

A NEW SPECIES OF *UPEROLEIA* (ANURA: LEPTODACTYLIDAE:
MYOBATRACHINAE) FROM NORTHEASTERN AUSTRALIA

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Davies, M., Watson, G.F., McDonald, K.R., Trenerry, M.P. & Werren, G. 1993 06 30: A new species of *Uperoleia* (Anura: Leptodactylidae: Myobatrachinae) from northeastern Australia. *Memoirs of the Queensland Museum* 33(1): 167-174. Brisbane. ISSN 0079-8835.

Uperoleia altissima sp.nov. is from elevated sites on the Atherton and Windsor Tablelands in northeastern Queensland. The species is dentate and the call is short and pulsatile, features that distinguish it from all congeners. □ Anura, Myobatrachinae, Leptodactylidae, *Uperoleia altissima*, new species, advertisement call, external morphology, osteology.

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Uperoleia is a genus of small, fossorial frogs with highly glandular skin and a conservative morphotype. The nominate species, *U. marmorata*, was described by Gray (1841) and prior to 1981 was thought to have a wide ranging distribution throughout northern and eastern Australia. Tyler et al. (1981a,b) revised the genus and raised the number of recognised species from three to 18. They restricted the known distribution of *U. marmorata* to the type locality in northern Western Australia.

Davies et al. (1985) described a further species from the Pilbara whilst Tyler et al. (1986) suppressed *U. variegata* leaving 18 recognised species. These studies were confined to the Northern Territory and northwestern Western Australia and, thus, did not deal in any detail with eastern species (*U. rugosa*, *U. fimbrianus* and *U. laevigata*). These they restricted to their type specimens and localities, pending revision of the *Uperoleia* in eastern Australia. When this was completed (Davies & Littlejohn, 1986; Davies et al., 1986), *U. fimbrianus* was synonymised with *U. rugosa* and an additional six species were described. Presently, 23 species are recognised within *Uperoleia*.

During the study of eastern Australian *Uperoleia* a number of specimens were located in museum collections that could not be positively identified. Amongst these were five specimens in the Queensland Museum collection taken near Atherton, NE Queensland. These frogs appeared to be dentate, so resembling *U. fusca* in

Eungella National Park near Mackay, mideastern Queensland. However, they were too poorly preserved to permit positive identification.

In late January 1991, M.D., G.F.W. and K.R.McD. visited the Atherton Tableland and located a species of *Uperoleia* in the Millstream National Park. The species was dentate and conspecific with the indeterminate specimens encountered previously and with others collected at later dates from this site and the Windsor Tableland. Here we describe it as a new species.

MATERIALS AND METHODS

Material cited here is deposited in the collections of the Queensland Museum, Brisbane (QM), South Australian Museum, Adelaide (SAM), Museum of Natural History, University of Kansas (KU), and American Museum of Natural History, New York (AMNH). Measurements of specimens follow Tyler et al. (1981a). Measurements taken (in mm) were: eye diameter (E); eye to naris distance (E-N); internarial span (IN); snout to vent length (S-V); tibia length (TL).

Osteological data were obtained from cleared and stained material after the methods of Davis & Gore (1947) and Dingerkus & Uhler (1977).

The tape recording was made using a Sony TC-D5PRO cassette recorder (tape speed 4.76 cm/s) and Beyer M-88 cardioid dynamic microphone. Air wet bulb temperature (the effective temperature of a frog calling on land) was measured at the calling site using an electronic thermistor thermometer (Takara Digimulti Model

D611). The recording was analysed on a DSP 5500 digital Sona-Graph (Kay Elemetrics Corp.) using the in-built setup #10, with playback on a Nakamichi Dragon cassette recorder. Overall variations in tape speed (i.e. from recording to playback) are estimated at less than 0.5%; and the frequency responses of all audio-electronic components are close to linear within the relevant frequency range determined (based on the manufacturer's specifications). For each call, three primary attributes were determined: (i) duration as the interval from the beginning of the first pulse to the end of the last pulse (ms); (ii) number of pulses per note (direct count); and (iii) dominant frequency (Hz) as the maximum value of the spectrum of power between the cursors for the whole note. One derived attribute was determined — pulse rate [pulses/s determined from (n-1 pulses)/duration (in seconds) measured from the beginning of the first pulse to the beginning of the last pulse]. Levels of resolution were less than 1ms for temporal aspects, and less than 40Hz for dominant frequency.

SYSTEMATICS

Family LEPTODACTYLIDAE
Subfamily MYOBATRACHINAE
Uperoleia Gray

Uperoleia altissima sp.nov.
(Figs 1-7)

MATERIAL EXAMINED

HOLOTYPE: QM J55301, an adult male collected by M. Davies, K.R. McDonald & G.F. Watson in Millstream National Park (145°22'30", 17°38'30"), altitude 820m, Atherton Tableland, NE Queensland adjacent to the park entrance, 5.2km W of Ravenshoe, on 27 January 1991.

PARATYPES: QM J19851-52, Atherton (17°16', 145°29'), I.R. Straughan; QM J19855-57, Carbeen, Atherton Mareeba Rd (17°09', 145°26'), I.R. Straughan; QM J19858, 2km S of Mareeba (17°02', 145°02'), I.R. Straughan; QM J51780-4 (formerly QNPWS N15767-15771) Windsor Tableland (16°13'30", 144°58'30"), altitude 1160-1200m, K.R. McDonald, 16 January 1989; SAM R40144-46, KU 220086 same data as holotype; SAMR40147 (formerly QNPWS N58829) Blunder Ck, Wooroora, Atherton Tableland (145°26', 17°44'), J.W. Winter, 16 June 1987; AMNH 135814 (formerly QNPWS N58823) same data, 17 June 1987; SAM R34321 Western Distributor, Windsor Tableland (145°02', 16°15'), M.P. Trenerry & G. Werren, 11 January 1989; SAM R34318

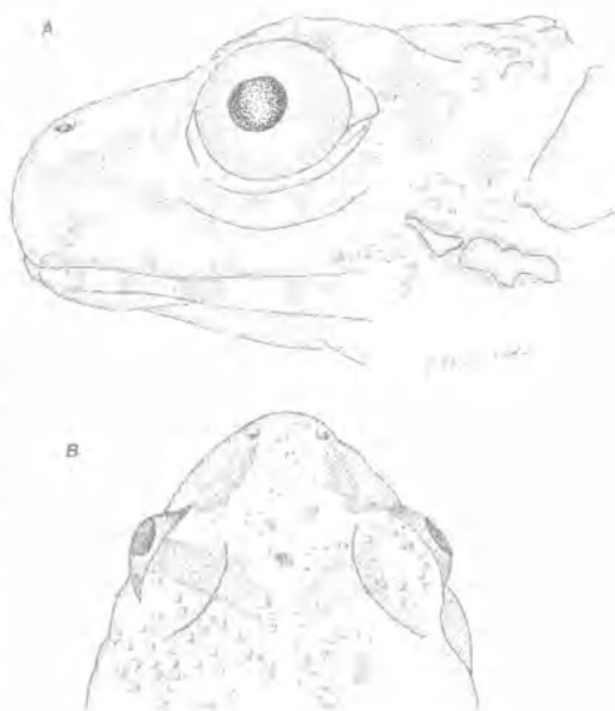


FIG. 1. A. Lateral and B. dorsal views of *Uperoleia altissima* sp.nov. (Holotype).

Millstream, Atherton Tableland, M.P. Trenerry & G. Werren, 15 January 1989; SAM R 34319 nr Ravenshoe, Atherton Tableland, M. Trenerry & G. Werren, 15 January 1989.

REFERRED MATERIAL: QM J31550-31553, nr Atherton, C. Corben.

DEFINITION

A small species (♂♂ 19-25mm S-V) characterised by the presence of maxillary teeth; moderately developed parotoid glands; darkly pigmented ventral surface excluding the pelvic patch ventromedially on thighs; grey dorsum with strong patterning; poorly to moderately exposed frontoparietal fontanelle; no webbing between the toes; vomerine fragments present; carpus of six elements; anteromedial processes of anterior hyale of hyoid slender; ilial crest absent; advertisement call a single pulsed note of 2-3 pulses and a pulse repetition rate of 75.5 pulses/s.

DESCRIPTION OF HOLOTYPE

Maxillary teeth present. Vomerine teeth absent. Snout moderately short, slightly rounded when viewed from above, rounded in profile (Figs 1,2). Eye to naris distance greater than internarial span (E-N/IN 1.29). Canthus rostralis moderately inconspicuous and straight. Nostrils dorsolateral,



FIG. 2. *Uperoleia altissima* sp.nov. in life (Holotype).

not surrounded by prominent lip. Tympanum not visible externally.

Fingers moderately long, slender, unwebbed, slightly fringed with prominent subarticular tubercles. In order of length $3 > 2 > 4 > 1$ (Fig. 3). Outer palmar tubercle large and prominent, inner indistinct. Hind limbs moderately short (TL/S-V 0.39). Toes long, unfringed and unwebbed. In order of length $4 > 3 > 5 > 2 > 1$ (Fig. 3). Metatarsal tubercles prominent; inner elongate, lying along axis of toe 1; outer rounded, acutely angled to long axis of foot. Subarticular tubercles prominent, not conical. Parotoid glands moderately developed; inguinal glands well developed; coccygeal glands not prominent; submandibular gland prominent and discrete (Fig. 1). Cloacal flap fimbriated and prominent.

Ventral surface coarsely granular. Male with unilobular submandibular vocal sac. Cream glandular nuptial pad on thumb.

Dorsum grey in preservative with apricot tipped tubercles and overlying black patterning. Black V-shaped marking between eyes and black suprascapular plicae. Limbs banded dorsally with black. Inguinal and femoral patches cream.

Ventral surface pigmented with small cream circular patches. Femoral region unpigmented (pelvic patch). Throat darkly pigmented with tiny white stipples.

In life, dorsum grey with black patterns. Dermal glands cream; eye golden. Inguinal and femoral patches flame scarlet (Smithe, 1975).

Dimensions: S-V 21.7; TL 8.4; E-N 1.8; IN 1.4; E 2.7.

VARIATION

Uperoleia altissima is a small species ranging 18.3-25.2mm S-V. The hind limbs are short (TL/S-V, mean = 0.38 (0.35-0.43) and eye to naris distance is always greater than internarial span (E-N/IN, mean = 1.40 (1.1-1.82)).

SAMR40144 (recorded specimen) differs from the other topotypic paratypes in that ventral pigmentation is not as dense and the dorsal pattern is not as discrete. In addition, this paratype has an abnormal third finger on the right hand, and the dorsum is more tubercular. SAM R34318, also from the type locality, also has sparse ventral pigmentation. The paratypes from near Atherton (QM J19858, J19855-56) have reacted to preserv-

TABLE 1. Characteristics of the advertisement call of an individual of *Uperoleia altissima* sp.nov. (SAM R40144) recorded on 27 January 1991, 5.2km W of Ravenshoe, NEQ. Means (with ranges of variation in parenthesis) of 20 successive calls are shown, Effective temperature at the calling site (air wet bulb) was 24°C.

No. of pulses	Duration (ms)	Pulse repetition rate (pulses/sec)	Dominant Frequency (Hz)
2.4 (2-3)	27.51 (21.90-31.30)	75.5 (69-80)	2560 (2560)

ative and are a dense uniform chocolate brown colour, masking all dorsal and ventral pigmentation. SAM R40147 has a smaller unpigmented pelvic patch which is slightly more anterior than in the other paratypes.

Differences between topotypic and Windsor Tableland material are very slight. The tips of dorsal tubercles tend to be cream rather than apricot (probably reflecting length of time in preservative). The inner palmar tubercles of most paratypes are masked by the unpigmented glandular nuptial pad, which extends around the base of the thumb. Slight fringing of the toes and minimal basal webbing between toes 2 and 3 and 3 and 4 is present in some material. Two of the Windsor Tableland paratypes, AMNH 135814 and the largest QM J19858 show greater development of the parotoid glands.

MATING CALL STRUCTURE

Twenty successive calls of the recorded individual were analysed and a summary of the call characteristics is listed in Table 1. The advertisement call of *U. altissima* is a short (mean duration 25.71ms), pulsatile call (mean pulse repetition rate 75.5 pulses/s) (Fig.4).

To the ear, the call is a sharp, loud click, repeated at a rate of about 90 calls/min. Among other species of *Uperoleia* whose calls have been described, seven (*U. aspera*, *U. glandulosa*, *U. littlejohni*, *U. lithomoda*, *U. mimula*, *U. minima* and *U. rugosa*) produce 'click' calls (short calls of Tyler et al., 1981a) with the call of *U. mimula* (reported ranges of variation are: duration 40-90ms; dominant frequency 2600-3300Hz; no. of pulses 3-5; pulse repetition rate 56-100 pulses/s; Davies et al., 1986) being most similar to that of *U. altissima*. The calls of these two north Queensland species are very similar except in call duration where there is no overlap in ranges of variation. Based on the calls analysed by Davies et al. (1986), the call of *U. mimula* is longer than the longer three-pulsed call of *U. altissima* (range 29.7-31.3ms). It should be noted that Davies et al. (1986) calculated pulse repetition rates using the formula $1000 \text{ (number of pulses) / duration in ms}$. More accurate estimates of this derived attribute

are obtained from using the formula $1000(n-1) \text{ pulses/duration in ms}$, or, as has been used here: $1000(n-1) \text{ pulses/duration from the beginning of the first to the beginning of the last pulses in ms}$. The formula used here provides the best estimate, especially in situations where the pulse duration is large compared to the interpulse interval. For comparison, recalculation of pulse repetition rate of *U. altissima*, using the formula of Davies et al. (1986), gives values of 92.8 (87-101) pulses/s.

OSTEOLOGY (based on SAM R40146)

Skull well ossified. Medial ossification of dorsal sphenethmoid incomplete, overlain anteriorly by posteromedial edges of nasals; ventrally extends about 1/3 length of orbit posteriorly. Prootic not fused with exoccipital; epiotic eminences prominent. Exoccipital not fused dorso- or ventromedially. Crista parotica short, stocky; confluent laterally with long unexpanded otic ramus of squamosal. Shallow groove of carotid canal posterolaterally on frontoparietals (Fig. 5). Frontoparietal fontanelle exposed anteriorly as inverted roughly triangular area, roofed medially

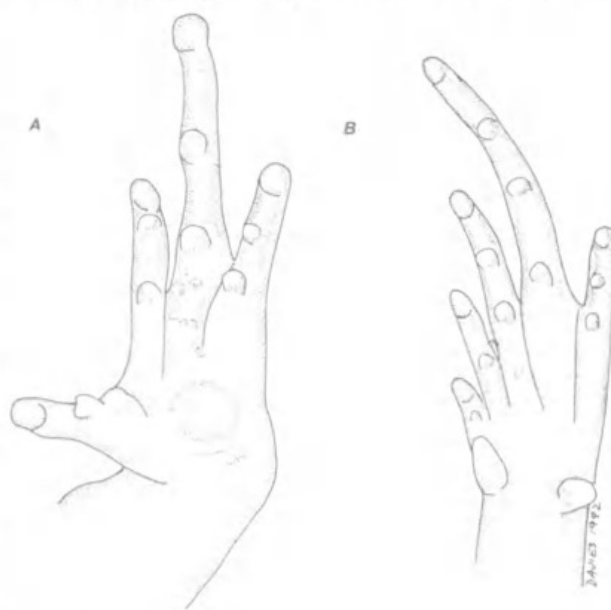


FIG. 3. A. Palmar view of hand. B. Plantar view of foot of *Uperoleia altissima* sp.nov. (Holotype).

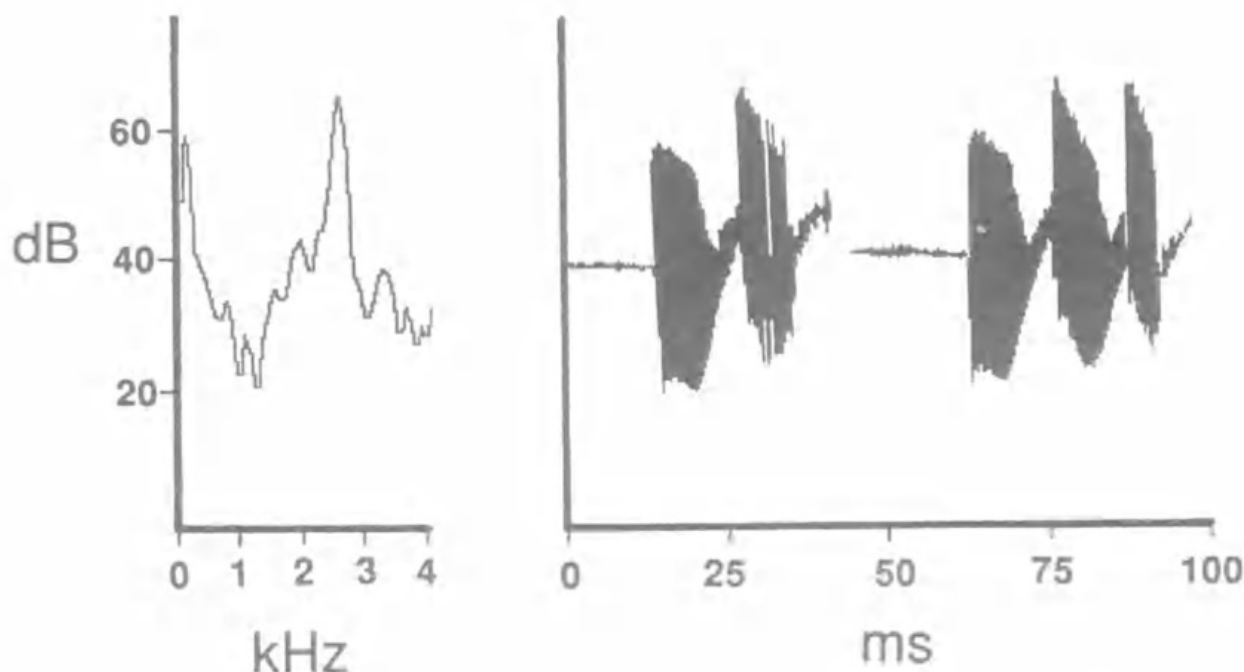


FIG. 4. Power spectrum and wave form of two advertisement calls of *Uperoleia altissima* sp. nov. (SAM R40144), recorded on 27 January 1991, 5.2 km W of Ravenshoe, NEQ, at a wet bulb air temperature of 24°C. Note that the ordinate for the wave form display is not labelled because it depicts a relative linear scale in volts.

and exposed again as an approximately diamond-shaped area posteriorly. Anterior extremities of frontoparietal fontanelle about level of anterior extremities of pterygoid. Posterior extremity undefined. Frontoparietal elements well ossified reaching posterior extremities of nasals anteriorly.

Nasals well ossified, approximately triangular, closely applied medially, overlying sphenethmoid posteriorly. Maxillary process poorly developed not reaching pars facialis of maxilla. Palatines moderately broad; reduced laterally, not in contact with pars facialis of maxilla but overly sphenethmoid medially.

Parasphenoid robust. Cultriform process moderately broad, truncated terminally, not reaching level of medial extremities of palatines. Alae robust, deep, slightly angled posterolaterally reaching level of extremities of medial rami of pterygoids (Fig. 5).

Pterygoid moderately robust; slender anterior ramus in long contact with well-developed pterygoid process of maxilla. Medial ramus moderately broad, acuminate. Posterior ramus moderately broad. Small cartilaginous quadrate at articulation of base of squamosal and quadratojugal. Squamosal shaft robust; short knobbed zygomatic ramus; long unexpanded otic ramus.

Maxilla and premaxilla dentate. Teeth sparse toward pterygoid process of palatal shelf of maxilla. Teeth relatively small. Alary process of premaxilla moderately slender, not inclined posteriorly. Vomerine processes of palatal shelf of premaxilla well developed, articulating medially. Pars facialis of maxilla moderately deep posteriorly, shallower anteriorly; lacking preorbital process.

Remnant fragments of dentigerous processes of vomers medial to palatines. Bony columella extremely robust (Fig. 5).

Pectoral girdle arciferal and robust. Omosternum and xiphisternum present. Sternum cartilaginous. Left clavicle previously fractured, right slender, curved; both closely applied medially. Coracoids robust, widely separated medially. Scapula bicapitate, curved, approximately same length as clavicle. Suprascapula about one half ossified.

Eight procoelous non-imbricate presacral vertebrae. Sacral diapophyses poorly to moderately expanded. Relative widths of transverse processes: III > IV > II = V = VI > VII > VIII.

Urostyle crest about 2/3 length of urostyle. Ilium with no dorsal crest. Dorsal prominence broadly obtuse; dorsal protuberance poorly-developed dorsolaterally (Fig. 6A).

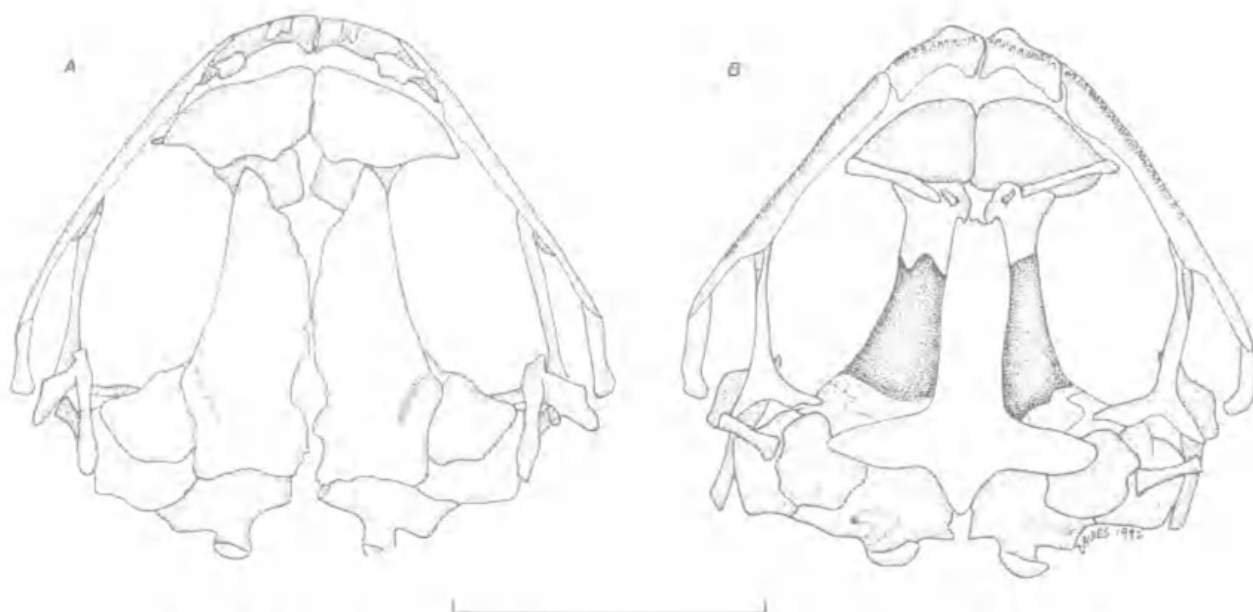


FIG. 5. A. Dorsal and B. ventral views of the skull of *Uperoleia altissima* sp. nov. (SAM R40146).

Humerus with well-developed anteroproximal crest. Phalangeal formula of hand 2,2,3,3; distal tips of terminal phalanges knobbed. Carpus of six elements, moderate torsion (Fig. 7). O. ulnare and O. radiale present. O. radiale larger of two. Both articulate with O. radioulna proximally and with each other distally. Distally both articulate with large transversely elongate O. centrale postaxiale. O. radiale articulates laterally with O. centrale preaxiale. O. centrale postaxiale articulates distally with bases of O. metacarpi III, IV and V; moderately well-developed lateral flange extends from lateroproximal corner. Palmar sesamoid anteroventrally. O. centrale preaxiale articulates laterally with O. centrale postaxiale and with unfused carpal elements of O. distale carpal 2 and 3 and laterally with basal prepollical element.

Phalangeal formula of foot 2,2,3,4,3. O. tibiale and fibulare elongated elements fused at either end. O. tibiale extends as far as distal end of O. fibulare. Three distal tarsal elements present. Lateral elements largest, lying at base of O. metatarsus III, extending laterally to articulate with medioproximal side of base of O. metatarsus IV and medially to base of O. metatarsus II. Second element lies between bases of O. metatarsi II and I. Medial element lies at the base of O. metatarsus I, articulating also with O. centrale prehallucis. Distal prepollical element subulate extending for about 2/3 length of O. metatarsus I (Fig. 7). Two sesamoids at base of prehallux.

Hyoid plate about as broad as long. Alary processes broad, not pedunculate. Anteromedial processes of anterior hyale slender and moderately long. Posterolateral processes of plate elongate. Posterior cornua long and ossified (Fig. 6B).

VARIATION IN OSTEOLOGY

Three paratypes were examined for osteological variation: QM J19581, 19587 and 51782. All are dentate but there are fewer teeth than in the described specimen. Maximum development is on the premaxilla and development decreases posteriorly. The posterior exposure of the frontoparietal fontanelle is minimal in J51782, but is the same as in the described paratype in the other two. Ossification of the nasals and of the sphenethmoid is slightly less in J51782 than that described. Development of the zygomatic ramus of the squamosal is slightly less in J19852 whilst the pars facialis of the maxilla is less crenate in J19851. Vomerine fragments are difficult to detect in this same paratype.

ETYMOLOGY

The specific name is derived from the Latin *altus* meaning high, in reference to the elevations at which the species has been collected.

COMPARISON WITH OTHER SPECIES

Uperoleia altissima is a dentate species, a feature shared by *U. marmorata*, *U. mjobergi*, *U. micromeles*, *U. tyleri*, *U. martini*, *U. laevigata* and *U. fusca*.

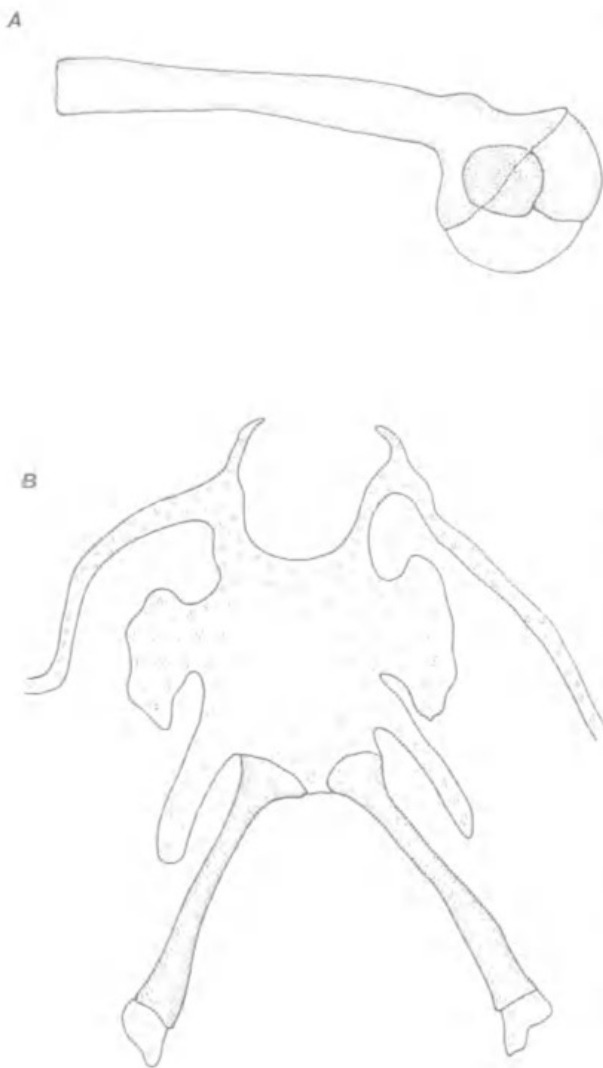


FIG. 6. A. Lateral view of the ilium (SAM R40146). B. Ventral view of the hyoid (QM J51782) of *Uperoleia altissima* sp. nov.

U. marmorata and *U. mjobergi* are confined to the Kimberley Division of Western Australia. Dentition in *U. micromeles* is sparse, similar to that found in *U. altissima*. This species is confined to desert areas in central Australia. It has very broadly spaced nasals ($E-N/IN < 1$) and broad more elongate palatines. In addition, the shape of the nasals is unusual within *Uperoleia*. *U. tyleri* and *U. martini* are large species with hypertrophied parotoid glands and uniform ventral pigmentation. *U. altissima* is most similar morphologically to *U. laevigata* and *U. fusca*. Both these species have long calls of 32-68 or 20 pulses. In addition, both have a completely-roofed frontoparietal fontanelle and a well-devel-

oped preorbital process on the pars facialis of the maxilla.

U. altissima is most similar in call structure to *U. mimula*. This is an edentate species in which vomerine fragments are absent and which has an extremely well-developed dorsal prominence on the ilium, features not shared by *U. altissima*.

HABITAT

The type locality is medium eucalypt woodland with *Themeda triandra* and *Imperata cylindrica* (Type 16O of Tracey, 1982) and is located on Glen Gordon Volcanics. Windsor Tableland vegetation is low to medium eucalypt woodland (Type T6S) on Mareeba granites. This area was highly disturbed being near a creek system with numerous mining tracks

DISTRIBUTION

U. altissima has been located only at elevated sites on the Atherton and Windsor Tablelands, NE Queensland.

DISCUSSION

Uperoleia comprises a number of cryptic species pairs including *U. rugosa* and *U. capitulata*, *U. tyleri* and *U. martini*, *U. laevigata* and *U. fusca*, *U. inundata* and *U. arenicola*, *U. mimula* and *U. lithomoda*. The recognition of *U. altissima* adds a third example to this latter cryptic species pair.

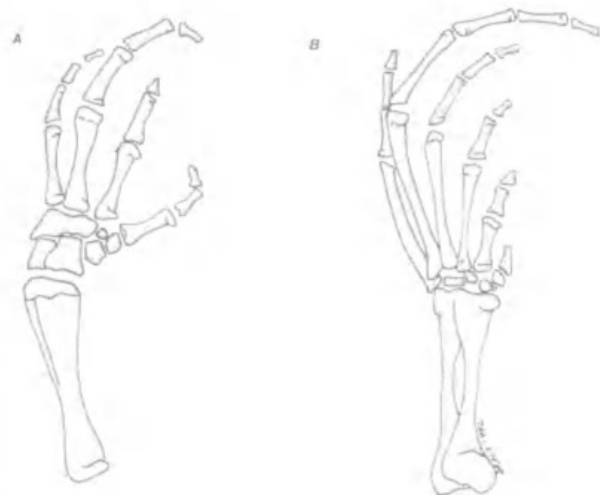


FIG. 7. A. Dorsal view of bones of hand. B. Dorsal view of bones of foot of *Uperoleia altissima* sp. nov. (SAM R40146).

Morphologically *U. mimula* and *U. lithomoda* are extremely similar (Davies et al., 1986) and close similarity in call structure between *U. mimula* and *U. altissima* exists. The presence of dentition in *U. altissima* may be the only feature that will aid field identification. Both *U. mimula* and *U. altissima* have been collected on the Windsor Tableland. The occurrence in sympatry of species with such similar call structures occurs also with *U. tyleri* and *U. martini* in southeastern Australia. To the ear on hot nights, calls of *U. mimula* and *U. lithomoda* are difficult to distinguish adding to the difficulty of field identification of this cryptic group of species.

The nature of the dentition in *U. altissima* has been shown to be a paedomorphic condition (Davies, 1989) together with a number of osteological features common to dentate species. These include the presence of vomerine fragments and the knobbed nature of the zygomatic ramus of the squamosal. Such features influenced by heterochrony provide explanations for the morphological divergences found within this enigmatic group of frogs.

ACKNOWLEDGEMENTS

Field work was supported by an Australian Research Grants Scheme award to M. Davies and M.J. Tyler. Glen Ingram and Patrick Couper are thanked for access to material in the Queensland Museum. Michael J. Tyler critically read the manuscript and is thanked for support.

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