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NEW AND REDISCOVERED SPECIES OF FROGS FROM THE DERBY-BROOME AREA OF WESTERN AUSTRALIA

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ABSTRACT

Three new species of frogs are described from localities in the Derby-Broome area. One is a member of the Hylidae (*Cyclorana vagitus* sp. nov.) and the others represent the Leptodactylidae (*Neobatrachus aquilonius* sp. nov. and *Uperoleia aspera* sp. nov.). Rediscovery of *U. mjobergi* (Andersson) permits a redefinition of the species.

INTRODUCTION

In each wet season from 1977 to 1980 we have undertaken surveys of the frog fauna in various parts of the Kimberley Division, Western Australia. These surveys have led to the description of 10 new species: Martin, Tyler and Davies (1980), Tyler and Davies (1979) and Tyler, Davies and Martin (1977, 1979, 1981).

In February 1980 we visited Derby, Broome and adjacent areas seeking to establish the position and nature of barriers to the southern dispersal of the Kimberley frog fauna, and the nature of that fauna. Here we describe three new species collected during that survey, and redescribe *Uperoleia mjobergi* (Andersson, 1913), formerly known from the two types. A manuscript synthesizing the ecology and biogeography of the Kimberley frog fauna is in preparation.

MATERIALS AND METHODS

The specimens reported here have been deposited in the following collections: Australian Museum, Sydney (AM), American Museum of Natural History, New York (AMNH), British Museum (Natural History), London (BMNH), Department of Zoology, University of Adelaide (AUZ), Museum of Natural History, University of Kansas, Lawrence (KU), Naturhistoriska Riksmuseet, Stockholm (NR), South Australian Museum, Adelaide (SAM), Western Australian Museum, Perth (WAM).

Methods of measurements follow Tyler (1968). Abbreviations used in the text are: E (eye diameter), E-N (eye to naris distance), HL (head length),

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HW (head width), IN (internarial span), S-V (snout to vent length), T (tympanum diameter), TL (tibia length). In *Neobatrachus* we introduce an additional measurement as an overall quantification of foot length. The length of the foot (FL) was measured from the proximal end of the outer metatarsal tubercle to the tip of the fourth toe.

Osteological data were obtained from cleared and Alizarin Red stained preparations using the technique described by Davis and Gore (1947). Differential Alizarin Red/Alcian Blue staining of bone and cartilage followed enzymic digestion of soft tissues employing the method of Dingerkus and Uhler (1977). Osteological descriptions follow Trueb (1979).

Mating calls were recorded with a Sony TC-510-2 tape recorder and a Beyer M-88 dynamic microphone, at a tape speed of 19 cm/sec. Appropriate temperatures (water or air wet-bulb) were measured close to the calling sites of males, using a Schultheis quick-reading thermometer. Calls were analysed using a sound spectrograph (Kay Model 6061-B Sona-Graph) with the response curve set in the FL-1 mode. Temporal characteristics of calls were determined from wide-band (300 Hz bandpass) and spectral characteristics of calls from narrow-band (45 Hz bandpass) spectrograms. Audiospectrograms were analysed using dividers and calibrated paper.

For *Uperoleia* species three calls of each of three individuals were analysed and mean values were calculated. Only one individual of *Neobatrachus* was recorded, and the recording is of poor quality; however the calls are judged to be representative of the many individuals whose calls were heard but not recorded.

SYSTEMATICS

Family Hylidae Hallowell

Cyclorana vagitus sp. nov.

Figs 1-5

Cyclorana cultripes: Tyler and Martin, 1977, p. 267 (part.)

Holotype

WAM R71037, an adult male of 46.8 mm S-V length collected by the roadside at the junction of the Great Northern Highway and the road to Derby, 41 km S of Derby, 124°38'E, 17°44'S, Kimberley Division, W.A. by A.H. Cross, M. Davies, A.A. Martin and M.J. Tyler on 14 February 1980.

Paratypes

There are 26 paratypes all of which are adults: WAM R71030-36, SAM R18008-10, KU 186039, AMNH 106555, BMNH 1980.4, AM R95415 taken at the type locality 14-21 February 1980; WAM R27251 Duncan Highway, 17 km N of Lake Argyle turnoff, near Kununurra, 8 June 1966, A.M. Douglas and G.W. Kendrick; SAM R16535, WAM R58836-37, 71039, Parry Creek Road, Kununurra, 25 January 1978, Davies, Martin and Tyler; WAM R71038, 29 km S of Northern Highway/Duncan Highway junction, 24 January 1978, Martin and Tyler; WAM R71029, Camballin, 18 February 1980, Davies, Martin and Tyler.

Diagnosis

A moderate-sized, robust species with a large and roughly triangular head, bearing diffuse dark grey and dark green mottling. Males 42-48 mm; females 44-48 mm S-V. Of species within the size range of *C. vagitus*, *C. cultripes* shares similar proportions, but has a short (370-375 msec) mating call, whereas in *C. vagitus* it is of approximately 1 sec. duration, and resembles the crying of a young baby.

Description of Holotype

Head high and distinctly broader (HW 18.4 mm) than long (HL 17.2 mm, HL/HW 0.93), angular but rounded terminally when viewed from above; rounded in profile; eye large and prominent (**Fig. 1**), its diameter (5.5 mm) more than one and one-quarter of eye to naris distance (4.0 mm). Canthus rostralis not prominent and very slightly curved. Nostrils inclined dorsolaterally and separated from one another by distance (3.2 mm) slightly more than three-quarters of internarial span (E-N/IN 1.25). Tympanum entirely visible, its diameter (3.6 mm) three-fifths of eye diameter (**Fig. 2**).

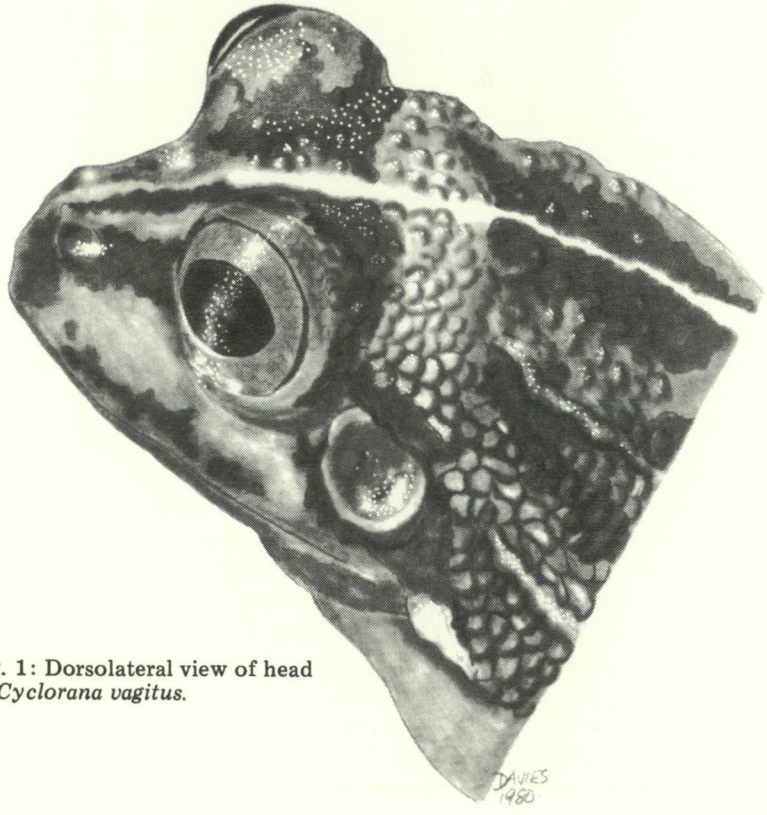

Fig. 1: Dorsolateral view of head of *Cyclorana vagitus*.

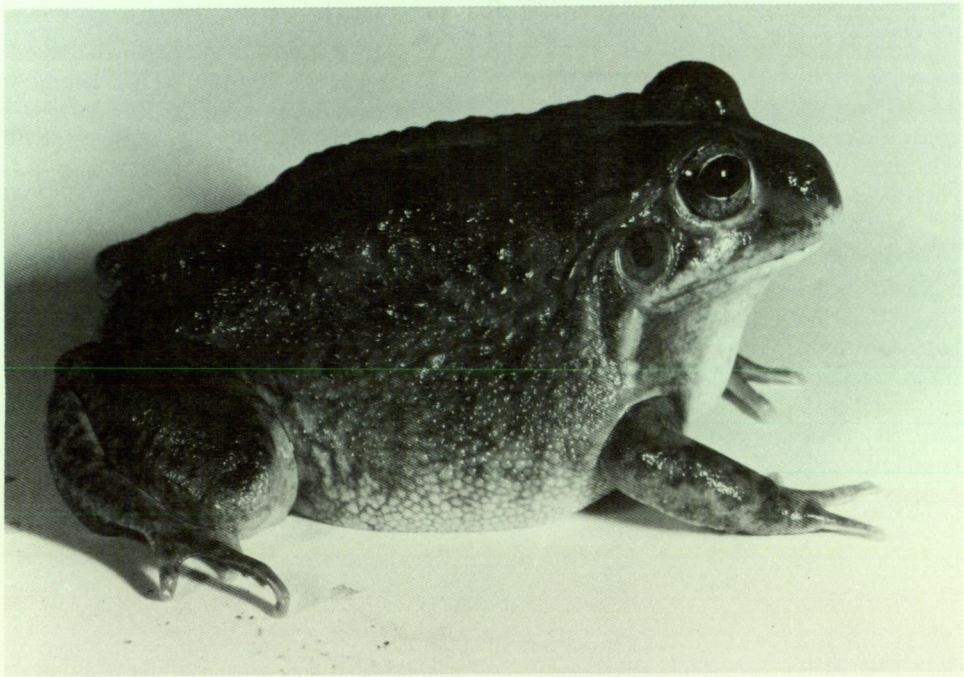

Fig. 2: *Cyclorana vagitus* in life. Paratype from Parry Creek Road, Kununurra. This individual has a snout to vent length of 45 mm.

Tongue broad, circular and slightly free behind. Choanae small and oval, and vomerine teeth on two converging elevations principally behind choanae.

Fingers rather broad and slightly flattened, with narrow, lateral fringes. Fingers in decreasing order of length 3 > 4 > 1 > 2. Subarticular tubercles extremely prominent; palmar tubercles large and prominent (**Fig. 3a**). Foot short, and toes have broad lateral fringes. Webbing on medial surface of fifth and third toes reaches subarticular tubercle at base of penultimate phalanx. Toes in decreasing order of length 4 > 3 > 5 > 2 > 1. Subarticular tubercles extremely prominent, large oval inner but no outer metatarsal tubercle (**Fig. 3b**). Hindlimbs very short (TL 17.5 mm, TL/S-V 0.37). Skin of dorsal surface smooth but for a few, small, scattered tubercles between eyes. Abdomen and lateral body surfaces uniformly and coarsely granular. A poorly developed supratympanic fold and a narrow tarsal fold.

Dorsal surface dull grey with extensive, irregular, darker mottling, and bearing a narrow, white mid-vertebral stripe. A narrow, dark, canthorostral stripe extends from nostril to eye, and continues behind eye as a broader stripe to above insertion of forearm. Throat heavily suffused with grey; remainder of undersurface is white.

Single, elongate, nuptial pad on medial surface of second finger.

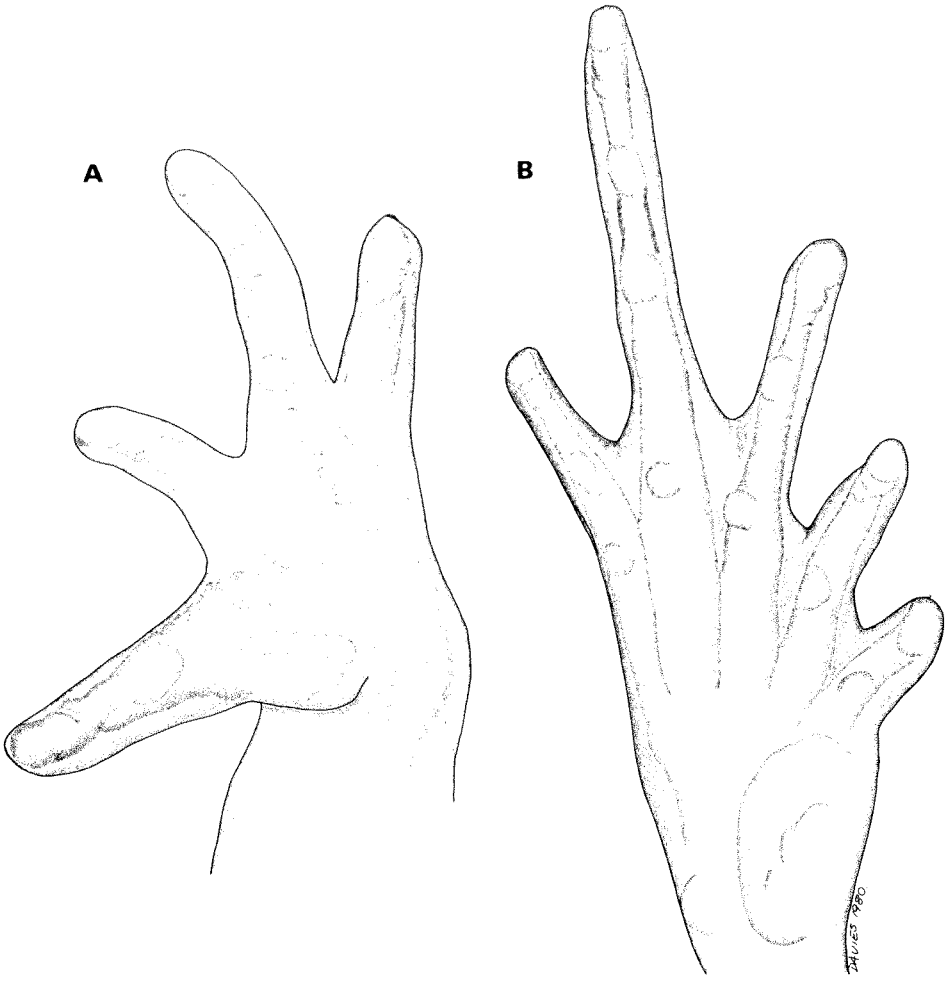

Fig. 3: (a) Palmar view of hand of *Cyclorana vagitus*; (b) Plantar view of foot of *C. vagitus*.

Variation

Males 41.8-47.8 mm S-V; females 43.8-47.6 mm. All are robust specimens in breeding condition, but none was observed in amplexus. Variation in proportions: E-N/IN 1.13-1.41, TL/S-V 0.36-0.44, HL/HW 0.85-0.96, HL/S-V 0.33-0.38.

The coloration is remarkably uniform. In life the frogs exhibit small and irregularly shaped patches of lichen green upon a dull grey-slate background, but in preservative these green markings are lost. The throat of males is slate.

Osteology

Skull robust with moderately ossified neurocranium. Sphenethmoid well ossified, extending anteriorly in a rhomboidal projection between and anteriorly to nasals to level of alary processes of premaxillaries. Sphenethmoid overlapped laterally by nasals. Prootic completely fused with exoccipitals dorsally, but ossification reduced ventromedially. Crista parotica well developed, moderately long and slender; short stocky otic ramus of squamosal lies alongside lateral extremities (**Fig. 4a**). Frontoparietal fontanelle slender and barely exposed for middle one third of orbital length. Frontoparietal elements well developed, extending about two-thirds length of orbit; orbital edges straight. Nasals triangular, moderately large with robust maxillary processes that articulate with well developed preorbital processes of deep pars facialis of maxillaries. Palatines robust, expanded laterally, blunt medially, ridged, extending to level of centre of dentigerous processes of prevomers. Parasphenoid robust; cultriform process extending to level of anterior extremity of pterygoid; alary processes long, moderately broad, at right angles to cultriform process and overlapped laterally by medial rami of pterygoids (**Fig. 4b**).

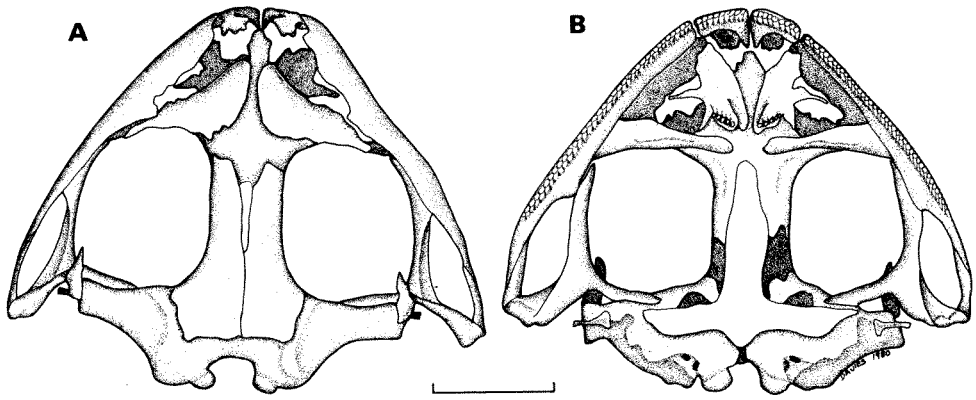

Fig. 4: (a) Dorsal view of skull of *Cyclorana vagitus*; (b) Ventral view of skull of *C. vagitus*. Scale bar = 5 mm.

Pterygoid well developed with robust posterior process, long, acuminate anterior process and long robust medial ramus; anterior ramus in long contact with pterygoid process of palatal shelf of maxillary, reaching to palatines. Quadratojugal robust and in firm contact with maxillary. Squamosal robust with short zygomatic ramus and slightly longer otic ramus. Maxillary and premaxillary dentate. Alary processes of premaxillaries inclined posteromedially. Palatine processes of premaxillaries long, almost abutting medially.

Prevomers entire, moderately short dentigerous processes inclined at an angle of approx. 45° to midline; alae forming margins of choanae. Bony columella present.

Pectoral girdle arciferal and robust; omosternum and xiphisternum present, clavicles robust and abutting medially; coracoids robust and widely separated medially; scapula bicapitate, longer than clavicles; suprascapula one-half to two-thirds ossified.

Humeral crest moderately well developed. Eight procoelous non-imbricate presacral vertebrae. Relative widths of transverse processes: III > sacrum > IV > II > V = VI = VII = VIII. Sacral diapophyses moderately expanded, ilia extend half way along their length. Urostyle bicondylar with long dorsal crest extending for posterior seven-eighths of urostyle. Phalangeal formula of hand: 2,2,3,3; distal tips of terminal phalanges knobbed. Well developed bony prepollex. Phalangeal formula of foot 2,2,3,4,3; well developed bony prehallux.

Comparison with Other Species

Smaller adult size is sufficient to distinguish *C. vagitus* from *C. australis* (males 71-79 mm; females 71-105 mm) and *C. novaehollandiae* (males 61-81 mm; females 75-101 mm). Subadult *C. australis* proportions are similar to those of *C. vagitus*, but lack the intense dorsal mottling of that species, and have a more clearly demarcated lateral head stripe.

The size range of *C. platycephalus* (males 45-55 mm; females 53-66 mm) just overlaps the upper limit of *C. vagitus*. It is further distinguished by its fully webbed toes and flattened head.

The dorsal patterns of markings of *C. brevipes*, *C. longipes* and *C. maculosus* are variable, but all exhibit dark islands of pigmentation upon a lighter background, whereas the dorsum of *C. vagitus* is irregularly mottled, without clear demarcation of dark from light areas.

Cyclorana cryptotis is generally brown upon an orange background, and hence coloured differently to *C. vagitus*. *Cyclorana cryptotis* is smaller than *C. vagitus* (males 34-44 mm; females 36-46 mm), and the tympanum is usually hidden beneath the skin, whereas the tympanum is large and prominent in *C. vagitus*.

Cyclorana maini is a diffusely marked species of a similar size to *C. vagitus*. Limb length possibly is slightly longer in the new species (TL/S-V 0.36-0.44 compared with 0.33-0.41 in *C. maini*) but the most distinctive difference is in the shape of the head as demonstrated by the more narrowly spaced nostrils (E-N/IN 0.97-1.23 in *C. maini*; 1.13-1.41 in *C. vagitus*). Although we lack a recording of the mating call of *C. vagitus*, we believe it to be of longer duration than that of *C. maini* (775-882 msec in *C. maini*: Tyler and Martin 1977, p. 276).

Cyclorana verrucosus is confined to south-eastern Queensland and northern and central New South Wales. Its habitus is similar to that of *C. vagitus*,

but it is distinguished by its extremely tubercular dorsal skin, and in particular by the development of elongate ridges along the back. In *C. vagitus* the skin tubercles are small, round and confined to the head.

Finally there is *C. cultripes* which morphologically resembles *C. vagitus* in several features. They differ in that *C. cultripes* has a broad, pale postocular bar lacked by *C. vagitus*, and *C. vagitus* lacks the dark canthal stripe of *C. cultripes*. The species are distinguished readily in mating call characteristics. *Cyclorana cultripes* (Tyler and Martin 1977, p. 267) has a short mating call (370-375 msec), whereas the call of *C. vagitus* has a duration of at least one second.

Mating Call

An irregularly repeated, quavering, crying sound which we estimate to have a duration of about one second.

Distribution

Confined to the Kimberley Division, Western Australia, south to the Fitzroy River.

Habitat

Found in flooded grassland at the type locality (**Fig. 5**) and on a flooded spinifex plain at Camballin. Specimens from the Kununurra area also were taken at or near inundated grasslands.

Fig. 5: Type locality of *Cyclorana vagitus* 41 km S of Derby, W.A. The entire area was inundated to a depth of 20 cm at the time of collection of the holotype. The bush in the centre foreground is approximately 2 metres high.

Etymology

From the Latin *vagitus*, 'crying or squalling' and referring to the mating call which resembles the plaintive crying of a young baby.

Family Leptodactylidae Berg

Neobatrachus aquilonius sp. nov.

Figs 6 and 7

Holotype

WAM R71005, an adult male of 51.3 mm S-V collected by the roadside during a transect 22-41 km S of Derby, Kimberley Division, W.A. by A.H. Cross, M. Davies, A.A. Martin and M.J. Tyler on 14 February 1980.

Paratypes

There are 17 paratypes: BM 1979.729; SAM R18012-14, 18032-33, 18101-02; WAM R71001-04, 71006-09, collected on or adjacent to the road 10-41 km S of Derby by Davies, Martin and Tyler on 13-19 February 1980, and WAM R62195 taken 32 km S of Derby by the same collectors on 13 February 1979. The series SAM R18032-33, 18101-02 has been cleared and stained with Alcian Blue and Alizarin Red, or Alizarin Red alone.

Diagnosis

A relatively large species (males 48-54 mm; females 52-59 mm S-V) with a diffuse dorsal pattern of mustard variegated with dark brown to black, and a mating call consisting of a short trill. Most closely related to *N. centralis* which is a slightly smaller species (males 42-51 mm) with a longer foot (FL/S-V 0.38-0.44, compared with 0.33-0.40 in *N. aquilonius*).

Description of Holotype

Head high and semi-circular when viewed from above, and rounded in profile. Snout high. Eye large and prominent, its diameter (5.9 mm) equivalent to one and one-half times eye to naris distance (4.0 mm). Pupil a vertical slit (**Fig. 6**). Canthus rostralis very poorly defined and straight. Nostrils inclined superiorly and separated from one another by a distance (3.3 mm) equivalent to three-quarters of eye to naris distance (E-N/IN 1.21). Tympanum not visible.

Tongue broad and circular. Choanae small and oval and vomerine teeth in two relatively long rows directly between choanae.

Fingers cylindrical, unwebbed and lacking lateral fringes. Subarticular and palmar tubercles moderately developed. Fingers in decreasing order of length $3 > 1 > 2 > 4$ (**Fig. 7a**). Foot long (FL 19.8 mm) with prominent, black, inner metatarsal tubercle but no outer metatarsal tubercle. Toes flattened slightly and with very small subarticular tubercles and approximately one-half webbed (**Fig. 7b**). Toes in decreasing order of length $4 > 5 = 3 > 2 > 1$. Hind limbs very short (TL 16.3 mm, TL/S-V 0.32).

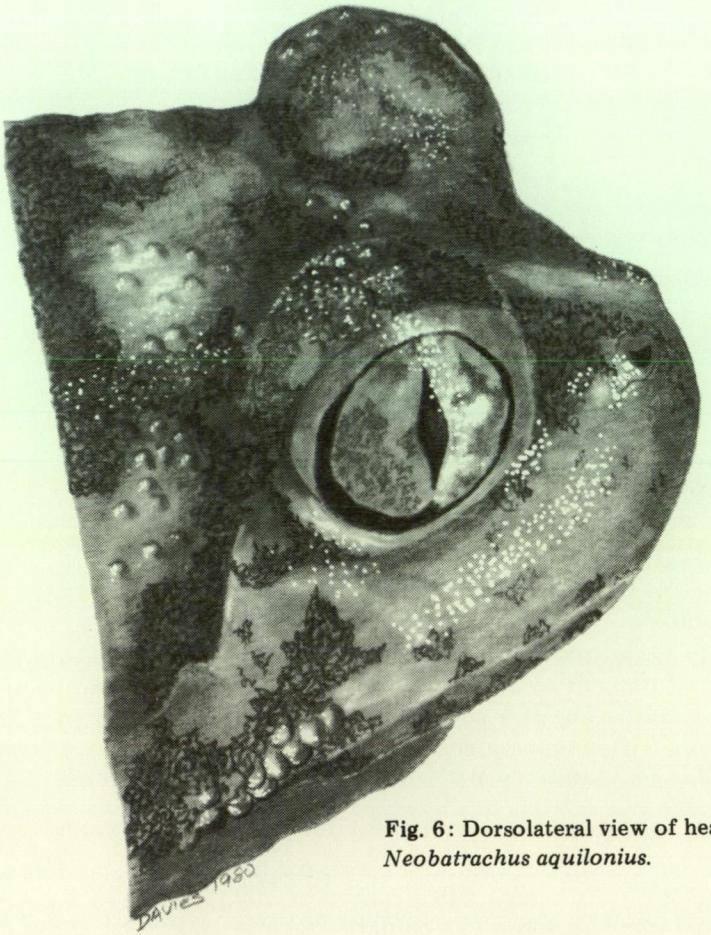

Fig. 6: Dorsolateral view of head of *Neobatrachus aquilonius*.

Skin of dorsal surface finely and evenly tubercular. From posterior half of upper eyelids many of these tubercles bearing minute, conical, black spines only visible microscopically. Ventral surface of body and limbs entirely smooth.

Dorsal surface pale grey with darker slate pattern including a narrow trans-ocular bar and single postocular stripes extending along the flanks, and a broad butterfly-shaped mark in the post-scapular area. Posteriorly the dark markings merge into a series of small, irregular patches. Back of thighs pale slate. Ventral surface of body white but for grey patches beneath angles of mandibular articulation.

Elongate nuptial pads on the medial surfaces of the first and second fingers.

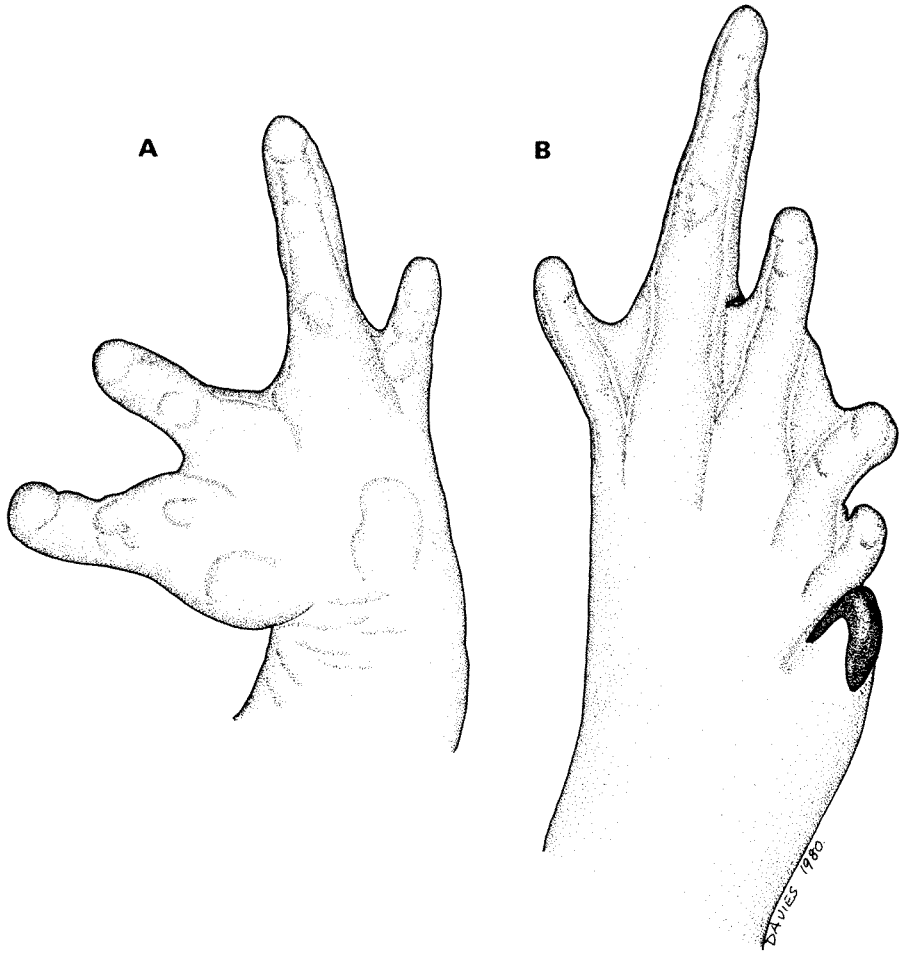

Fig. 7: (a) Palmar view of hand of *Neobatrachus aquilonius*; (b) Plantar view of foot of *N. aquilonius*.

Variation

S-V length of adult males 47.9 -53.9 mm, in females 52.2-59.0 mm.

Head exhibiting minimal variation in proportions. Eye consistently large and prominent. E-N/IN 0.93-1.31. Body large and robust and hindlegs very short (TL/S-V 0.29-0.35).

Five of the 17 paratypes have pale, narrow mid-vertebral stripes. Dark markings on dorsum vary in position and intensity.

In life ground colour of dorsal surface mustard yellow, variegated dark brown to black. Top of head light brown; bright yellow band bordering

superior edge of nictitating membrane. Undersurface of limbs plum, dorsal surface variegated with mustard yellow and brown. Ventral surface of body white.

Comparison with Other Species

There are currently four congeners recorded from Western Australia: *N. pelobatoides* (Werner), *N. sutor* Main, *N. wilsmorei* (Parker) and *N. centralis* (Parker).

Neobatrachus pelobatoides has a much longer call than *N. aquilonius* (approx. 3.6 sec.; Littlejohn and Main 1959), and has a significantly shorter S-V length: 45 mm compared with 59 mm. Its head is flatter and when present, its mid-vertebral stripe is red (yellow or green in *N. aquilonius*).

Neobatrachus sutor is up to 51 mm in length and is gold with black markings. Its distinctive mating call is a short tap repeated at approximately 0.4 sec. intervals (Littlejohn and Main 1959). It is therefore also a smaller species with a call unlike the trill of *N. aquilonius*.

Neobatrachus wilsmorei is a highly distinctive species characterised by its chocolate brown colour with, on each side, a pair of diverging, bright yellow stripes commencing behind the eye. Its call is a single pulse of about 0.04 sec. duration, repeated at approximately 1.4 sec. intervals. *Neobatrachus centralis* is a poorly defined species because little is known of the population at the type locality near Lake Eyre in South Australia. Data derived from specimens collected at South Australian localities, east, south and west of the type locality suggest that *N. centralis* is a slightly smaller species than *N. aquilonius* (males 42-51 mm in *N. centralis*, compared with 48-54 mm in *N. aquilonius*), and *N. centralis* has a longer foot (FL/S-V 0.38-0.44, compared with 0.33-0.40 in *N. aquilonius*). The populations of *Neobatrachus* from the west and south-east of the continent reported as *N. centralis* by various authors do not appear to represent *N. aquilonius*.

Neobatrachus sudelli was resurrected from the synonymy of *N. pictus* by Roberts (1978) who suggested that this species might prove a senior synonym of *N. centralis*. The holotype of *N. sudelli* from Warwick, Queensland, is reported by Moore (1961) to have an S-V length of 41.4 mm. Two adult males collected at St George, 340 km west of Warwick (SAM R3717, 3440A) have S-V lengths of 36.8 mm and 43.3 mm respectively, and a gravid female measures 42.0 mm. These sizes are substantially less than the size ranges of *N. aquilonius* cited above. *Neobatrachus pictus* includes individuals with a pattern of markings similar to *N. aquilonius*, but has a substantially longer foot (FL/S-V 0.42-0.54).

Mating Call

The mating call can be described as a soft, slow rattle. The call of the one individual recorded consists of 11 pulses repeated at a rate of 18.33 pulses/sec., with a total call duration of 565 msec. Each pulse has a duration of

approximately 25 msec, and the dominant frequency of the call lies at about 1500 Hz.

The trilled call structure of *N. aquilonius* distinguishes it from *N. sutor* and *N. wilsmorei*, whose calls consist of short, single notes (Littlejohn and Main 1959). From *N. pictus* and *N. pelobatoides*, which have pulsed calls, it is clearly distinguishable by its lower pulse number (11, compared with about 33 in *N. pictus* and 70 in *N. pelobatoides*: Roberts 1978; Littlejohn and Main 1959); its call duration is also lower. The call structure is similar to that of *N. sudelli* in eastern Australia (Roberts 1978) and of the population in south-western Australia called *N. centralis* by Littlejohn and Main (1959).

Distribution

We collected this species 22-41 km south of Derby. A few individuals were heard calling on the inundated Roebuck Plains approximately 25 km east of Broome, but at no other sites, on a 200 km transect from Derby to Broome. It is possible that Andersson's (1913) report of *Heleioporus pictus* from Mowla Downs about 110 km south of the Fitzroy River is a record of this species, but that individual was a male 44 mm in length, and thus was 4 mm smaller than any adult male in the series taken by us.

Breeding Biology

One of the paratype females laid 1426 eggs on 14 February 1980. The developing spawn perished during transit to Adelaide and so was preserved upon arrival. The diameter of a sample of 10 fertile ova averaged 1.9 mm and the capsule diameters averaged 2.7 mm.

Etymology

From the Latin *aquilonius* meaning 'northern'. This species is the most northern member of *Neobatrachus* yet described.

Uperoleia aspera sp. nov.

Figs 8-12

Holotype

WAM R69648, an adult male of 26.8 mm S-V collected by the roadside 28 km S of Derby (123°43'S, 17°30'E), Kimberley Division, W.A. by M. Davies, A.A. Martin and M.J. Tyler on 14 February 1980.

Paratypes

There are 19 paratypes, consisting of 13 adult males and six adult females (five gravid): WAM R69649, SAM R18093-97, AM R95416, AMNH 106556, KU 186040 collected with the holotype. WAM R69655-58, SAM R18098, Great Northern Highway, 8 km NE of Broome, 15 February 1980; WAM R69653-54, Great Northern Highway, 167 km E of Broome, 17 February 1980; WAM R69651-52, 41 km S of Derby at Great Northern

Highway junction; WAM R69650, 20-41 km S of Derby, 14 February 1980. The entire series was collected by M. Davies, A.A. Martin and M.J. Tyler.

Diagnosis

A moderate-sized species (males 24-30 mm, females 29-34 mm S-V), lacking maxillary teeth. Toes webbed only at base. Dorsal surface commonly covered with large tubercles. Mating call a repetitive click. Frontoparietal foramen scarcely detectable.

Description of Holotype

Maxillary teeth absent. Vomerine teeth absent. Snout short, broadly rounded when viewed from above and in profile. Eye diameter 3.4 mm; eye to naris distance (2.15 mm) considerably greater than internarial span (IN 1.4 mm, E-N/IN 1.54). Canthus rostralis straight. Tympanum not visible externally (**Fig. 8**).

Fig. 8: Dorsolateral view of head of *Uperoleia aspera*.

Fingers short, slender, unwebbed, with a trace of lateral fringes, and with prominent subarticular tubercles; in order of length 3 > 4 > 2 > 1. Palmar tubercles large and prominent (**Fig. 9a**). Hindlimbs short (TL 8.9 mm,

TL/S-V 0.33). Toes long, narrowly fringed and with trace of basal webbing (**Fig. 9b**); in order of length 4 > 3 > 2 > 5 > 1. Metatarsal tubercles very large. Subarticular tubercles prominent.

Dorsal surface coarsely tubercular. Parotoid and coccygeal glands well developed; inguinal glands not visible externally. Trace of narrow skin fold in

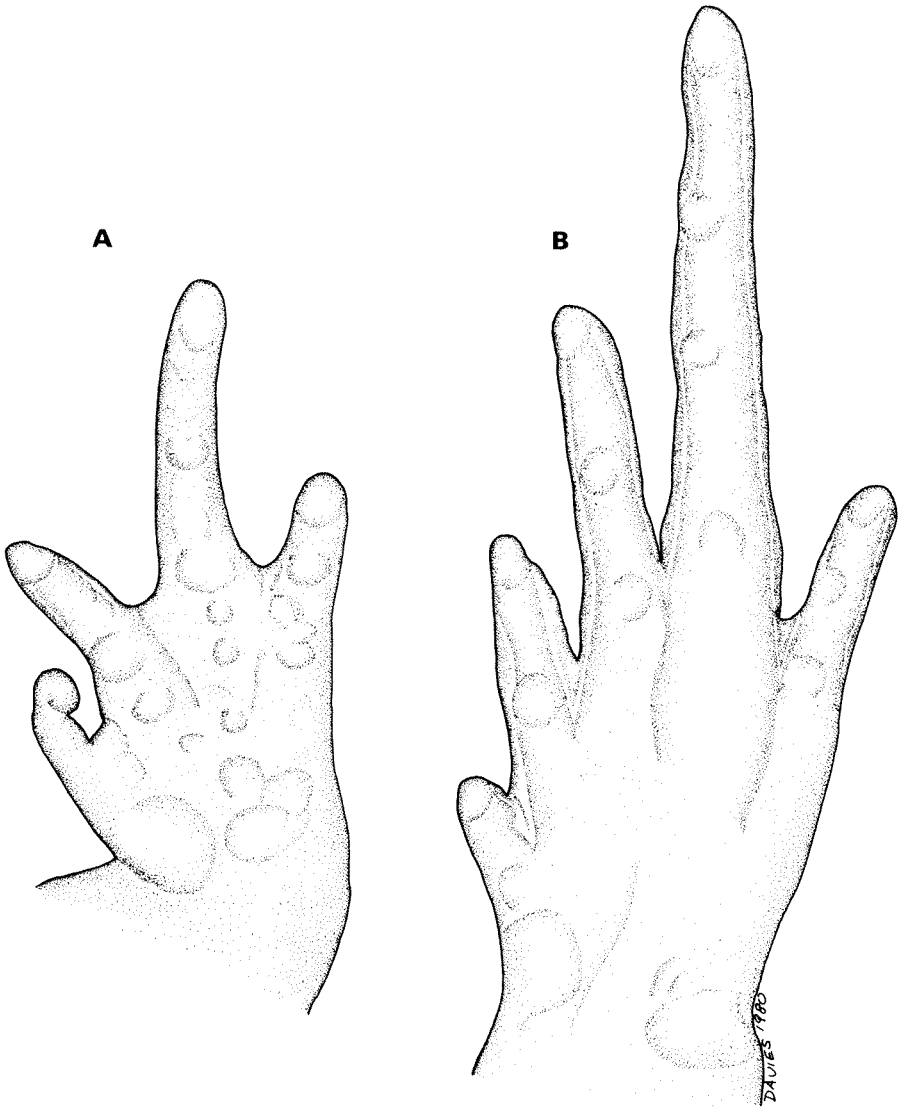

Fig. 9: (a) Palmar view of hand of *Uperoleia aspera*; (b) Plantar view of foot of *U. aspera*.

mid-dorsal region of head, and a group of tubercles around jaw articulation. Ventral surface irregularly granular, most conspicuously so on submandibular area and flanks. Cloacal flap well developed.

Unilobular, submandibular vocal sac.

Dorsal surface dull brown, bearing numerous, very small and diffuse darker patches. Dermal glands creamish with small black spots. Tubercles at posterior angle of mouth white. Ventral surface dull cream, throat stippled with greyish. Unpigmented patches in inguinal and on post-femoral areas.

Variation

A species of moderate size when compared with congeners. Males 23.8-30.3 mm S-V, females 29.0-33.8 mm. Limbs consistently short (TL/S-V 0.28-0.34). Nostrils narrowly spaced in comparison with distance separating each from eye (E-N/IN 1.25-1.92).

Glandular development consistent — inguinal glands scarcely detectable externally in most specimens, whereas coccygeal and parotoid glands readily discernible. Toe webbing restricted to base of toes in all specimens. One specimen has an abnormal right foot.

In life pale brown mottled with darker brown. Top of head and dermal glands pale yellow marked with brown. Ventral surface white, with submandibular area of males dull grey or slate.

Mating Call

To the ear the mating call is a sharp, loud click, repeated at a rate of about 3 calls/sec. However analysis shows the call to consist of 5-6 pulses produced at a rate too high for the ear to resolve (about 170 pulses/sec.) **(Fig. 10).** Call duration is 30-35 msec and the dominant frequency is centred at about 2800 Hz **(Table 1).**

Of the other species of *Uperoleia* whose calls are known, only *U. lithomoda* and *U. minima* produce 'click' calls (short calls of Tyler, Davies and Martin 1981). The call of *U. lithomoda* is a single pulse of 26-29 msec duration, and that of *U. minima* consists of 2-3 pulses, with a call duration of 17-23 msec. In both these species the dominant frequency is higher than in *U. aspera* (*U. lithomoda* 3420 Hz; *U. minima* 3517 Hz: Tyler, Davies and Martin 1981).

Osteology

Skull moderately ossified, sloping anteroventrally. Sphenethmoid poorly ossified in two portions just anteriorly to anterior extremities of fronto-parietals, ventrally to position about one-quarter posteriorly of length of orbit. Sphenethmoid not making bony contact with nasals. Prootic incompletely fused with exoccipital. Crista parotica poorly ossified, short and stocky; not articulating with long, unexpanded otic ramus of squamosal

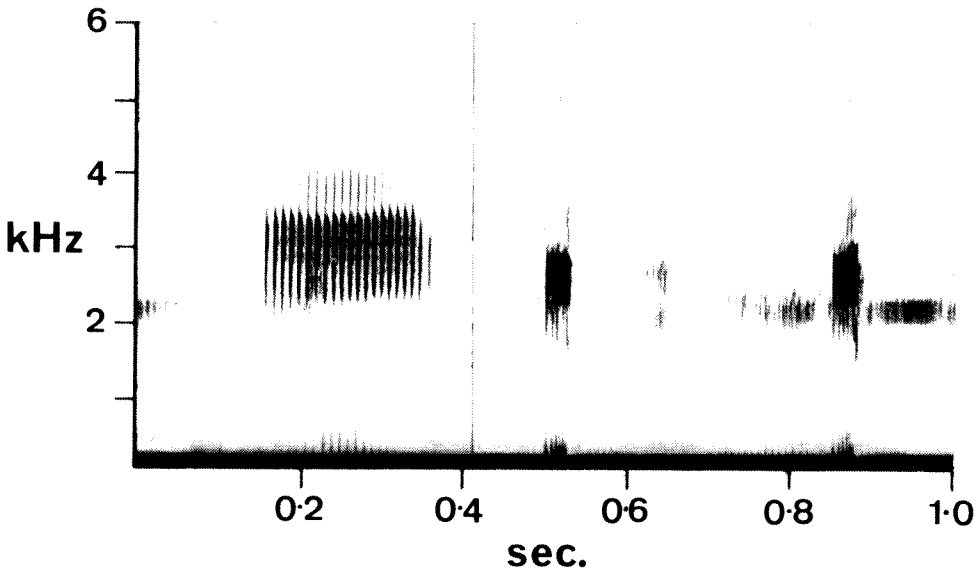

Fig. 10: Audiospectrograms (300 Hz bandpass) of left, a call of *Uperoleia mjobergi*; right, two calls of *U. aspera*; both recorded 28 km S of Derby, W.A.

TABLE 1

Characteristics of mating calls of *Uperoleia aspera* and *U. mjobergi* at a site 28 km S of Derby, W.A., recorded on 14 February 1980 at a wet-bulb air temperature of 25.6°C. Mean values are given with ranges in parentheses.

	N	No. of pulses	Call duration (msec)	Pulse repetition rate (pulses/sec)	Dominant frequency (Hz)
U. aspera	3	5.67 (5-6)	33.33 (30-35)	169.84 (166.67-171.43)	2778 (2650-2900)
U. mjobergi	3	22.11 (20-25)	225 (210-240)	98.12 (94.49-102.09)	3272 (3166-3350)

laterally. Frontoparietal fontanelle poorly exposed in form of narrow slit anteriorly with slight medial expansion at level of posterior extremity of orbit, returning to narrow slit posteriorly (**Fig. 11a**). Frontoparietal elements well ossified, orbital edges angled slightly posterolaterally. Carotid canal groove absent. Nasals approximately triangular, well ossified, poorly separated anteromedially, widely posteromedially. Maxillary processes moderately blunt, widely separated from poorly developed preorbital processes of shallow pars facialis of maxillary. Palatines reduced laterally, expanded medially and articulating with and slightly overlapping ventrally ossified portion of sphenethmoid at about 45° (**Fig. 11b**).

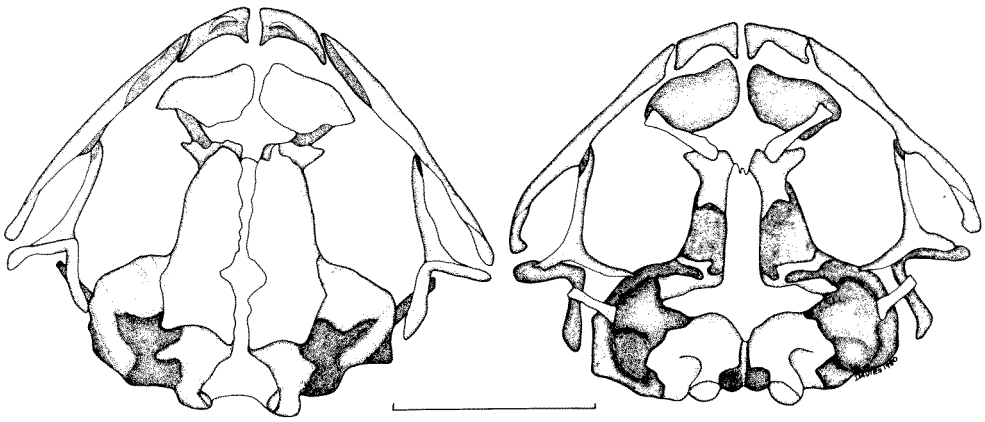

Fig. 11: (a) Dorsal view of skull of *Uperoleia aspera*; (b) Ventral view of skull of *U. aspera*. Scale bar = 5 mm.

Parasphenoid robust, cultriform process broad with serrated extremity; alary processes moderately short at right angles to cultriform process and not overlapped laterally by medial arms of pterygoids.

Pterygoid moderately developed; long anterior arm in short contact with pterygoid process of pars palatina at level about three-quarters anteriorly along the length of the orbit; posterior arm short and robust, anterior arm long and acuminate.

Cartilaginous quadrate present between base of squamosal and quadratojugal. Squamosal moderately robust with no zygomatic ramus and long unexpanded otic ramus.

Maxillary and premaxillary edentate. Alary processes of premaxillary perpendicular and inclined medially; palatine processes well developed, not abutting medially; pterygoid processes small. Prevomers absent; bony columella present.

Pectoral girdle arciferal and robust. Tiny cartilaginous omosternum, well developed xiphisternum; sternum cartilaginous. Clavicles slender, curved, moderately applied medially; coracoids robust, widely separated medially. Scapula bicapitate, slightly longer than clavicles. Suprascapula about one-half ossified.

Eight procoelous non-imbricate presacral vertebrae. Relative widths of transverse processes III > sacrum > IV > II = V = VI = VII = VIII. Sacral diapophyses poorly expanded; ilia extending two-thirds of their length. Bicondylar sacrococcygeal articulation. Coccygeal crest extending along anterior one-third of urostyle.

Humerus with well developed anteroproximal crest; phalangeal formula of hand: 2,2,3,3; distal tip of terminal phalanges knobbed. Small bony prepollex; palmar sesamoid. Phalangeal formula of foot: 2,2,3,4,3. Well developed bony prehallux.

Comparison with Other Species

Of the species currently recognised, three may be distinguished from *U. aspera* by possession of conspicuous maxillary teeth (*U. laevigata*, *U. marmorata* and *U. mjobergi*). Some individuals of *U. micromeles* exhibit vestigial teeth, but that species is readily distinguished by its very low E-N/IN ratio (0.83-0.90, compared with 1.25-1.92 in *U. aspera*).

The minimal degree of exposure of the frontoparietal fontanelle is a feature shared or approached by each of the above species and by *U. fimbrianus*, *U. variegata*, *U. minima* and *U. lithomoda*. Adult size and mating call distinguished *U. minima*: males of that species have an S-V range of 16-21 mm (compared with 24-30 mm in *U. aspera*), and whereas *U. minima* has a 'short' call sounding like a single click, *U. aspera* emits a series of clicks. *Uperoleia lithomoda* also produces a 'short' call. Its size range (21-25 mm S-V) overlaps that of *U. aspera* but it is evidently similar to that species in a number of respects, indicating a close relationship.

Uperoleia borealis has a 'long' mating call and more extensive webbing between the toes.

Uperoleia variegata is consistently smaller than *U. aspera* (19-23 mm S-V in 17 adult males in the type series). The call of that species is not known.

Data on *U. fimbrianus* are restricted to the description of the holotype (a 28 mm female) and our supplementary description. This size is only just below the range of *U. aspera*. Differences noted are the similarity of the lengths of the second and fourth toes in *U. fimbrianus* (fourth longer than second in *U. aspera*) and the conspicuous fimbriated supra-anal flap of *U. fimbrianus*. Additionally, the species are geographically remote: *U. fimbrianus* is known only from southern Queensland, and *U. aspera* from the southern limit of the Kimberley — a geographic separation of 2700 km.

Habitat

We collected specimens at several sites where flooding following heavy rain had created temporary pools in shallow, excavated gravel scrapes adjacent to roads. In each case the surrounding area was grassland with isolated tussocks reaching a height of 1 m (**Fig. 12**).

Fig. 12: Type locality of *Uperoleia aspera* 28 km S of Derby, W.A. Inundated grassland. The bush slightly to the left of the centre of the photograph is approximately 1.5 m high.

Distribution

The type series was taken at sites extending from 8 km north-east of Broome to 28 km south of Derby. We located specimens beside the Gibb River Road 54 km east of Derby. The species may occur further east in the vicinity of the Fitzroy River, but we did not collect this species (or any congener) on a night transect extending approximately 90 km south of Broome.

Etymology

Derived from Latin *aspera* (rough in relation to texture) describing the texture of the skin of the dorsum.

Uperoleia mjobergi (Andersson, 1913)

Figs 13-16

When Tyler *et al.* (1981) redefined this species only the holotype and the single paratype were available. However we found the species to be reasonably abundant in the Derby-Broome area, with the result that we now are able to provide considerably more morphological and biological detail.

Description

The redescription of Tyler *et al.* (1981) can be supplemented as follows. This is a small species in which males range 20.1-25.1 mm in S-V and females 21.0-23.0 mm. Hindlimbs are short to very short (TL/S-V 0.28-0.36).

Two morphological features are unique to this species: presence of a large heel papilla, and vast lateral extent of the parotoid and inguinal glands. These glands may be confluent, or slightly separated as in **Fig. 13**. Individuals not exhibiting this hypertrophy externally were at dissection found to exhibit hypertrophy subcutaneously.

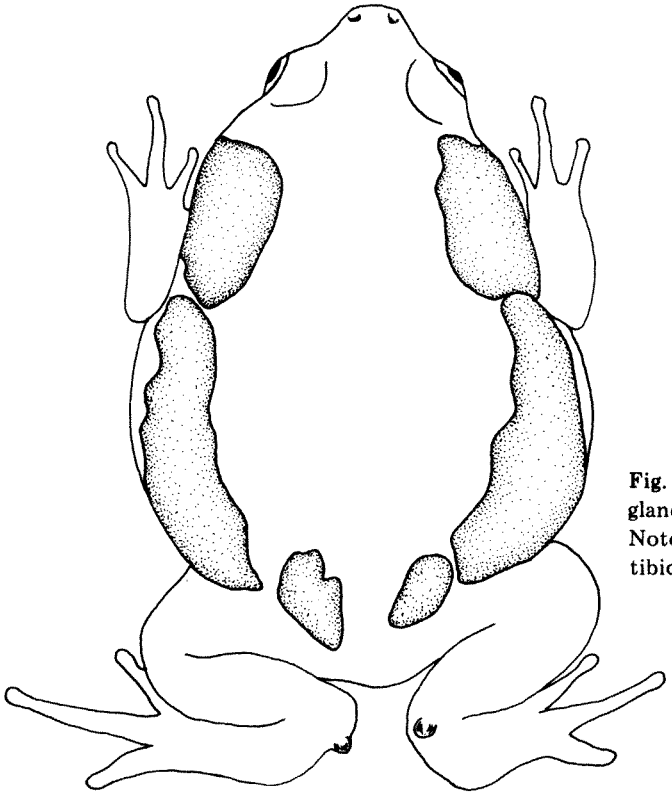

Fig. 13: Disposition of dermal glands of *Uperoleia mjobergi*. Note also the position of the tibio-tarsal papilla.

Dorsal surface is very weakly to coarsely tubercular. In its most extreme form plicae and tubercles are particularly prominent upon the head (**Fig. 14**).

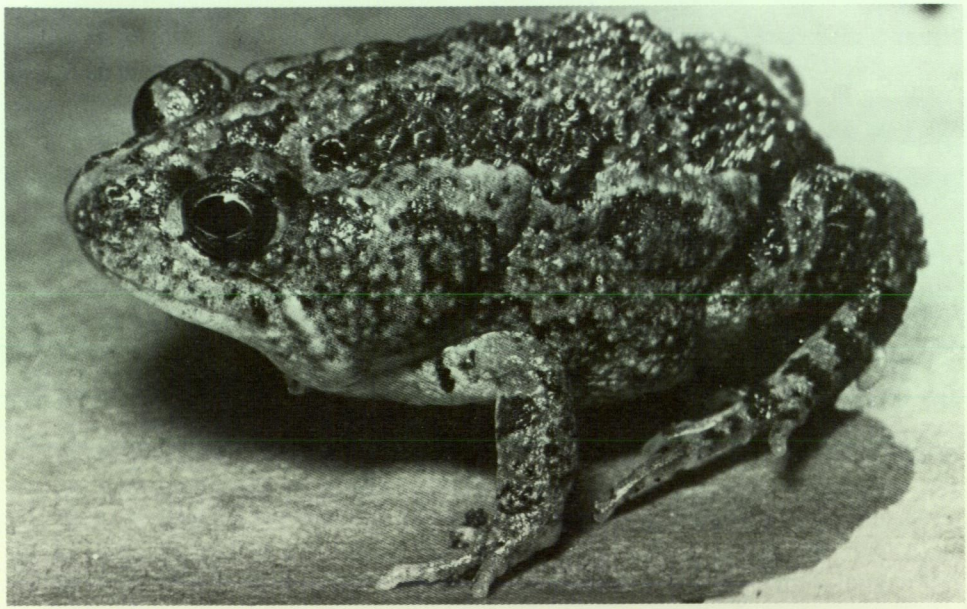

Fig. 14: *Uperoleia mjobergi* in life. Collected 18 km S of Derby, W.A. This individual has a snout to vent length of about 22 mm. Note the hypertrophied parotoid and inguinal glands.

Variation in coloration involves relative extent, rather than presence or absence, of markings upon the dorsum. In preservative the back is pale grey, commonly with five discrete markings as follows: a pair of reniform markings commences behind the eyes, passes posteriorly and occasionally coalesces medially over part of their length. There is a smaller, oval or circular patch in the pre-sacral area, and a pair of large and roughly circular or oval patches above the inguinal area. The dorsolateral edges of the inguinal glands are creamish or golden. The axillary and post-femoral areas are pale pink (two months after preservation). The tibiae are cross-barred with narrow dark stripes.

In life the ground colour is light brown and the patches upon it are dark brown. The light markings upon the inguinal glands are a pale silvery-yellow. The groin and post-femoral patches are scarlet-orange. The ventral surface is off-white and the submandibular area of males is greyish-brown.

Habitat

We found this species in areas of relatively dense, low-growing vegetation. At a site 83 km east of Broome adult specimens were recovered in the daytime from beneath a small log. This is unusual within our experience of

Uperoleia because individuals of most species pass the daytime beneath the surface of the ground. However we note that the types of *U. mjobergi* were collected beneath debris (Andersson 1913).

Osteology

Skull moderately ossified and sloping anteroventrally; small lateral portions of sphenethmoid ossified posteriorly to palatines extending for about half length of orbit in ventral view. Sphenethmoid not making bony contact with nasals. Prootic fused with exoccipital; lack of ossification medially, ventrolaterally and ventromedially. Crista parotica well developed, short and stocky; not articulating with long otic ramus of squamosal laterally. Frontoparietal fontanelle elongate, very narrow with slight medial expansion. Extremities of fontanelle difficult to define due to lack of ossification of sphenethmoid anteriorly and exoccipital posteriorly. Frontoparietals well ossified, very shallow groove of carotid canal present posterolaterally (Fig. 15a). Nasals triangular and moderately well ossified, moderately separated medially; maxillary processes blunt, widely separated from preorbital processes of shallow pars facialis of maxillary. Palatines short, reduced laterally, angled at about 45° to anterior, ventral extremities of sphenethmoid where they articulate. Parasphenoid robust; cultriform process moderately broad with serrated anterior extremity; alae moderately short and broad, at right angles to cultriform process, not overlapped by medial arm of pterygoid.

Pterygoid moderately developed; anterior arm in long contact with pterygoid process of maxillary; medial arm slender and acuminate, not in bony contact with prootic region; posterior arm robust, articulating with base of squamosal and cartilaginous quadrate.

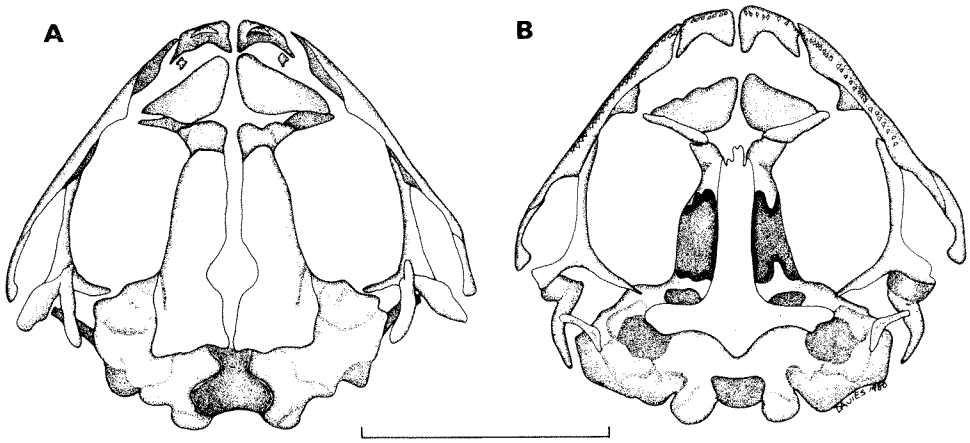

Fig. 15: (a) Dorsal view of skull of *Uperoleia mjobergi*; (b) Ventral view of skull of *U. mjobergi*. Scale bar = 5 mm.

Cartilaginous quadrate present between base of squamosal and quadratojugal. Squamosal moderately robust with tiny knobbed zygomatic ramus and long unexpanded otic ramus.

Maxillary and premaxillary dentate (**Fig. 15b**). Alary processes of premaxillaries bifurcate, perpendicular to dentigerous processes. Palatine processes well developed, not abutting medially. Prevomers absent; bony columella present.

Pectoral girdle arciferal and robust. Very small omosternum; xiphisternum present; sternum cartilaginous. Clavicles slender, curved, moderately separated medially; coracoids robust, widely separated medially. Scapular bicapitate, about same length as clavicles; suprascapula about one-half ossified.

Eight procoelous non-imbricate presacral vertebrae. Relative widths of transverse processes: III > sacrum > IV > II = V = VI = VII = VIII. Ilia extend to anterior extremity of sacrum. Sacral diapophyses poorly expanded. Sacrococcygeal articulation bicondylar; urostyle crest extending one-half to two-thirds length of urostyle.

Humerus with well developed anteroproximal crest; phalangeal formula of hand: 2,2,3,3; distal tip of terminal phalanges knobbed. Small bony prepollex; palmar sesamoid. Phalangeal formula of foot: 2,2,3,4,3. Well developed bony prehallux.

Mating Call

The mating call is a short 'rasp' or 'creak', consisting of 20-25 pulses produced at a rate of about 98 pulses/sec. (**Table 1**). Call duration is 210-240 msec and the dominant frequency lies at about 3300 Hz (**Fig. 10**).

'Rasp' calls (long calls of Tyler, Davies and Martin 1981) characterize many species of *Uperoleia*, including *U. arenicola*, *U. borealis*, *U. crassa*, *U. inundata* and *U. talpa*. However calls of all species are distinguishable by the combination of pulse number, pulse repetition rate, call duration and dominant frequency. *U. mjobergi* has a longer call duration, higher pulse number and faster pulse repetition rate than all Western Australian species except *U. borealis*. From *U. borealis* it is distinguished by its higher dominant frequency (3300 Hz as against 2600 Hz) (Tyler, Davies and Martin 1981).

Distribution

Uperoleia mjobergi is common and widely distributed on the Fitzroy River plains and surrounding area (**Fig. 16**).

Material Examined

Twenty-three adult specimens (18 males, 5 gravid females): AM R95417, AMNH 106557, BM 1980.5, KU 186041, WAM R71041, AUZ A582-583, NR AM2050; SAM R18020-21, 18 km S of Derby, 13 February 1980; SAM R18022-28, 22-41 km S of Derby, 14 February 1980; WAM R71043, SAM R18029, Great Northern Highway, 83 km E of Broome, 17 February 1980; SAM R18030-31, WAM R71042, Great Northern Highway, 160 km E of Broome, 17 February 1980; WAM R71040, Camballin, 18 February 1980.

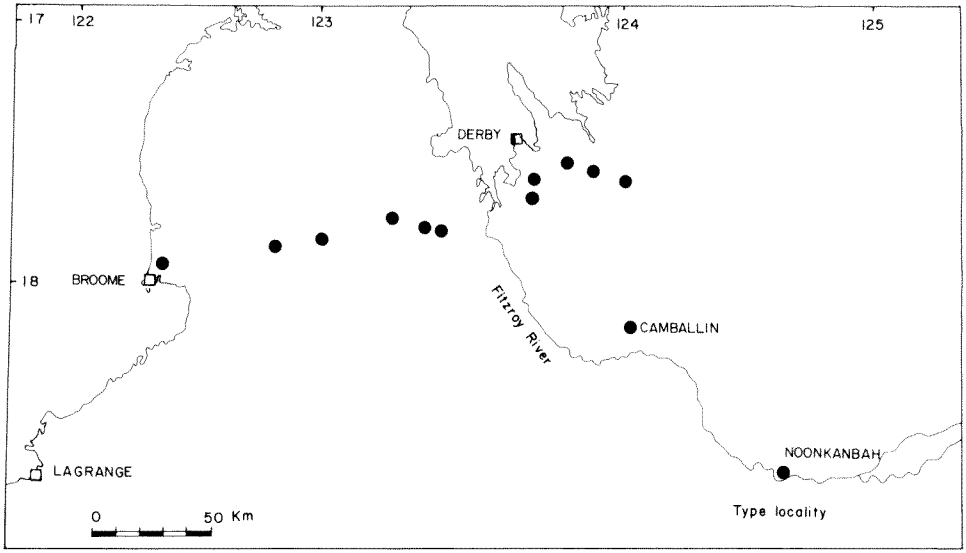

Fig. 16: Distribution of *Uperoleia mjobergi*.

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