

Description of a new moss frog from the south-western Cape (Anura: Ranidae: *Arthroleptella*)

A. Channing, D. Hendricks and A. Dawood

Biochemistry Department, University of the Western Cape, Private Bag XI 7, Bellville, 7535 Republic of South Africa

Received 21 April 1994; accepted 28 July 1994

A new species of moss frog, genus *Arthroleptella*, is described from the Kleinrivier mountains of the south-western Cape. It is morphologically indistinguishable from the other three species in the area. The four Cape species are allopatric, each has a unique male advertisement call, and preliminary molecular data shows consistent differences.

'n Nuwe mospadda-spesie van die genus *Arthroleptella* van die Kleinrivierberge word beskryf. Dit is morfologies ononderskeibaar van die ander drie spesies in die gebied. Al vier Kaapse spesies is allopatries, elkeen het 'n unieke advertensieroep, en voorlopige molekule data toon kenmerkende verskille.

Moss frogs of the genus *Arthroleptella* are small (15 mm) cryptic ranids endemic to South Africa. Five forms have been described, of which only *A. hewitti* from Natal and *A. lightfooti* from the south-western Cape are currently recognized (Poynton 1964), together with the recently described *A. ngongoniensis* from the Natal midlands (Bishop & Passmore 1993).

These frogs are found in moist situations on mountain slopes. The eggs are laid under moss or leaf litter, in clutches of about 10, and development is direct.

We collected specimens from isolated mountain ranges in the south-western Cape as part of a molecular study to calibrate mtDNA sequence divergence with the geological age of the mountains. As part of this study we recorded male advertisement calls. Advertisement calls are species specific and useful indicators of genetic isolation in complexes of cryptic, morphologically indistinguishable frogs. We discovered that populations with four distinct advertisement calls are present, one on each mountain range. Three of these represent species that had earlier been named, and one is new to science. We describe the new species below, and review the genus *Arthroleptella*.

Abbreviations: PEM – Port Elizabeth Museum, CAS – California Academy of Sciences, TM – Transvaal Museum, Pretoria, SAM – South African Museum, Cape Town.

Arthroleptella drewesii n. sp.

Holotype: A male, collected from the Fernkloof Nature Reserve in Hermanus, (34° 23' S, 19° 17' E), 26 August 1992 by R.C. Drewes and A. Channing. The holotype has been deposited in the Port Elizabeth Museum (PEM A2319).

Paratypes: Two male paratypes were collected from the type locality 9 May 1993, and deposited in the Port Elizabeth Museum (PEM A2320) and the California Academy of Sciences (CAS 193248).

Other material: A male, collected from the type locality 9 May 1993, was cleared and stained (PEM A2321). Two other males (AC1172, 1173) were examined before being used for DNA extraction.

Comparative material: 94 specimens were examined from the

Cape Flats (TM 14050, 14051); Lamotte (TM 19730, 19737, 20399, 20401, 20403, 20405–20409); Skeleton Gorge (TM 26616–26619, 26621, 26624, 26625, 26628, 26630–26632, 26634–26641, SAM 43263, 43267, 43839, 46123, 46115–46122, 46124, 46128–46130); Bushlands Pass (TM 55236–55362, 55364–55369); Riviersonderend (SAM 18339); Tottentots Holland mountains (SAM 13940); Steenbras (SAM 18307); Bats Cave, De Hoop (SAM 46346–46348); Newlands (SAM 18355); Banhoek Mts (SAM 18356); Kalk Bay (SAM 43825); Table Mountain (SAM 46380–46382); Franschoek (SAM 48522).

Diagnosis: The new species is morphologically indistinguishable from the other three species now recognized from the mountains of the south-western Cape. Male advertisement calls, however, are quite distinct (see below).

Poynton (1964) showed that the morphological features which had been used to characterize these species were variable, and it was impossible to use these to separate the taxa. He regarded the south-western Cape material as all belonging to *Arthroleptella lightfooti*. A careful examination of the one hundred specimens available in this study confirms that this complex consists of morphologically indistinguishable species. Preliminary results from a DNA sequencing study, summarized below, confirm that the four Cape species are different.

Description of holotype: A male in breeding condition, SVL 14.8 mm (Figure 1). The snout is bluntly rounded. The nostrils are small and round, with an internarial distance half the distance between the anterior corners of the eyes. The eyelid, measured from anterior to posterior corner is larger than the internarial distance.

A broken glandular ridge extends from the upper lip at the angle of the jaw to the arm insertion. The vocal pouch is black, with well defined lateral folds.

The fingertips are rounded and slightly expanded. Each finger has a basal subarticular tubercle.

The internal nares are slightly oval, and the tongue has a shallow median incision.

The legs are short. The foot, measured to include the metatarsal tubercle is subequal to the length of the tibia. The toes possess a trace of webbing at the base, and each toe has



Figure 1 Holotype of *Arthroleptella drewesii*.

rounded subarticular tubercles. The inner metatarsal tubercle protrudes distinctly, while the outer metatarsal tubercle is a small ridge. Toe tips are slightly expanded and rounded.

The posterior faces of the thighs are joined by a swollen glandular area. A minute white flattened tubercle is present at the proximal end of each tarsus.

The eyelids are warty, and there is a row of black warts running backwards from each eye to the sacral region. From the sacral region an irregular series of warts occurs to the vent. The dorsal warts are black against a brown background. Arms and legs are darkly marked with brown blotches on a pale background. The pigmentation covers most of the paler background, but is lighter in parts.

The ventral surface is darkly marked against a pale background, which is nearly obscured. The soles of the hands and feet are similarly marked. Very small white tubercles are present on the anterior region of the vocal pouch, extending

Table 1 Measurements of the holotype and paratypes of *Arthroleptella drewesii*

	PEM A2319	PEM A2320	CAS 193248
SVL	14,8	15,0	14,0
Internarial	1,3	1,4	1,5
Inter-eye	2,6	3,0	3,0
Eyelid	1,8	2,2	2,1
Foot	6,8	6,1	7,1
Tibia	6,5	6,6	6,5

backwards to below the angle of the jaw.

The cleared and stained specimen (PEM A2321) was indistinguishable from a cleared specimen of *Arthroleptella villiersi*. Poynton (1964) discussed the variation in shoulder girdle morphology which invalidated its use as a taxonomic character. The cleared specimen of *A. drewesii* confirms that skeletal morphology offers no characters to separate species in this group.

Measurements of the holotype and paratypes are listed in Table 1.

Colour in life. The dorsum is a uniform dark brown with paler legs. A black mask extends from the nostrils, through the canthal area to the arm insertion. The ventral surface is black, but paler on the lower belly.

Advertisement call: All recordings were made in the field using a Sony TCD 5M recorder and a directional microphone. Air temperatures varied from 17 to 21°C. Males call from beneath moss and overhanging vegetation on wet slopes. The call consists of 5–10 notes in 70 ms, more or less evenly spaced, with a longer interval between the final two notes. Some notes may be double (Figure 2). The notes are loosely grouped, with the following arrangements in our sample (double notes in parentheses): 1,4,1; 1,3,1; 1,(1),4,1; (1),1,2,5,1; and 2,(2),2,(1),2. The mean emphasized frequency is 4,0 kHz ($n=6$, range 3,9–4,0) with a mean duration of 0,69 s ($n=6$, range 0,59–0,77).

Distribution: *A. drewesii* is known only from the slopes of the

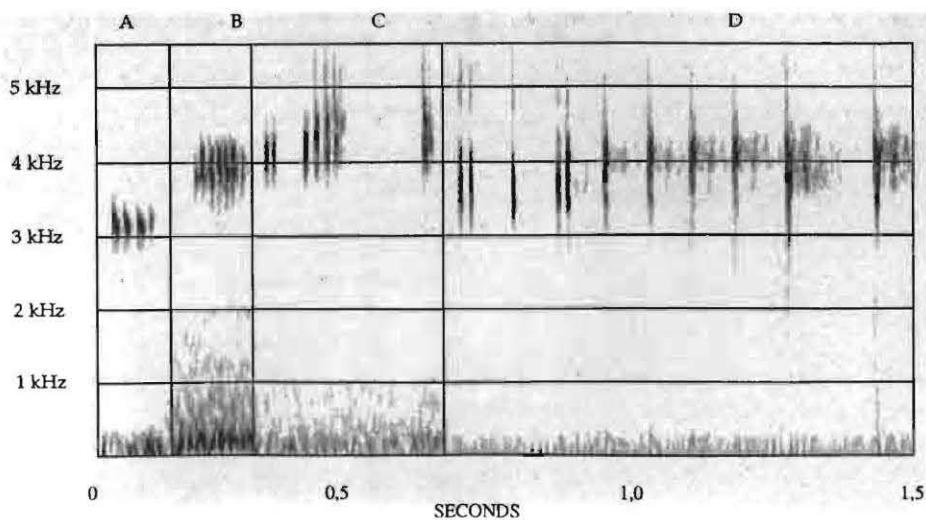


Figure 2 Sonagrams of typical advertisement calls of the four Cape species of *Arthroleptella*. A — *A. lightfooti*, B — *A. villiersi*, C — *A. bicolor*, D — *A. drewesii*.

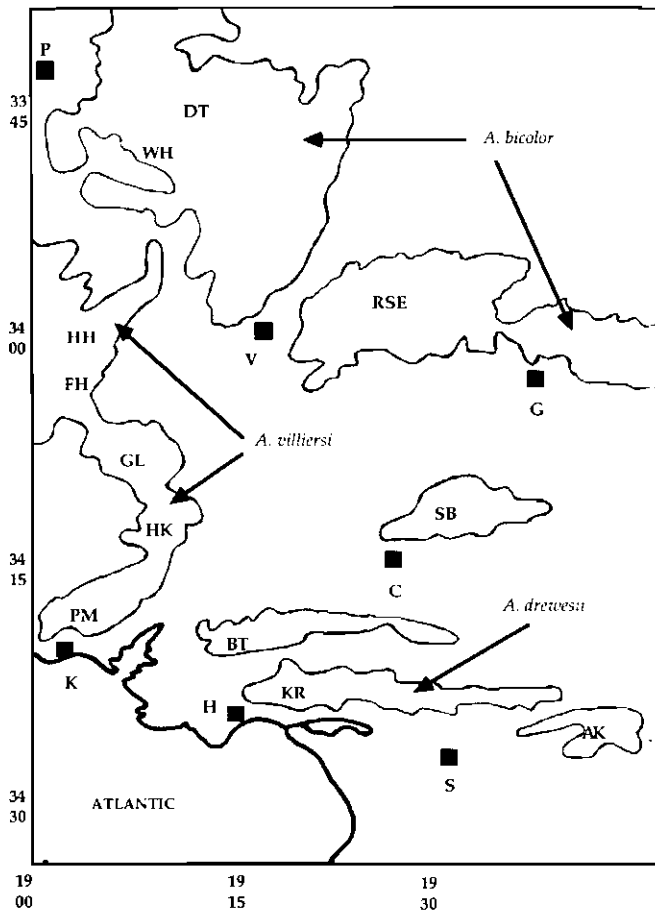


Figure 3 Map of part of the south-western Cape, South Africa, to show the distribution of *Arthroleptella drewesii*, *A. villiersi*, and *A. bicolor*. *A. drewesii* is found on the Kleinrivier mountains near Hermanus. *A. villiersi* is known from the range which includes the Palmiet and Hottentots-Holland mountains. *A. bicolor* is known from Bainskloof, through the Du Toits mountains, and on to the Riviersonderend mountains. Key: Towns are indicated by solid squares. P — Paarl, V — Villiersdorp, G — Greyton, C — Caledon, K — Kleinmond, H — Hermanus, S — Stanford. The outlines of the mountains are based on the 1:250 000 topographical map, sheet 3319 Worcester. Abbreviations of mountains DT — DU Toits, WH — Wemmershoek, RSE — Riviersonderend, HH — Hottentots-Holland, FH — Franschhoek, GL — Groenland, HK — Houwoek, PM — Palmiet, BT — Babilonstoring, KR — Kleinrivier, AK — Akkedis.

low Kleinrivier mountains at Hermanus (Figure 3). Further fieldwork may extend its range.

Etymology: The species is named for R. C. Drewes, who co-collected the holotype.

Advertisement calls and distribution of the species of *Arthroleptella*

Although it is not possible to separate the Cape species morphologically, the male advertisement calls are distinct. Presently each species is known from different mountain ranges. Further collecting of recordings is necessary to establish the ranges of these species. The following summary compares the calls of all six species presently recognized in southern Africa.

Arthroleptella bicolor

Calls were recorded on the Bainskloof Pass, and the Riviersonderend mountains. The call consists of an irregular series of clicks, which run together into a chirping call (Figure 2C). The following groupings of notes were found in our sample: 1,1,3,1; 1,1,4,1, and 1,1,5,1. The mean duration of each call is 0,31 s ($n=5$, range 0,30–0,37), with 6 to 8 notes or clicks. In the typical call illustrated, there is an initial pair of notes, followed after a short interval by a burst of 4 or 5 notes, and concluded after another interval by a single note. The mean dominant energy is 4,3 kHz ($n=5$, range 4,2–4,3). The distribution of this species is restricted to the mountains east of Wellington, the Du Toits, and the Riviersonderend mountains.

Arthroleptella drewesii

The call consists of a series of more or less evenly spaced clicks. Five to ten single or double clicks are produced in 0,7 s. The dominant energy in the call is between 3,9 and 4,0 kHz (Figure 2D). Males call from ledges on moss covered slopes, often concealed under vegetation. Males call in large numbers day and night during the rainy season from June through September. This species is only known from the Fernkloof Nature Reserve in Hermanus, and adjacent wet areas on the Kleinrivier mountains above 200 m.

Arthroleptella ngongoniensis

Males call day and night, on misty days, from concealed positions at the base of vegetation. The trilled cricket-like call has 10 pulses, is 55 ms long, and has a 5,5 kHz midpoint frequency (Bishop & Passmore 1993). The call is repeated three or four times with an interval of 1 s between calls. A sonagram is illustrated in Bishop & Passmore (1993). This rare frog is only known only from the Ixopo area of Natal, South Africa.

Arthroleptella hewitti

Males call from moss near water along streams. The call is a single short, high pitched note. Each note is 0,03 s long at a dominant frequency of 2,2 to 2,7 kHz. Sometimes males only produce one note after long intervals, while during a chorus, calls are produced rapidly, up to 6 s⁻¹. A sonagram is illustrated in Passmore & Carruthers (1979). *A. hewitti* is known from the lower escarpment slopes of Natal.

Arthroleptella lightfooti

Calls were recorded from the plateau of Table Mountain. Males call from the base of vegetation, or from nests below moss. The call is a high pitched chirp (Figure 2A), consisting of a mean of 3,5 pulses ($n=17$, range 3–4) with a mean emphasized frequency of 3,3 kHz ($n=17$, range 3,1–3,4). The mean duration of the call is 0,09 s ($n=17$, range 0,08–0,11). This species is known only from Table mountain and other slopes on the Cape peninsula.

Arthroleptella villiersi

Males call from concealed positions under moss and other vegetation in damp spots. The call is a brief, high pitched ticking (Figure 2B) consisting of a mean of 4,1 pulses ($n=151$, range 3–5) with a mean emphasized frequency of 3,9

kHz ($n = 151$, range 3,8–4,3). The mean duration of the call is 0,06 s ($n = 118$, range 0,03–0,09). This species has been found in the lower Palmiet valley, the coastal vegetation near Rooi Els, and on the Palmiet, Hottentots-Holland, and Jonkershoek mountains. Calls were recorded from the lower Jonkershoek valley and in Swartboskloof, near Hangklip and Rooi Els, and in the lower Palmiet valley where the river enters the sea.

Preliminary molecular evidence

Detailed results of this study will be published elsewhere. We sequenced a 450 base pair fragment of the cytochrome b gene, which we amplified using PCR. *Arthroleptella drewesii* shows sequence differences of 34% from *A. bicolor*, 21,4% from *A. villiersii*, and 31,7% from *A. lightfooti*. *Arthroleptella bicolor* differs by 26,1% from *A. villiersii* and by 21,5% from *A. lightfooti*. *Arthroleptella villiersii* differs from *A. lightfooti* by 14,2%.

These values are similar to the sequence differences for cytochrome b between known congeners. *Bufo* shows differences of 5–20% between species (Graybeal 1993), while labrid fish show species differences of 16,8–30,9% (Hare *et al.* 1994). Lizard genera differ by 15–35% (Hedges *et al.* 1991).

Discussion

The discovery of a complex of allopatric cryptic species on the slopes of the mountains in the south-western Cape follows the discovery of a new genus of petropedetine ranid on the same mountains near Stellenbosch (Channing & Boycott 1989). Not all the mountains have been surveyed. A detailed field study is essential to determine the ranges of these spe-

cies, especially in areas where two species are apparently adjacent, for example near Franschoek where the Wemmershoek and Hottentots-Holland mountains are joined by a small spur. Molecular work is in progress which should enable the construction of a phylogeny for this group.

Acknowledgements

We thank M. Cherry, W. D. Haacke, J. Vindum, and R.C. Drewes for permitting us access to specimens or information in their care.

References

- BISHOP, P. J. & PASSMORE, N.I. 1993. A new species of *Arthroleptella* Hewitt (Ranidae: Phrynobatrachinae) from the mist belt of the Natal highlands, South Africa. *Ann. Transvaal Mus.* 36: 17–20.
- CHANNING, A. & BOYCOTT, R.C. 1989. A new frog genus and species from the mountains of the southwestern Cape, South Africa (Anura: Ranidae). *Copeia* 1989: 467–471.
- GRAYBEAL, A. 1993. The phylogenetic utility of cytochrome b: lessons from bufonid frogs. *Mol. Phylo. Evol.* 2: 256–269.
- HARE, J. A., COWEN, R.K., ZEHR, J.P., JUANES, F. & DAY, K.H. 1994. Biological and oceanographic insights from larval labrid (Pisces: Labridae) identification using mtDNA sequences. *Mar. Biol.* 118: 17–24.
- HEDGES, S. B., BEZY, R.L. & MAXSON, L.R. 1991. Phylogenetic relationships of xantusid lizards, inferred from mitochondrial DNA sequences. *Mol. Biol. Evol.* 8: 767–780.
- PASSMORE, N. I., & CARRUTHERS, V.C. 1979. South African Frogs. Witwatersrand University Press. 270 pp.
- POYNTON, J. C. 1964. The amphibia of southern Africa: a faunal study. *Ann. Natal Mus.* 17: 1–334.