera*, *U. lithomoda*, *U. minima* and *U. trachyderma* have a much shorter call duration and lower pulse numbers (Table 1b); the calls sound like 'clicks' to the ear. *Uperoleia borealis*, *U. crassa* and *U. mjobergii* have much longer call durations and higher pulse rates (Table 1b); the calls sound like a short rasp or grate. The call of *U. talpa* has a similar pulse rate to *U. micra* but much lower frequency and higher pulse number. The calls of all eight Kimberley species are clearly discrete in two or more characters. The variation in temperature between sets of recording was 3.9°C, but temperature is unlikely to have affected any metric used to differentiate calls over that small a range. For example, pulse rate in *U. laevigata* Keferstein, 1867 of eastern Australia is strongly temperature dependent, but the regression coefficient is only 5.56 which would generate a maximum increment in pulse rate of 21.7 between the high and low temperatures compared here (data reported as *U. rugosa* Andersson, 1916 by Robertson 1986; Davies & Littlejohn 1986). The only other *Uperoleia* species known from the Kimberley is *U. marmorata*, but no call data are available.

Remarks. The discovery of another species of *Uperoleia* brings the total number of species in the genus to 26. This is the second-largest genus of Australian frog after *Litoria*. Continued exploration of remote areas of the Kimberley and revision of *Uperoleia* using morphology, genetics and call data may reveal further species.

The new species has only been found at four locations in the high rainfall zone of the northwest Kimberley. This area is rich with terrestrial vertebrate species, including frogs, lizards, snakes and mammals (Storr & Smith 1975; Smith & Johnstone 1991). Biological surveys continue to discover new species of vertebrates with regularity, including other new species of frogs (Doughty & Anstis 2007; Doughty *et al.* in press). Invertebrate and plant species are being discovered at even higher rates (e.g. McKenzie *et al.* 1991; Barrett 2006; Harvey & Edward 2007). These findings indicate that the true biodiversity of the region is underestimated. With recent interest in increasing mining, agriculture and tourism in the region, it is essential that large areas are set aside in managed reserves to ensure protection of both described species and additional new species awaiting discovery and description.

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References

- Andersson, L.G. (1913) Results of Dr. E. Mjöberg's Swedish Scientific Expeditions to Australia 1910–1913. 4. Batrachians. *Kunglia Svenska Vetenskapsakademiens Handlingar*, 52(4), 1–26.
- Andersson, L.G. (1916) Results of Dr. E. Mjöberg's Swedish Scientific Expeditions to Australia 1910–1913. 9. Batrachians from Queensland. *Kunglia Svenska Vetenskapsakademiens Handlingar*, 52(9), 1–20.
- Barrett, R.L. (2006) A review of *Planchonia* (Lecythidaceae) in Australia. *Australian Systematic Botany*, 19, 147–153.
- Davies, M. & Littlejohn, M.J. (1986) Frogs of the genus *Uperoleia* (Anura: Leptodactylidae) in south-eastern Australia. *Transactions of the Royal Society of South Australia*, 110, 111–143.
- Davies, M., Mahony, M. & Roberts, J.D. (1985) A new species of *Uperoleia* (Anura: Leptodactylidae) from the Pilbara region, Western Australia. *Transactions of the Royal Society of South Australia*, 109, 103–108.
- Davies, M., McDonald, K.R. & Corben, C. (1986) The genus *Uperoleia* Grey (Anura: Leptodactylidae) in Queensland, Australia. *Proceedings of the Royal Society of Victoria*, 98, 147–188.
- Davies, M., Watson, G.F., McDonald, K.R., Trenerry, M.P. & Werren, G. (1993) A new species of *Uperoleia* (Anura: Leptodactylidae: Myobatrachinae) from northeastern Australia. *Memoirs of the Queensland Museum*, 33, 167–174.
- Doughty, P. & Anstis, M. (2007) A new species of rock-dwelling hylid frog (Anura: Hylidae) from the eastern Kimberley region of Western Australia. *Records of the Western Australian Museum*, 23, 241–257.
- Doughty, P., Anstis, M. & Price, L.P. (in press) A new species of *Crinia* from the high rainfall zone of the northwest Kimberley, Western Australia. *Records of the Western Australian Museum*.
- Gerhardt, H.C. & Huber, F. (2002) *Acoustic Communication in Insects and Anurans*. University of Chicago Press, Chicago, USA, 542 pp.
- Gray, J.E. (1841) Descriptions of some new species and four new genera of reptiles from Western Australia, discussed by John Gould, Esq. *Annals of the Magazine of Natural History*, 7, 86–91.
- Harvey, M.S. & Edward, K.L. (2007) A review of the pseudoscorpion genus *Ideoblothrus* (Pseudoscorpiones, Syarinidae) from western and northern Australia. *Journal of Natural History*, 41, 445–472.
- Keferstein, W. (1867) Ueber einige neue oder seltene Batrachier aus Australien und dem tropischen Amerika. *Nachrichten der Akademie der Wissenschaften in Göttingen*, 1867, 341–361.
- Littlejohn, M.J., Roberts, J.D., Watson, G.F. & Davies, M. (1993) Family Myobatrachidae. In: Glasby, C.J., Ross, G.J.B. & Beesley, P.L. (Eds), *Fauna of Australia, Vol. 2A Amphibia and Reptilia*. Australian Government Publishing Service, Canberra, ACT, Australia, pp. 41–57.
- Loveridge, A. (1933) A new genus and three species of crinine frogs from Australia. *Occasional Papers of the Boston Society of Natural History*, 8, 89–94.
- McKenzie, N.L., Johnston, R.B. & Kendrick, P.G. (1991) *Kimberley Rainforests*. Surrey Beatty & Sons, Chipping Norton, NSW, Australia, 490 pp.
- Robertson, J.G.M. (1986) Male territoriality, fighting and assessment of fighting ability in the Australian frog *Uperoleia rugosa*. *Animal Behaviour*, 34, 673–772.
- Smith, L.A. & Johnstone, R.E. (1991) Amphibians and reptiles of Mitchell Plateau and adjacent coast and lowlands, Kimberley, Western Australia. In: *Biological Survey of Mitchell Plateau and Admiralty Gulf, Kimberley, Western Australia*. Western Australian Museum Press, Perth, WA, Australia, pp. 215–227.
- Storr, G.M. & Smith, L.A. (1975) Amphibians and reptiles. In: Miles, J.M. & Burbidge, A.A. (Eds), *A Biological Survey of the Prince Regent River Reserve, North-west Kimberley, Western Australia*. Department of Fisheries & Wildlife, Perth, WA, Australia, pp. 85–88.
- Tyler, M.J., Davies, M. & Martin, A.A. (1981a) Australian frogs of the leptodactylid genus *Uperoleia* Gray. *Australian Journal of Zoology Supplementary Series*, 79, 1–64.
- Tyler, M.J., Davies, M. & Martin, A.A. (1981b) New and rediscovered species of frogs from the Derby-Broome area of Western Australia. *Records of the Western Australian Museum*, 9, 147–172.
- Tyler, M.J., Davies, M. & Martin, A.A. (1981c) Frog fauna of the Northern Territory: new distributional records and the description of a new species. *Transactions of the Royal Society of South Australia*, 105, 149–154.
- Tyler, M.J., Davies, M. & Watson, G.F. (1986) Frogs of the Gibb River Road, Kimberley Division, Western Australia. *Records of the Western Australian Museum*, 13, 541–552.
- Tyler, M.J. & Doughty, P. (2008) *Frogs of Western Australia* (4th edition). Western Australian Museum Press, Perth, WA, Australia.
- Tyler, M.J., Martin, A.A. & Davies, M. (1979) Biology and systematics of a new limnodynastine genus (Anura: Leptodactylidae) from north-western Australia. *Australian Journal of Zoology*, 27, 135–150.
- Young, J.E., Tyler, M.J. & Kent, S.A. (2005) Diminutive new species of *Uperoleia* Grey (Anura: Myobatrachidae) from the vicinity of Darwin, Northern Territory, Australia. *Journal of Herpetology*, 39, 603–609.