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The advertisement call of the relict frog *Tsingymantis antitra* from Madagascar

(Anura, Mantellidae)

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Tsingymantis is a monotypic relict lineage of mantellid frogs that inhabits an eroded limestone formation in the north of Madagascar. Herein we describe the formerly unknown advertisement call and provide information on morphological characters of two male voucher specimens. The call consists of a series of very short unpulsed notes repeated at regular intervals. It is not very intense and audible for humans only at a distance of less than around 10 metres from the calling male. We provide the first evidence for the presence of inconspicuous but clearly recognizable nuptial pads in reproductively active males and confirm the absence of femoral glands.

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Introduction

Mantellid frogs are a family endemic to Madagascar and Mayotte Island. Composed by three subfamilies (Boophinae, Laliostominae and Mantellinae) and more than 200 described species, they are the largest amphibian clade in Madagascar (Glaw & Vences 2006). Despite intensive field work and numerous taxonomic revisions this group of amphibians is still incompletely known with assumingly many undescribed species (Andreone et al. 2008, Vieites et al. 2009). Among mantellids, the genus *Tsingymantis* is especially enigmatic concerning its evolutionary relationships to the three subfamilies. Intensive efforts to resolve its phylogenetic position revealed ambiguous results (Kurabayashi et al. 2008, Wollenberg et al. 2011), and the genus is tentatively considered to belong to the subfamily Mantellinae (Raselimanana et al. 2007). Described only in 2006, *Tsingymantis antitra* is the single species of this genus (Glaw et al. 2006). It inhabits the karstic "tsingy" limestone of the Ankarana massif in northern Madagascar where its tadpoles develop in rock pools (Randrianiaina et al. 2011). So far, data on only a few voucher specimens have been published, as deposited in the collections of UADBA (Departement de Biologie Animale, Antananarivo), ZFMK (Zoologisches Forschungsmuseum A. Koenig, Bonn), and ZSM (Zoologische Staatssammlung, München), making up a total of 13 females and only one single male (Raselimanana et

Fig. 1. Voucher of calling male of *Tsingymantis antitra* (ZSM 1200/2012 = ZCMV 13527, snout-vent length 55.2 mm) in the "tsingy" limestone at Ankarana National Park: **a,** dorsolateral view in life; **b,** ventral view; **c,** palmar surface of left hand.

al. 2007). The advertisement call of this species is so far unknown. Here, we fill this gap of information by providing a detailed call description based on newly obtained recordings, and additional data on the morphology of the two males.

Material and methods

All field observations and recordings were made by the first author on 26 January 2012 in the Ankarana National Park near the "Campement des Princes" (precise coordinates not available, but not far to other known localities of this species; Randrianiaina et al. 2011). Although exact temperature measurements were not taken, the estimated temperature at the recording locality was around 23 °C. Several calls of one male were recorded at a distance of approximately three meters from the animal using a Tascam DR07 digital recorder at a sampling rate of 44.1 kHz and 24-bit resolution (saved as uncompressed files). Recordings were resampled at 22.05 kHz and 16-bit resolution and computer-analysed using the software Adobe Audition version 1.5. Frequency information was obtained through Fast Fourier Transformation (FFT, width 1024 points), and the audiospectrogram was obtained at Hanning window function with 256 bands resolution. Temporal measurements are given in milliseconds (ms) or seconds (s), as range, with mean ± standard deviation in parentheses. Terminology of call description follows Köhler (2000).

Results

The recorded male was calling from an oval (30 × 16 cm) and 15 cm deep rocky pool which contained 11 tadpoles. After a few minutes the male left the pool and moved to a site on a limestone about five meters from the pool. Five minutes later, the male started to call again from this new position. After the recording of its calls the male (ZSM 1200/2012, field number ZCMV 13527, Fig. 1) was collected. The frog started calling approximately ten minutes after one of the first heavy rains of the year at Ankarana National Park on 26 January 2012 at 21:05 h. The call sounds like a trill and consists of a series of very short unpulsed notes repeated at regular intervals (Fig. 2). Numerical call parameters are as follows: call duration 606–1065 ms (802 ± 176 ms; N = 5); number of notes/call 10–15 (11.7 ± 2.3; N = 5); note duration 10–16 ms (12.3 ± 1.7 ms; N = 53); inter-note interval duration 58–65 ms (60.6 ± 2.0 ms; N = 51); note repetition rate 13.5–13.8 notes/s; call repetition rate approximately 1.4–6.0 calls/minute (very irregular); dominant frequency range 800–5400 Hz; maximum call energy at 960–1175 Hz (1171 ± 93 Hz; N = 43). We here refrain from the alternative interpretation, i. e. to consider each "call" as one very long and distinctly pulsed note, because it is uncertain if this vocalization is produced during a single expiration or not.

The *Tsingymantis* call is not very intense or conspicuous. The call of this species is audible for humans only at a distance of less than about 10 meters from the calling male. No vocal sac was observed during call emission, just the male's flanks were seen vibrating. The species might have a very slightly distensible subgular vocal sac, as found in some other mantellids with inconspicuous calls, but this could not be verified by observation.

During the night of 26 January 2012, altogether

Table 1. Morphological measurements (in mm) of two males of *Tsingymantis antitra*.

Specimen number	ZSM 1199/2012 (ZCMV 13526)	ZSM 1200/2012 (ZCMV 13527)
Snout-vent length	53.0	55.2
Greatest head width	18.5	19.7
Head length	23.7	24.6
Tympanum diameter	4.7	4.9
Horizontal eye diameter	5.9	7.1
Eye-nostril distance	5.7	5.9
Nostril-snout tip distance	2.1	2.8
Nostril-nostril distance	3.8	4.4
Forelimb length	40.0	41.2
Hand length	17	17.8
Hindlimb length	84.1	85.5
Foot length including tarsus	38.9	40.4
Foot length	14.6	16.6
Tibia length	23.1	28.1
Relative hindlimb length when adpressed along body	between eyes and nostril	between eyes and nostril

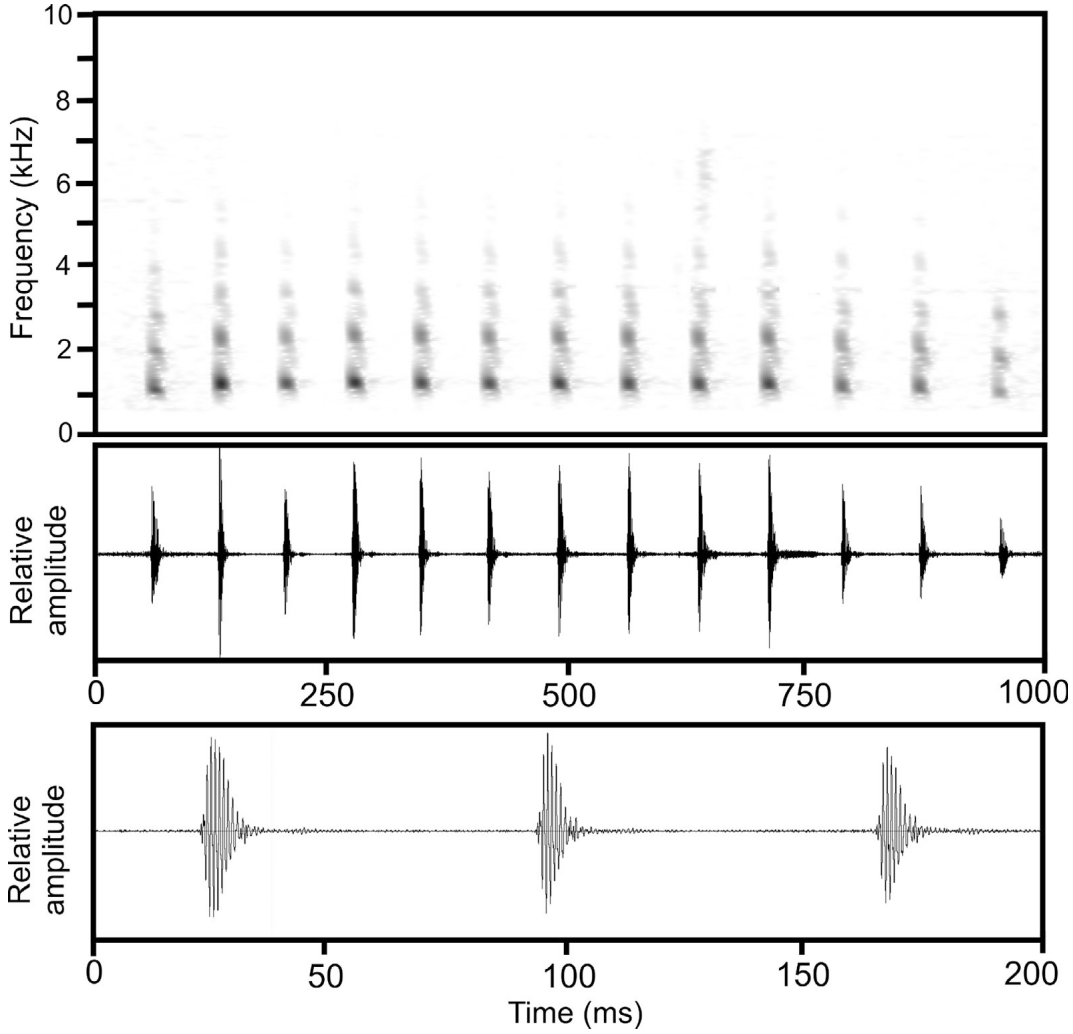

Fig. 2. Audiospectrogram (above) and corresponding waveform (center) of a call of *Tsingymantis antitra* from Ankarana, plus expanded waveform (below) showing the unpulsed character of notes. Recorded on 26 January 2012 at 21:05 h.

about seven calling males were heard in the same limestone rock area. Only these calling males could be observed in the area. The majority of the frogs were concealed in limestone cavities and about five of them were seen in or near pools with tadpoles (all frogs were encountered singly and not in aggregations). The population density of *Tsingymantis* cannot be estimated by our data as observations were limited to a small area of suitable habitat only.

Since only one *Tsingymantis* male is known so far to science we provide a short morphological characterization of the two newly collected males in the following (additional data is provided in Table 1). The dorsal skin of ZSM 1200/2012 (ZCMV 13527) is regularly granular, differing from the smooth skin of known females. A prominent prepollical tubercle is visible at the base of the first finger. No large and swollen nuptial pads are visible but in microscopic view, along the prepollical tubercle and inner side of the first finger a dense coverage of small keratinized spicules forms a weakly developed nuptial pad structure. There are no recognizable traces of femoral glands. Dorsal coloration is brownish with beige spots, as is typical for the species. Arms and legs have almost the same colours as the dorsum. Flanks are light brown, of a lighter beige than the dorsum.

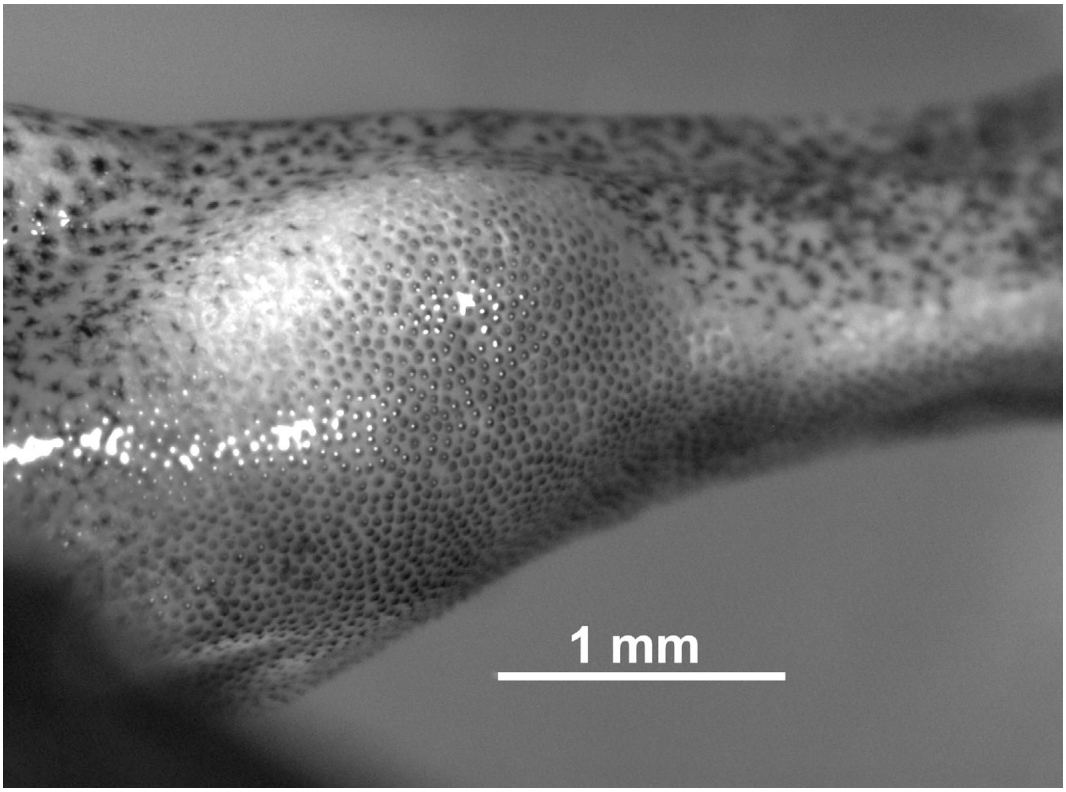

Fig. 3. Nuptial pads of a male *Tsingymantis antitra* (ZSM 1199/2012).

Terminal disks of fingers and toes are whitish with brownish spot. ZSM 1199/2012 (ZCMV 13526) was not seen calling, but was identified as a male due to its small size, its granular dorsal skin, and the presence of nuptial pads on the inner side of the first finger (see Fig. 3). There are no recognizable traces of femoral glands.

Discussion

The snout-vent length (SVL) of the two recently collected males of *Tsingymantis antitra* agrees with that of the single male (55.9 mm) studied by Raselimanana et al. (2007). According to these authors, the average SVL of 13 females was 61.6 mm (55.9–67.2 mm). Thus, our measurements confirm that there might be sexual size dimorphism in *Tsingymantis* with males being smaller than females although more data are necessary to confirm this preliminary result. Other morphometric differences between sexes might exist as well. Raselimanana et al. (2007) could not find a distinct difference between the relative size of the tympanum of males and females, but had only one male at hand. The relative tympanum diameter (as ratio tympanum diameter/SVL) of the two newly collected males was 0.088 in both cases, similar to the value of 0.082 in the male measured by Raselimanana et al. (2007). The relative tympanum diameter of females averaged 0.077 (0.071–0.083, N = 13; Raselimanana et al. 2007) indicating that males might have a slightly larger tympanum diameter than females. A similar difference, but more strongly expressed, is also found in other mantellids of the subfamily Mantellinae, particularly in several subgenera of the genus *Mantidactylus* (Glaw & Vences 2006).

The presence of nuptial pads, even if only weakly developed, and the absence of femoral glands in reproductively active males of *Tsingymantis* suggests that this genus probably does not share the mantelline synapomorphies related to reproduction (summarized in Glaw & Vences 2006) and confirms its isolated position among the three established mantellid subfamilies (Kurabayashi et al. 2008, Wollenberg et al. 2011).

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