

Notes on vocalizations in three species of *Atelopus* from Central and South America

(Anura: Bufonidae)

Bemerkungen zu Lautäußerungen dreier *Atelopus*-Arten aus Mittel- und Südamerika
(Anura: Bufonidae)

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KURZFASSUNG

Über den kurzen Rufotyp bei drei *Atelopus*-Arten wird berichtet. Von zwei Arten (*A. peruvensis* GRAY & CANNATELLA, 1985, *A. tricolor* BOULENGER, 1902) waren bisher keine Lautäußerungen bekannt; bei der dritten Art (*A. chiriquiensis* SHREVE, 1936) stimmt der Ruf mit Beschreibungen des kurzen Rufotyps von anderer Stelle innerhalb ihres Verbreitungsgebietes weitgehend überein. Die Rufe der behandelten Taxa sind vergleichbar mit dem kurzen Rufotyp bei anderen *Atelopus*-Arten. Von *A. tricolor* konnte zudem ein deutlich längerer Ruf aufgenommen werden. Er gleicht in der Struktur dem gepulsten Rufotyp, der für diverse *Atelopus*-Arten beschrieben wurde, ist jedoch kürzer als bei anderen Arten.

ABSTRACT

We report on short calls in three species of *Atelopus*. In two (*A. peruvensis* GRAY & CANNATELLA, 1985, *A. tricolor* BOULENGER, 1902) vocalizations were previously unknown; in the third (*A. chiriquiensis* SHREVE, 1936) they resemble short call descriptions from elsewhere within its distribution range. Short calls in these taxa are comparable to those known from other species of the genus. Concerning *A. tricolor*, we also report on a distinctly longer call. In overall structure it corresponds to the pulsed call type known in *Atelopus* species, although it is considerably shorter than in other species.

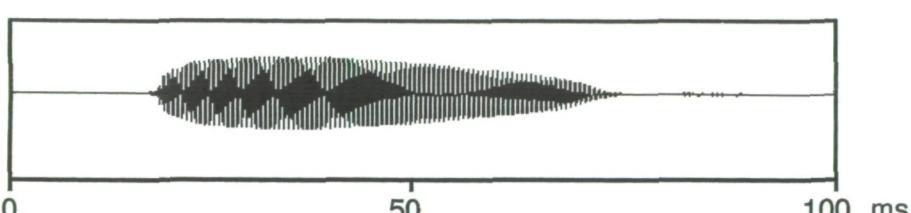
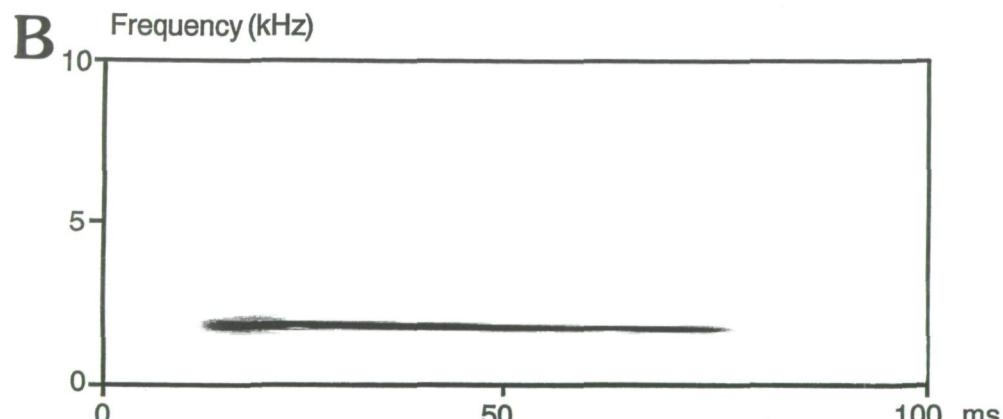
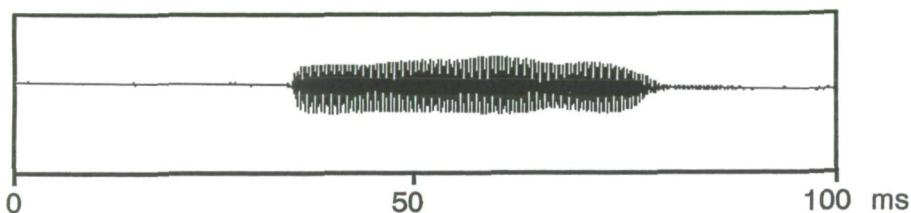
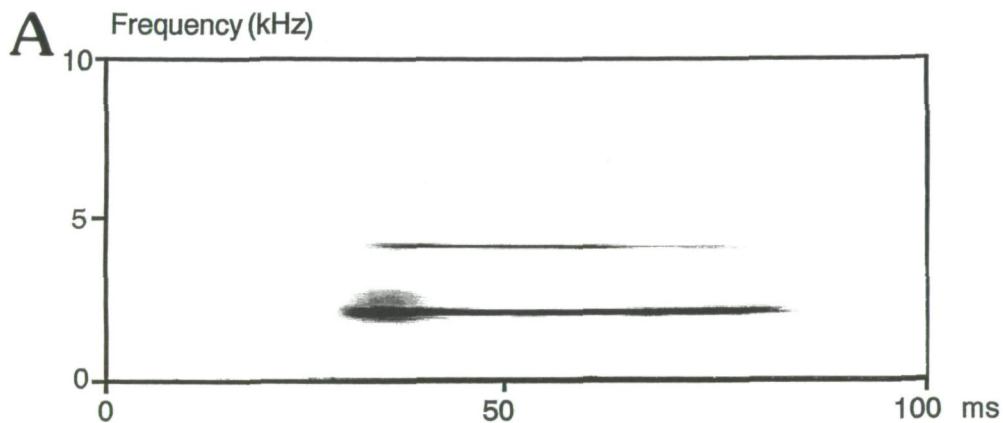
KEY WORDS

Amphibia, Anura, Bufonidae, *Atelopus chiriquiensis*, *A. peruvensis*, *A. tricolor*, vocalizations, Neotropics

Contrary to anurans in general, in Neotropical bufonids of the genus *Atelopus* acoustic communication has been suggested to be of minor importance; individuals communicate primarily by visual cues (COCROFT & al. 1990; LINDQUIST & HETHERINGTON 1996; LÖTTERS 1996). According to MCDIARMID (1971), this is supported by two circumstances. First, most species of *Atelopus* occur along fast moving or cascading noisy streams which may considerably disturb acoustic communication. Second, as known thus far, members of the genus except for some Amazonian species (e.g., *A. spinarius* COPE, 1871) usually lack a middle ear. Nevertheless, yet in males of 13 species or subspecies of *Atelopus* vocalizations have been recognized (summary in LÖTTERS 1996: 79). Moreover, recently JASLOW & LOMBARD (1996) demonstrated that at least the earless *A. chiriquiensis* SHREVE, 1936 is capable of detecting aerial sound with frequencies higher than 1 kHz.

COCROFT & al. (1990) noted three different call types among eight *Atelopus* species analyzed: pulsed calls having a duration of 227-1240 ms, pure tone calls lasting 180-297 ms, and short calls with a duration of 22-100 ms. However, their functional significance in the intraspecific ethological context is only poorly understood (COCRIFT & al. 1990). At least, short calls are produced by males when they are crowded (e.g., in a collecting bag), physically contacted, or clasped by other males (JASLOW 1979; COCRIFT & al. 1990; LINDQUIST & HETHERINGTON 1996), and thus may have release function.

Calls with possible release function in male *Atelopus* can be provoked easily by handling or touching their backs. Using this method, we recorded calls in one male each of *A. chiriquiensis* (from a trail to Cerro Chirripó, about 2150 m a.s.l., Provincia San José, Costa Rica — recorded by E.M.), *A. peruvensis* GRAY & CANNATELLA,



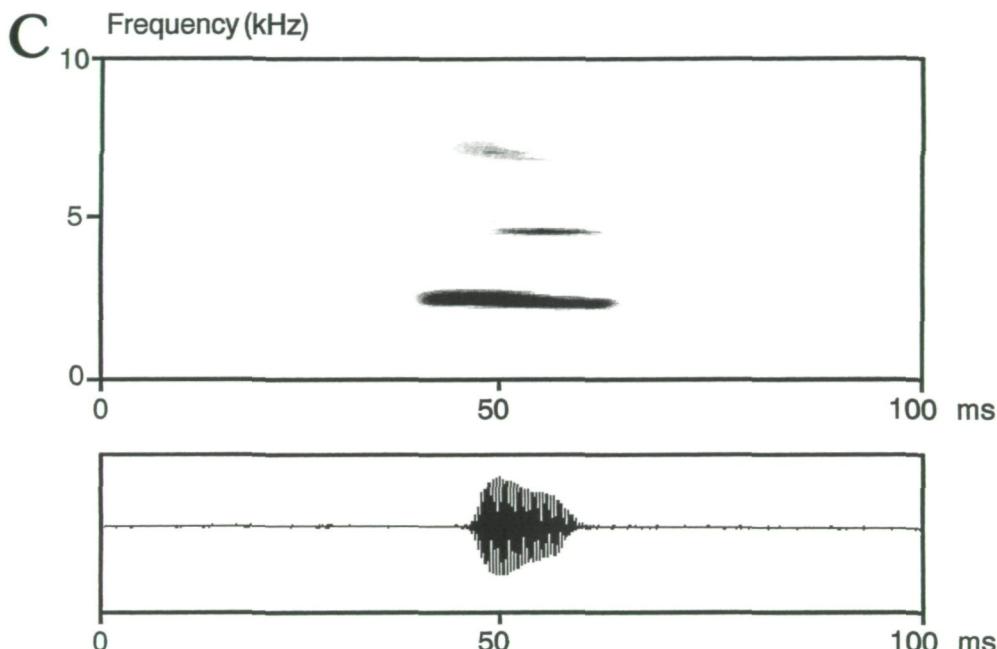


Fig. 1 (opposite page and above):
Spectrograms and oscillograms of short calls of (A) *Atelopus chiriquiensis* SHREVE, 1936,
(B) *A. peruvensis* GRAY & CANNATELLA, 1985, and (C) *A. tricolor* BOULENGER, 1902.

Abb. 1 (gegenüberliegende Seite und oben):
Spektrogramme und Oszillogramme vom kurzen Rufotyp von (A) *Atelopus chiriquiensis* SHREVE, 1936,
(B) *A. peruvensis* GRAY & CANNATELLA, 1985 und (C) *A. tricolor* BOULENGER, 1902.

1985 (in captivity; specimen from the Departamento Cajamarca, Peru — recorded by S.L.), and *A. tricolor* BOULENGER, 1902 (from Río Néces, Departamento La Paz, Bolivia — recorded by S.R.). In addition, in another male *A. tricolor* (from the road from Paractí to Cochabamba, about 1300 m a.s.l., Departamento Cochabamba, Bolivia) a relatively long call of unknown function was recorded in captivity by S.L. This type of call was repeatedly emitted by the male when seeing one of the two females which were in the same tank. The studied specimen of *A. tricolor* from Río Néces is deposited at Colección Boliviana de Fauna, La Paz (CBF 2502; the other *A. tricolor* male was not preserved), that of *A. peruvensis* at Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn (ZFMK 64569). The male *A. chiriquiensis* recorded is in the private collection of E.M.

(129.1993). Various calls in the latter species were already described by JASLOW (1979) who studied a Panamanian population, however. No data are available on vocalizations in *A. peruvensis* or *A. tricolor*. For *A. peruvensis* and *A. tricolor* we used recording equipment as mentioned by LÖTTERS & WIDMER (1997), and for *A. chiriquiensis* that described by MEYER (1996). Analyses of call parameters (table 1) were done by means of a Medav® MOSIP 3000 sound spectrograph with integrated software (Spektro® 3.2.). Frequency information was obtained using fast Fourier transformation (FFT width 512).

Spectrograms and oscillograms are shown in fig. 1. Data of call parameters are listed in table 1. The calls in *A. chiriquiensis*, *A. peruvensis*, and the shorter one in *A. tricolor* can be identified as short calls sensu COCROFT & al. (1990). According to

Table 1: Parameters of vocalizations recorded in three species of *Atelopus*. SVL = Snout-vent length. Terminology of call types follows COCROFT & al. (1990). Data on "Call duration" and "Number of pulses per call" include arithmetic mean \pm one standard deviation, and range.

Tabelle 1: Parameter der aufgenommenen Lautäußerungen dreier *Atelopus*-Arten. SVL = Kopf-Rumpf-Länge. Terminologie der Rufarten nach COCROFT & al. (1990). Die Angaben zu "Rufdauer" und "Anzahl Pulse je Ruf" beinhalten das arithmetische Mittel \pm eine Standardabweichung sowie die Spannweite.

Species / Art	<i>A. chiriquiensis</i>	<i>A. peruvensis</i>	<i>A. tricolor</i>	<i>A. tricolor</i>
SVL [mm]	28.3	37.0	21.9	?
Call type / Rufart	short call / kurzer Ruf	short call / kurzer Ruf	short call / kurzer Ruf	(pulsed call) / (gepulster Ruf)
Number of calls analyzed / Anzahl untersuchter Rufe	13	12	10	15
Temperature [$^{\circ}$ C] / Temperatur [$^{\circ}$ C]	25.5	15.0	17.5	26.2
Call duration [ms] / Rufdauer [ms]	24.61 \pm 12.25 12-52	73.83 \pm 22.53 44-114	23.50 \pm 21.23 7-77	103.13 \pm 4.45 92-108
Number of pulses per call / Anzahl Pulse je Ruf	unpulsed call / ungepulster Ruf	unpulsed call / ungepulster Ruf	unpulsed call / ungepulster Ruf	17.80 \pm 1.08 16-19
Frequency range [kHz] / Frequenzbereich [kHz]	1.70-2.35	1.50-2.15	2.10-2.90	2.25-7.0
Dominant frequency range [kHz] / Bereich der Dominanzfrequenz [kHz]	1.90-2.15 (n = 13)	1.50-1.75 (n = 11) 1.80-2.10 (n = 1)	2.10-2.85 (n = 1) 2.15-2.70 (n = 5)	2.97-3.45 (n = 15) 2.45-2.85 (n = 4)

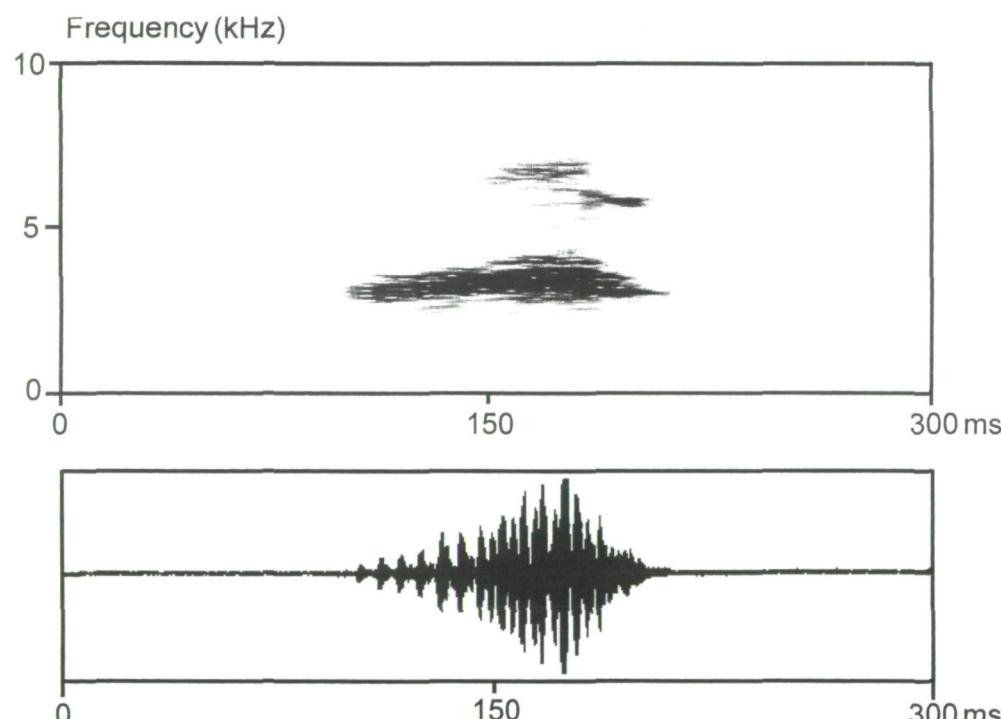


Fig. 2: Spectrogram and oscillogram of a pulsed call of *Atelopus tricolor* BOULENGER, 1902.

Abb. 2: Spektrogramm und Oszillogramm eines gepulsten Rufes von *Atelopus tricolor* BOULENGER, 1902.

these authors, short calls in most *Atelopus* are pulsed, while only in *A. zeteki* DUNN, 1933 they are not. Short calls of those taxa studied in this paper also lack pulsed structure (fig. 1). Moreover, they do not show distinct frequency modulations. Frequency ranges are similar in *A. chiriquensis* and *A. peruvensis*, whereas the frequency range of the smaller *A. tricolor* is somewhat wider (table 1). The call durations are extremely variable and overlap considerably between the three species analyzed here or those studied by previous authors (e.g., COCROFT & al. 1990). This includes the two populations of *A. chiriquensis* from Costa Rica (studied here) and Panamá (studied by JASLOW 1979) where no significant differences were found.

COCROFT & al. (1990) found intra-individual variation in the dominant frequency of short calls among seven *Atelopus* species. We report this for *A. peruvensis* and *A. tricolor* (table 1).

The longer call recorded in *A. tricolor* does not only differ from the short call in duration but also in showing a distinct amplitude modulation and in being pulsed (figs. 1C and 2). Hence, we are convinced that our two recordings of this species correspond to completely different call types. However, pulsed or pure tone calls as

reported from eight and three species of *Atelopus*, respectively (COCROFT & al. 1990), are usually longer than our second call received from *A. tricolor*. Nevertheless, in overall structure (pulses, amplitude modulation, frequency modulation) it resembles the pulsed call type sensu COCROFT & al. (1990). The relatively short duration of this call might possibly be due to the somewhat unusual high temperature during recording (*A. tricolor* is a montane forest inhabiting species). However, it cannot be excluded that the call recorded by us refers to an unknown type. Also from the (artificial) behavioral context mentioned above, the longer call recognized in *A. tricolor* may best be interpreted as an advertisement call, as suggested for pulsed calls in *Atelopus* species studied by COCROFT & al. (1990).

Intraspecific variation and interspecific overlap suggest that the evolution of at least short calls has been conservative in *Atelopus*. Two observations fit well to this assumption: (1) Sympatry of two or more species of *Atelopus* is rare (LÖTTERS 1996: 96). (2) Intraspecific acoustic communication in general plays a less important role. Since many species of *Atelopus* (occasionally only the males) have brightly colored throats (e. g., LÖTTERS 1996) signaling at least towards nearby males may also be effected by inflated vocal sacs.

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