

# A new species of Diurnal Frog in the genus *Crossodactylus* Duméril and Bibron, 1841 (Anura, Leptodactylidae) from Southeastern Brazil

Luciana B. Nascimento<sup>1</sup>, Carlos A.G. Cruz<sup>2</sup>, Renato N. Feio<sup>3</sup>

**Abstract.** A new species of *Crossodactylus*, belonging to the *C. gaudichaudii* species group, was described from the Municipality of Santa Maria do Salto, in the Atlantic Rain Forest of the State of Minas Gerais, southeastern Brazil. The new species was characterised by its: small size; slender body; head being longer than its width; snout rounded in dorsal view and protruding in lateral view; skin very granulated on sacral region; males having four to six keratinized conical spines arranged in a circle on their thumb; inner tarsal fringe extensively developed; toes extensively fringed on both edges; and ventral body surface with brownish blotches and short stripes. The descriptions of advertisement calls and tadpoles are included.

**Resumo.** Uma nova espécie de *Crossodactylus*, pertencente ao grupo de *C. gaudichaudii*, é descrita do município de Santa Maria do Salto, na Mata Atlântica do Estado de Minas Gerais, sudeste do Brasil. A nova espécie é caracterizada pelo corpo esbelto, cabeça mais longa que larga, focinho arredondado em vista dorsal e protuso em vista lateral, pele bastante granulada na região sacral, machos possuindo de quatro a seis espinhos córneos cônicos, dispostos em círculo no polegar, fimbria tarsal interna bastante desenvolvida, artelhos bastante fimbriados em ambas as margens e superfície ventral do corpo com manchas e pequenas faixas amarronzadas. Descrições do canto de anúncio e do girino são apresentadas.

## Introduction

The genus *Crossodactylus* includes ten species distributed from northeastern to southern Brazil and northern Argentina (Carcerelli and Caramaschi, 1992; Frost, 2004). Caramaschi and Sazima (1985) recognized three species groups in this genus: the *C. gaudichaudii* group, including *C. aeneus* Müller, 1924, *C. bokermanni* Caramaschi and Sazima, 1985, *C. caramaschii* Bastos and Pombal, 1995, *C. dantei* Carcerelli and Caramaschi, 1992, *C. gaudichaudii* Duméril and Bibron, 1841, and *C. lutzorum* Carcerelli and Caramaschi, 1992, characterized by protruding snout and distinct canthus rostralis; the *C. trachystomus* group, including *C. dis-*

*par* A. Lutz, 1925, *C. grandis* B. Lutz, 1951, and *C. trachystomus* (Reinhardt and Lütken, 1862 “1861”), characterized by short, rounded snout, and less evident canthus rostralis; and the monospecific group of *C. schmidtii* Gallardo, 1961, characterized by very short snout and rounded canthus rostralis. Herein, we describe a new species belonging to the *C. gaudichaudii* species group, from the Atlantic Rain Forest of the State of Minas Gerais, southeastern Brazil. Descriptions of vocalizations, tadpoles, and notes on the species natural history are given.

## Materials and methods

The examined specimens were deposited in the following collections: MNRJ (Museu Nacional, Rio de Janeiro, Rio Janeiro, Brazil), MZUSP (Museu de Zoologia, Universidade de São Paulo, São Paulo, São Paulo, Brazil), MC-NAM (Museu de Ciências Naturais, Pontifícia Universidade Católica de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil), and MZUFV (Museu de Zoologia “João Moojen de Oliveira”, Universidade Federal de Viçosa, Minas Gerais, Brazil).

Measurements (in millimeters) of adult specimens were taken using a digital caliper, following the method of Duellman (1970) and Cei (1980). Abbreviations were as follows: SVL (snout-vent length), HL (head length), HW (head

- 1 - Departamento de Ciências Biológicas, Museu de Ciências Naturais, Pontifícia Universidade Católica de Minas Gerais, Av. Dom José Gaspar 290, Coração Eucarístico, 30535-610 Belo Horizonte, Minas Gerais, Brazil  
e-mail: luna@pucminas.br
- 2 - Departamento de Vertebrados, Museu Nacional, Universidade Federal do Rio de Janeiro, Quinta da Boa Vista, 20940-040 Rio de Janeiro, RJ, Brazil  
e-mail: cagacruz@uol.com.br
- 3 - Departamento de Biologia Animal, Universidade Federal de Viçosa, 36561-000 Viçosa, Minas Gerais, Brazil  
e-mail: rfeio@ufv.br

width), ED (eye diameter), TD (tympanum diameter), END (eye-nostril distance), IND (internarial distance), IOD (interorbital distance), UEW (upper eyelid width), THL (thigh length), TL (tibia length), FL (foot length, including tarsal length).

Nomenclature and measurements (in millimeters) of tadpoles follow the methods of Altig and McDiarmid (1999), except for the interorbital and internarial distances, which were taken between inner margins of eyes and nostrils, respectively. Tadpoles were fixed and preserved in 5% formalin. Vocalizations were recorded with a Panasonic tape recorder model RQ L31, and sonograms were analyzed using the software Avisoft-Sonograph Light 1 (version 2.7) and Cool Edit 2000. Vocalizations were digitalized and edited at a sampling frequency of 22050 Hz, 16 bit resolution, FFT with 256 points, 100% frame, FlatTop Window and 50% overlap. Advertisement call terminology follows Duellman and Trueb (1986).

***Crossodactylus cyclospinus* sp. nov.**

(fig. 1A, B)

**Holotype:** MNRJ 34501, adult male, collected at Fazenda Duas Barras (15°53'S, 40°28'W, altitude 800 m approximately), Municipality of Santa Maria do Salto, State of Minas Gerais, Brazil, on 15th October 2003, by R.N. Feio, L.B. Nascimento, C.A.G. Cruz, D.P. Cabral, M.G. Soares, and P.L. Ferreira.

**Paratypes:** MNRJ 34500, 34502-04 adult males, MNRJ 34505 juvenile, collected with the holotype; MNRJ 35404, MNRJ 35406-07, MCNAM 4813, and MZUFV 5609 adult males, MNRJ 35405 adult female, MNRJ 36478 juvenile, collected at the type locality, between 5th to 9th January 2004, by L.B. Nascimento, D.S. Fernandes, D.P. Cabral, and M.G. Soares.

**Diagnosis:** A species belonging to the *Crossodactylus gaudichaudii* species group: characterized by small size (males 23.2-24.4 mm SVL; female 29.4 mm SVL); slender body; head longer than its width; snout rounded in dorsal view and protruding in lateral view; skin very granulated on sacral region; males having four to six keratinized conical spines arranged in a circle on their thumb; inner tarsal fringe extensively developed; toes extensively fringed on both edges; ventral body surface with brownish blotches and short stripes; advertisement call with note duration ranging from 0.003 to 0.04 s and fundamental frequency ranging from 700 to 1200 Hz.

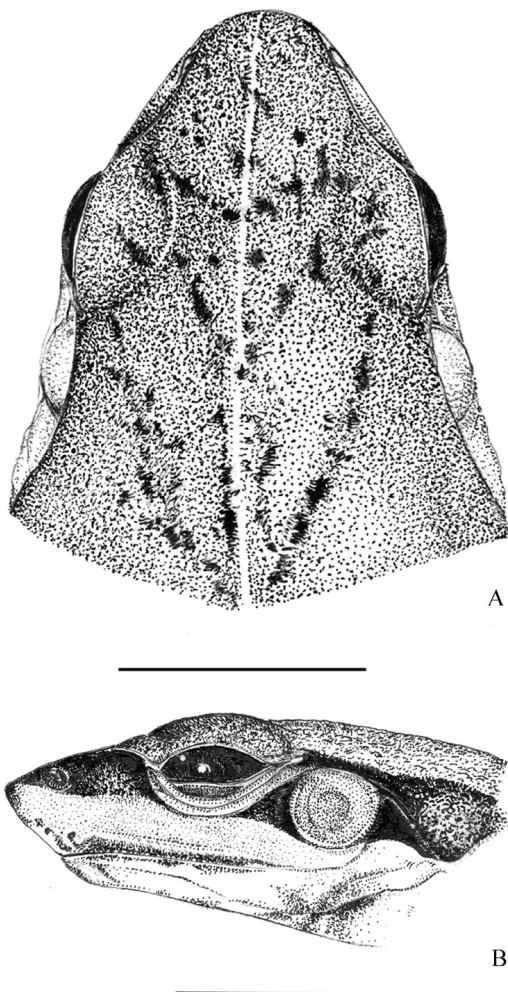
**Comparison with other species:** The new species was distinguished from all other species



**Figure 1.** *Crossodactylus cyclospinus* sp. nov., holotype (MNRJ 34501; SVL 23.9 mm). (A) Dorsal and (B) ventral view.

of the *C. gaudichaudii* species group by the circular arrangement of conical spines (four to six) on their thumb (no circular distribution is observed in *C. gaudichaudii*, *C. aeneus*, *C. bokermanni*, *C. caramaschii*, *C. dantei*, and *C. lutzorum*) (Caramaschi and Sazima, 1985; pers. obs.). *Crossodactylus cyclospinus* sp. nov. differed from *C. bokermanni*, *C. dantei*, *C. lutzorum*, and *C. gaudichaudii* by having minuscule keratinized spines on its upper lip (absent in *C. bokermanni*, *C. dantei*, *C. lutzorum*, and *C. gaudichaudii*) (Cochran, 1955; Caramaschi and Sazima, 1985; Carcerelli and Caramaschi, 1992; pers. obs.). The new species was further distinguished from *C. caramaschii*, and *C. lutzorum* by the presence of a gland posterior to the bucal commissure (absent in *C. caramaschii*, and *C. lutzorum*) (Carcerelli and Caramaschi, 1992; Bastos and Pombal, 1995; pers. obs.), and from *C. dantei* by the elongated form of this gland (triangular in *C. dantei*) (Carcerelli and Caramaschi, 1992; pers. obs.). A light stripe extending from the snout to arm insertion was present in the new species and in *C. bokermanni* and *C. caramaschii* (absent on *C. aeneus*, *C. dantei*, *C. gaudichaudii*, and *C. lutzorum*) (Caramaschi and Sazima, 1985; pers. obs.). Additionally, *Crossodactylus cyclospinus* sp. nov., *C. gaudichaudii* and *C. aeneus* differ from all other species of the *C. gaudichaudii* group by the presence of a lateral cream stripe on the posterior half of their flanks (absent in *C. bokermanni*, *C. caramaschii*, *C. dantei*, and *C. lutzorum*) (Caramaschi and Sazima, 1985; Carcerelli and Caramaschi, 1992; Bastos and Pombal, 1995; pers. obs.).

**Description of holotype:** Body slender; head longer than its width; snout rounded in dorsal view and protruding in lateral view (fig. 2A, B); canthus rostralis distinct, straight; loreal region concave, weakly inclined; nostrils small, rounded, near the tip of snout, directed laterally; tympanum large, rounded, approximately two thirds of eye diameter; supratympanic fold distinct; labial spines minuscule, keratinized, regularly distributed on upper lip; premaxillary



**Figure 2.** *Crossodactylus cyclospinus* sp. nov., holotype (MNRJ 34501). (A) Dorsal and (B) lateral view of head (scale = 5 mm).

and maxillary teeth present; vomerine teeth absent; tongue large, ovoid; distinct gland immediately posterior to the buccal commissure; vocal sacs subgular, paired, weakly developed; arms moderately robust; six conical keratinized spines, arranged in a circle on dorsal surface of the thumb (fig. 3A); fingers slightly fringed; finger lengths  $II \cong IV < I < III$ ; finger tips rounded (fig. 3B); scutes weakly developed on fingers; fingers without webbing; subarticular tubercles rounded; supernumerary tubercles present; outer metacarpal tubercle ovoid; inner metacarpal tubercle elliptical; legs mod-

erately robust; toes extensively fringed on both sides; tarsal fringe well-developed, continuous with toe I fringe; toe lengths  $I < II < V < III < IV$ ; toe tips truncated (fig. 3C); outer metatarsal tubercle small, protruding, rounded; inner metatarsal tubercle large, elliptical; dorsal skin rugose, very granulated on sacral region; some small granules along dorsolateral fold, ventral skin of thigh, tibia and around cloacal region; gular region and belly smooth.

**Color in preservative:** Dorsum brown with dark spots more concentrated at sacral region; dark brown stripe extending dorsolaterally from snout to inguinal region; cream stripe extending laterally from snout to arm insertion, immediately below the dorsolateral stripe; lateral cream stripe beginning at the posterior half of flank, reaching inguinal region; tympanum light brown; dorsal surfaces of thigh, tibia, and feet light brown with darker transversal bars; arms light brown with darker spots dorsally; iris light copper; gular and chest regions cream with brownish scattered blotches and short stripes; ventral surfaces of upper arms, inner surface of forearms, thigh, tibia, and belly cream; outer surface of forearms, hands, and feet dark brown ventrally.

**Measurements of holotype:** SVL 23.9, HL 11.4, HW 7.8, ED 3.0, TD 2.1, END 1.5, IND 3.2, IOD 2.6, UEW 2.2; THL 12.1, TL 12.5, FL 17.1.

**Variation:** Conical spines on the thumb varied in their degree of keratinization and number (four to six in males; absent in the female). In the female, the tarsal fringe was less well developed and the lateral cream stripe on flank was wider. Some specimens showed scattered brownish blotches and short stripes on the belly. Variation in measurements can be seen in Table 1.

**Tadpole:** Measurements of four tadpoles in developmental stage 36 (Gosner, 1960) can be seen in Table 2. Their body was elliptical in dorsal view and ovoid in lateral view (fig. 4A);

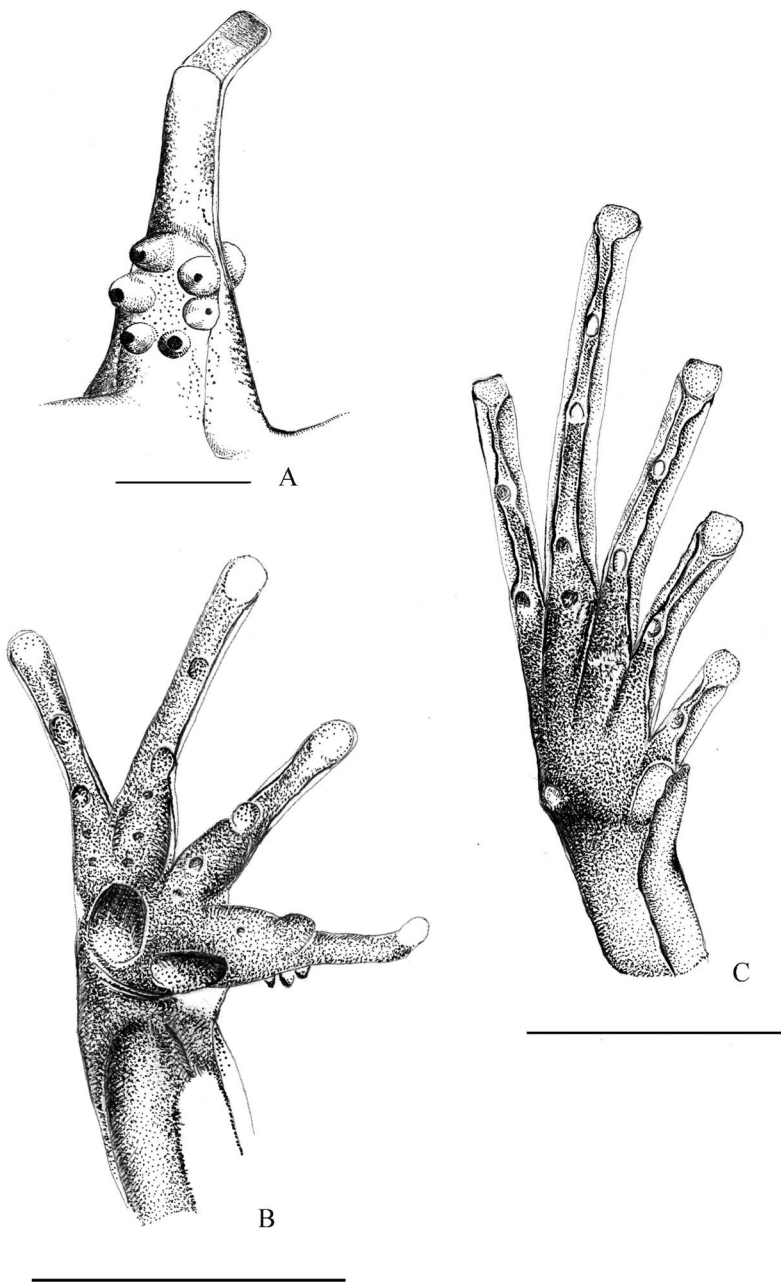
**Table 1.** Mean ( $\bar{x}$ ), standard deviation (SD), and range of measurements (mm) of nine adult males and one adult female of *Crossodactylus cyclospinus* sp. nov.

	Male			Female
	$\bar{X}$	SD	Range	
Snout vent length	23.7	0.4	23.2-24.4	29.4
Head length	9.8	0.9	9.1-11.4	10.0
Head width	7.9	0.3	7.6-8.3	8.8
Eye diameter	3.2	0.3	2.9-3.6	3.7
Tympanum diameter	2.3	0.3	1.9-2.9	2.4
Eye nostril distance	1.7	0.3	1.2-2.1	2.3
Internarial distance	3.4	0.3	3.0-4.0	4.1
Interorbital distance	2.8	0.3	2.5-3.3	3.6
Upper eyelid	2.3	0.2	2.0-2.6	2.1
Thigh length	11.8	0.6	10.7-12.7	12.2
Tibial length	12.8	0.3	12.4-13.2	13.3
Foot length	15.0	2.7	12.5-18.2	14.7

**Table 2.** Mean ( $\bar{x}$ ), standard deviation (SD), and range of measurements (mm) of four tadpoles of *Crossodactylus cyclospinus* sp. nov. in developmental stage 36 (Gosner, 1960).

	$\bar{X}$	SD	Range
Total length	44.3	1.2	42.7-45.5
Body length	15.6	0.2	15.3-15.8
Body width	10.4	0.4	10.0-11.0
Body height	7.9	0.7	7.5-9.0
Tail length	29.2	1.1	27.6-30.0
Tail height	9.6	0.5	8.8-9.9
Internarial distance	3.4	0.1	3.3-3.6
Interorbital distance	3.0	0.2	2.9-3.3
Eye diameter	1.9	0.1	1.9-2.0
Eye-nostril distance	1.2	0.1	1.1-1.3
Oral disc width	3.7	0.1	3.6-3.8

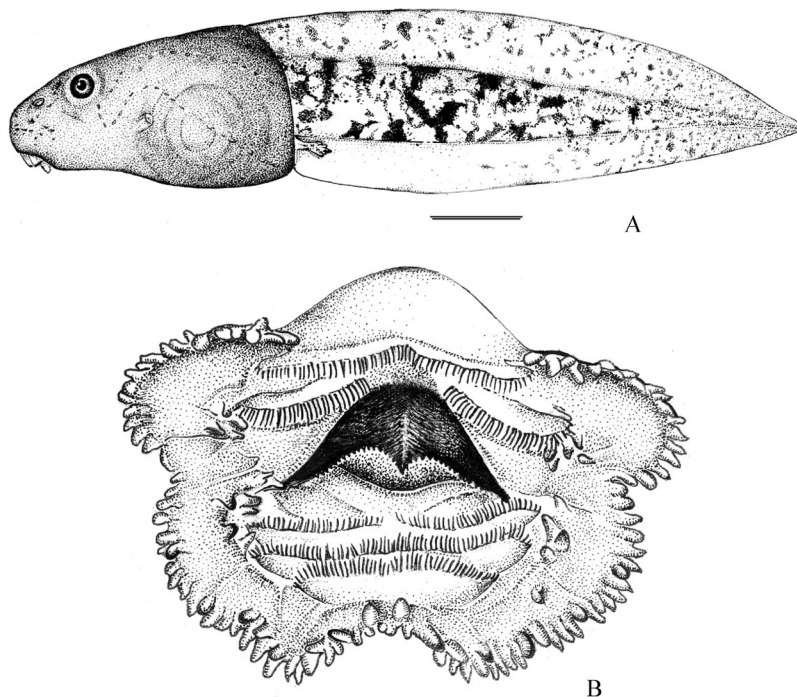
snout rounded in dorsal and lateral views; body wider than its height; eyes directed laterally; nostrils at the same distance between the snout and the eyes, located dorsally, bean-shaped; pores of lateral line system distributed on dorsal and lateral surfaces of body; spiracle short, sinistral, free distally, its opening slightly anterior to mid-body, and postero-dorsally oriented; oral disc ventral; lips developed, laterally emarginated, bordered by one row of small papillae, with a wide gap on anterior lip; scattered submarginal papillae distributed laterally; tooth row formula 2(2)/3(1), third posterior tooth row shorter than others; jaw sheath strongly developed, serrate; upper jaw sheath wide-arched, in-



**Figure 3.** (A) Dorsal view of finger I showing the keratinized spines (scale = 1 mm); ventral view of (B) hand and (C) foot (scale = 5 mm).

cised, and lower jaw sheath V-shaped (fig. 4B); cloacal tube dextral, medium-sized, with wide opening; tail approximately twice body length, slightly higher than body; dorsal fin slightly higher than ventral fin and extending onto the posterior third of body; dorsal and ventral fins

slightly arched; tail tip nearly rectilineal; tail musculature higher than dorsal fin, extending to the tail tip. In preservative, dorsum was light brown with small, scattered brown blotches, ventral surface with fine brown reticulations and grayish reflex; tail with regular brown blotches

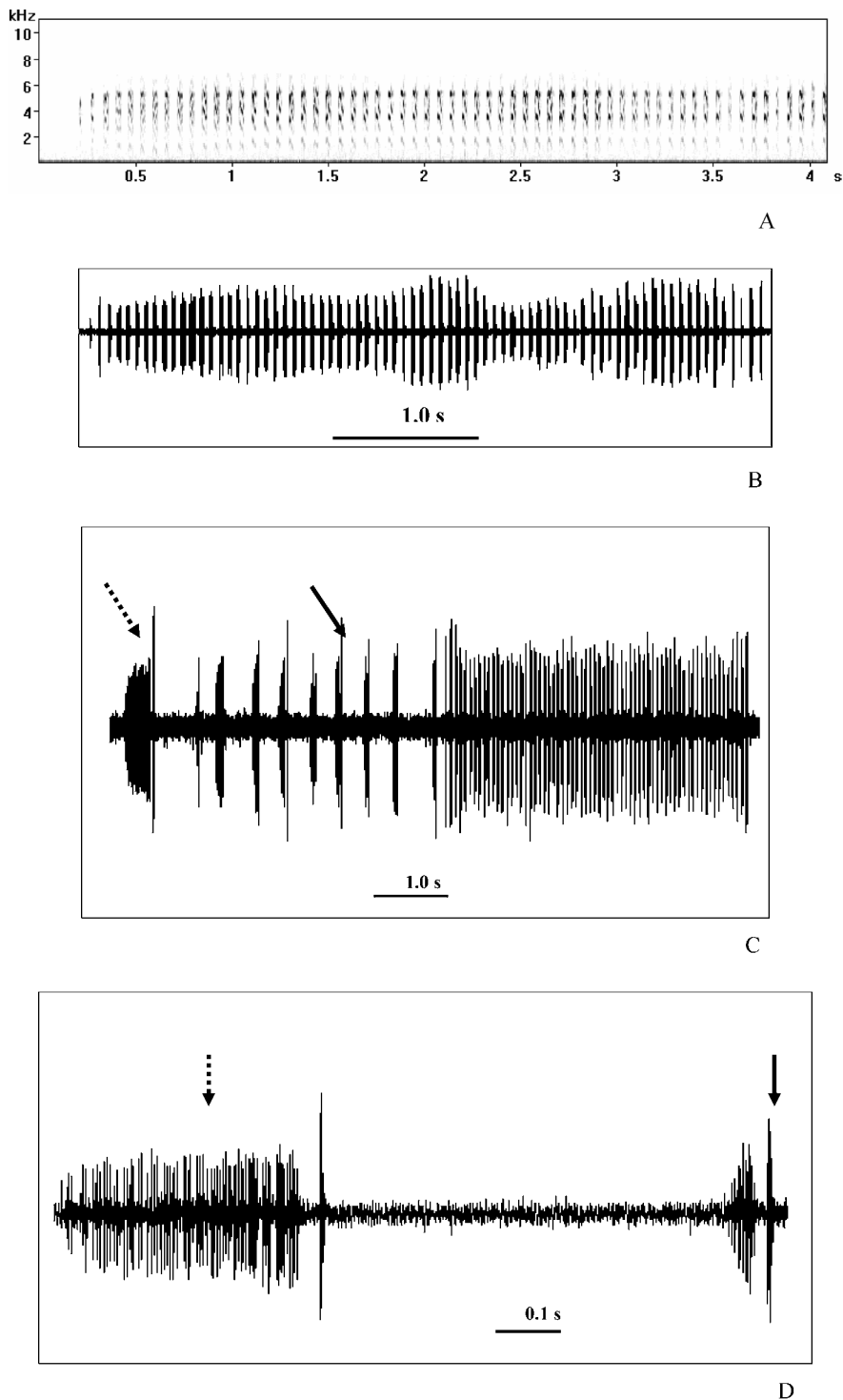


**Figure 4.** Tadpole of *Crossodactylus cyclospinus* sp. nov. (MNRJ 36479), stage 36 (Gosner, 1960). (A) Lateral view (scale = 5 mm) and (B) oral disc (scale = 1 mm).

on dorsal fin and caudal musculature, ventral fin poorly brown pigmented. Three newly metamorphosed individuals measured SVL 14.7–15.7 ( $\bar{x}$  = 5.1). The tadpole of *C. cyclospinus* sp. nov. was distinguished from all other known tadpoles of *Crossodactylus* by having an incised upper jaw sheath (concave in *C. bokermanni*, *C. gaudichaudii*) (Caramaschi and Sazima, 1985; Francioni and Carcerelli, 1993).

**Vocalization:** On 7th January 2004, the advertisement call of one male of *Crossodactylus cyclospinus* sp. nov. was recorded; this was a long call ( $\bar{x}$  = 4.33 s; SD = 0.74; range 3.57–6.25 s;  $n$  = 25 calls) with many harmonic notes ( $\bar{x}$  = 63.3 notes; SD = 11.9; range 35–98,  $n$  = 25 calls); intercall interval varied ( $\bar{x}$  = 14.36 s; SD = 10.06; range 3.29–33.80 s,  $n$  = 16 intercall intervals); mean note duration was 0.028 s (SD = 0.004; range 0.003–0.04 s;  $n$  = 1601 notes); mean note interval

was 0.04 s (SD = 0.003; range 0.029–0.065 s,  $n$  = 1576 note intervals). The dominant frequency was generally situated in the second and third harmonic ( $\bar{x}$  = 4981 Hz; SD = 626.6; range 3488–5447,  $n$  = 25 calls) and fundamental frequency ranged from 700 to 1200 Hz (fig. 5A, B). Two other call types were emitted when the male noticed the presence of the observer (herein called A and B) (fig. 5C). One or two notes constituted call A: when consisting of one note, call duration ranged from 0.01 to 0.012 s ( $\bar{x}$  = 0.011 s; SD = 0.001;  $n$  = 4 calls), with two notes, call duration ranged from 0.031 to 0.089 s ( $\bar{x}$  = 0.58 s; SD = 0.015;  $n$  = 56 calls); first note duration ranged from 0.004 to 0.062 s ( $\bar{x}$  = 0.03 s; SD = 0.015;  $n$  = 56 calls); the interval between notes ranged from 0.01 to 0.02 s ( $\bar{x}$  = 0.015 s; SD = 0.002;  $n$  = 56 calls); and the second note duration ranged from 0.008 to 0.019 s ( $\bar{x}$  = 0.013 s; SD = 0.003;  $n$  = 56 calls). In both cases, dominant frequency



**Figure 5.** (A) Sonogram of part of the advertisement call; (B) waveform of the advertisement call; (C) waveform of the advertisement call preceded by calls A (solid arrow) and B (dashed arrow); and (D) waveform of calls A (solid arrow) and B (dashed arrow) of *Crossodactylus cyclospinus* sp. nov., recorded at Fazenda Duas Barras, Municipality of Santa Maria do Salto, Minas Gerais, Brazil, on 07 January 2004, 01:30 PM, air temperature 30°C. Voucher specimen MNRJ 35406.

ranged from 4112 to 5297 Hz ( $\bar{x}$  = 4640.83 Hz; SD = 313.05;  $n$  = 61 calls). Call B consisted of two notes, differing from A by a longer first note (fig. 5D). Call B duration ranged from 0.397 to 0.49 s ( $\bar{x}$  = 0.432 s; SD = 0.051;  $n$  = 3 calls). First note duration ranged from 0.363 to 0.459 s ( $\bar{x}$  = 0.401 s; SD = 0.051;  $n$  = 3 calls); the interval between notes ranged from 0.018 to 0.023 s ( $\bar{x}$  = 0.021 s; SD = 0.003;  $n$  = 3 calls), and the second note duration ranged from 0.008 to 0.011 s ( $\bar{x}$  = 0.01 s; SD = 0.002;  $n$  = 3 calls). The dominant frequency of call B ranged from 4328 to 5103 Hz ( $\bar{x}$  = 4823 Hz; SD = 429.9;  $n$  = 3 calls). Advertisement calls of the *C. gaudichaudii* species group are known for *C. gaudichaudii* (Weygodt and Carvalho-e-Silva, 1992) and *C. caramaschii* (Bastos and Pombal, 1995) (table 3). Weygodt and Carvalho-e-Silva (1992) presented four different calls for *C. gaudichaudii*, recorded in terraria. The first one was considered an aggressive encounter call, and the other three, advertisement calls. The call named “long range advertisement call” by Weygodt and Carvalho-e-Silva (1992) was the only one used herein for comparisons, since it was the most similar to the advertisement call of *C. cyclospinus* sp. nov. Both calls were similar in the number of notes per call (35-98 notes in *C. cyclospinus* sp. nov., 25-130 notes in the call of *C. gaudichaudii*)

and intervals between notes (0.029-0.065 s in *C. cyclospinus* sp. nov., 0.04-0.05 s in *C. gaudichaudii*). However, they differed in note duration (0.003-0.04 s in *C. cyclospinus* sp. nov., 0.04-0.05 s in *C. gaudichaudii*) and fundamental frequency (700-1200 Hz in *C. cyclospinus* sp. nov., 2000-5500 kHz in *C. gaudichaudii*). Advertisement call of *C. cyclospinus* sp. nov. was similar to *C. caramaschii* but differed in fundamental frequency [700-1200 Hz in *C. cyclospinus* sp. nov., 1600 Hz in *C. caramaschii* (Bastos and Pombal, 1995)]. The dominant frequency on the third harmonic in *C. cyclospinus* sp. nov. and *C. caramaschi* support the idea of a relationship between the species of genus *Crossodactylus* and *Hyloides* as suggested by Bastos and Pombal (1995).

*Natural History:* Adults, juveniles, and tadpoles of *Crossodactylus cyclospinus* sp. nov. were diurnal and were collected during the wet season, in October 2003 and January 2004. As with other species in the *C. gaudichaudii* group, except *C. bokermanni* (Caramaschi and Sazima, 1985), the new species occurred in shallow rivulets in forested areas in Atlantic Rain Forest. Males were vocalizing from rocks or under plants in the middle of these rivulets. The frogs were vigilant, and when a male noticed the presence of an observer he turned to this direction and emitted an A or B call. When threatened individuals hid in the litter or entered the water. The female was collected at the same site as the males: creamy white ovules were observed through transparent skin on her belly.

*Distribution:* The new species is only known from the type locality at Fazenda Duas Barras, Municipality of Santa Maria do Salto, State of Minas Gerais, southeastern Brazil. This locality is in the mountain range called Serra do Cariri, which separates the States of Minas Gerais and Bahia, and the Basin of Jequitinhonha and Buranhém rivers.

*Etymology:* The specific name refers to the circular distribution of keratinized spines on the thumb. *Cyclo* is a greek vernacular name

**Table 3.** Comparison between acoustic parameters of the advertisement calls of species of the *Crossodactylus gaudichaudii* group. Data from Weygoldt and Carvalho-Silva (1992) and Bastos and Pombal (1995).

	<i>C. cyclospinus</i> sp. nov.	<i>C. caramaschi</i>	<i>C. gaudichaudii</i>
Call duration (s)	3.57-6.25	4.71-6.09	2-13
Intercall interval (s)	3.29-33.8	–	–
Notes per call	35-98	49-59	25-130
Notes duration (s)	0.003-0.04	–	0.04-0.05
Intervals between notes (s)	0.029-0.065	–	0.04-0.05
Intercall interval (s)	3.29-33.8	–	–
Dominant frequency (Hz)	3488-5447	5000	–
Fundamental frequency (Hz)	700-1200	1600	–



meaning “circle, ring” and *-spinus* is a Latin vernacular name meaning “spine”.

**Additional specimens examined:** *C. aeneus*: MNRJ 33195-98, Teresópolis, Rio de Janeiro, Brazil; *C. caramaschii*: MNRJ 31421, MNRJ 18675, Eldorado, São Paulo, Brazil; *C. dantei*: MNRJ 4769 (holotype), MNRJ 4770-4811 (paratypes), Murici, Alagoas, Brazil; *C. gaudichaudii*: MNRJ 27586-88, 27610-11, 27626-27, 27706-08, MC-NAM 5109-5120, Rio de Janeiro, Rio de Janeiro, Brazil; *C. lutzorom*: MNRJ 4753 (holotype), MNRJ 4754-4768 (paratypes), Valença, Bahia, Brazil.

**Acknowledgements.** We thank J.P. Pombal Jr. and B.V.S. Pimenta for comments and suggestions on the manuscript; R. Young for the English revision; D.P. Cabral, M.G. Soares, P.L. Ferreira and D.S. Fernandes for field and laboratory assistance; L. Aleixo for logistical support; P.R. Nascimento for the drawings; Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for financial support and CAGC fellowship. This work is part of the project “Inventário de áreas prioritárias para conservação da biodiversidade nos vales dos rios Jequitinhonha e Mucuri”, supported by Project on the Conservation and Sustainable Use of Brazilian Biological Diversity/Brazilian Ministry of the Environment (PROBIO/MMA) and coordinated by Conservation International do Brasil (CI-Brasil). Instituto Brasileiro do Meio Ambiente e Recursos Naturais Renováveis (IBAMA) provided licenses to collect the specimens (199/2002/Fauna MINAS GERAIS, 02015.018836/02 and 231/03 NUFAS/MINAS GERAIS, 02015.018836/02-16).

## References

Altig, R., McDiarmid, R.W. (1999): Body plan. Development and morphology. In: Tadpoles. The Biology of Anuran Larvae, McDiarmid, R.W., R. Altig, Eds, p. 24-51. Chicago, The University of Chicago Press.

- Bastos, R., Pombal Jr., J.P. (1995): New species of *Crossodactylus* (Anura: Leptodactylidae) from the Atlantic Rain Forest of southeastern Brazil. *Copeia* **1995**: 436-439.
- Caramaschi, U., Sazima, I. (1985): Uma nova espécie de *Crossodactylus* da Serra do Cipó, Minas Gerais, Brasil (Amphibia, Leptodactylidae). *Revista Brasileira de Zoologia* **3**: 43-49.
- Carcerelli, L.C., Caramaschi, U. (1992): Ocorrência do gênero *Crossodactylus* Duméril and Bibron, 1841 no nordeste brasileiro com descrição de duas espécies novas (Amphibia, Anura, Leptodactylidae). *Revista Brasileira de Zoologia* **52**: 415-422.
- Cei, J.M. (1980): Amphibians of Argentina. *Monitore Zoologico Italiano (N.S.)*, Monog. 2: xii+609.
- Cochran, D.M. (1955). Frogs of Southeastern Brazil. *United States National Museum Bulletin* **206**: xvi+423.
- Duellman, W.E. (1970). The hylid frogs of Middle America. *Monograph of the Museum of Natural History* **21**: 1-372.
- Duellman, W.E., Trueb, L. (1986). *Biology of Amphibians*. McGraw Hill, New York.
- Francioni, E., Carcerelli, L.C. (1993): Descrição do girino de *Crossodactylus gaudichaudii* Duméril and Bibron, 1841 (Anura, Leptodactylidae). *Memória do Instituto Butantan* **55**: 63-67.
- Frost, D.R. (2004): Amphibian Species of the World: An Online Reference. V.3.0 (22 August 2004). Electronic database accessible at <<http://research.amnh.org/herpetology/amphibia/index.html>>, American Museum of Natural History, New York, USA. [captured on 10 October 2004].
- Gosner, K.L. (1960): A simplified table for staging anuran embryos and larvae, with notes on identification. *Herpetologica* **16**: 183-190.
- Weygoldt, P., Carvalho e Silva, S.P. (1992): Mating and oviposition in the hylodine frog *Crossodactylus gaudichaudii* (Anura: Leptodactylidae). *Amphibia-Reptilia* **13**: 35-45.

*Received: May 19, 2005. Accepted: July 13, 2005.*