



## A new species of the lizard genus *Bachia* (Squamata: Gymnophthalmidae) from the Cerrados of Central Brazil

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### Abstract

A new species of *Bachia* of the *bresslaui* group, is described from Estação Ecológica Serra Geral do Tocantins, a recently created protected area in the Central Brazilian Cerrados of state of Tocantins. The new species is most similar to *Bachia psamophila* from which it differs in limb morphology and head and body scalation. As in *Bachia psamophila* the shovel-shaped snout of the new species is highly prominent, an adaptation related to its psamophilous habits.

**Key words:** *Bachia oxyrhina*, new species, Gymnophthalmidae, Brazil, Cerrado, Jalapão, Tocantins state, Estação Ecológica Serra Geral do Tocantins

### Introduction

Fossorial gymnophthalmid lizards of the genus *Bachia* lack an external ear opening, have an elongate body and tail, present a distinctive eyelid and show substantial variation in levels of limb reduction (Colli *et al.* 1998; Kohlsdorf & Wagner 2006; Rodrigues *et al.* 2007). The genus was last reviewed on the basis of external attributes by Dixon (1973) who recognized 15 species and 12 subspecies which were allocated in four species groups: *bresslaui*, *dorbignyi*, *heteropa*, and *flavescens*. Since then, taxonomy of *Bachia* has been largely based on Dixon's review although the status of several species has been reevaluated and new species have been described (Hoogmoed & Dixon 1977; McDiarmid & DeWeese 1977; Avila-Pires 1995; Kizirian & McDiarmid 1998; Castrillon & Strussmann 1998; Rodrigues *et al.* 2007). These new contributions have increased the number of species in the genus to 20 (Rodrigues *et al.* 2007). Species of *Bachia* have also been the subject of molecular studies. In the study of Pellegrino *et al.* (2001) designed to investigate relationships among Gymnophthalmidae, three species (*Bachia bresslaui*, *B. flavescens* and *B. dorbignyi*) were sequenced for nuclear and mitochondrial genes and recovered as the basal genus of the tribe Cercosaurini. The genus was also recovered as the sister group of all cercosaurines by Castoe *et al.* (2004); these authors used the same species of *Bachia* and a slightly reduced data set than that used by Pellegrino *et al.* (2001), and assigned tribal rank (Bachini) to the genus based on its distinctive morphology. In a more recent study with larger taxon sam-

pling, Kohlsdorf and Wagner (2006) investigated the reversibility of digit loss in *Bachia*. They used formalin-fixed tissues to obtain a molecular phylogenetic hypothesis for the relationships of 15 taxa. The major taxonomic consequences of that paper were not further explored but indicate that Dixon's systematic arrangement needs to be reviewed. Some clades of the topology obtained by Kohlsdorf and Wagner (2006) received weak support but none of Dixon's four species groups were confirmed. Furthermore, their study also indicates that the status of several subspecies should be reconsidered, suggesting a morphological reanalysis of the genus. While waiting for such studies, as a matter of convenience, we still rely on Dixon's species groups to orient description and comparisons of new taxa, as will be the case herein after.

Species of *Bachia* of the *bresslaui* group are characterized by lanceolate, keeled, and imbricate dorsal and lateral body scales, quadrangular and juxtaposed ventrals, 2–2 femoral and 1–1 preanal pores, presence of interparietal, supraocular, and superciliary scales, and a varied number of digits on limbs. Seven species fit this description: *Bachia bresslaui*, *B. cacerensis*, *B. micromela*, *B. panoplia*, *B. psamophila*, *B. scolecoides*, and *B. pyburni*.

In a recent paper, two new Brazilian species of *Bachia* of the *bresslaui* group were described from sandy habitats in the Cerrados of the west bank of the Rio Tocantins, state of Tocantins (Rodrigues *et al.* 2007). In the course of a faunal survey in the newly created protected area Estação Ecológica Serra Geral do Tocantins, we obtained another undescribed species of the *bresslaui* group also in sandy habitats but from the east bank of the Rio Tocantins. Herein, we describe the new species and comment on its variation and habitat.

## Material and methods

Length measurements were taken after fixation to the nearest mm with a ruler; scale counts and observations of other morphological characters were performed with a stereomicroscope Zeiss STEMI SV6. Scale nomenclature follows Dixon (1973). The hemipenis was prepared following the procedures described by Manzani and Abe (1988), modified by Pesantes (1994) and Zaher (1999). The retractor muscle was manually separated and the everted organ filled with stained petroleum jelly. Hemipenian calcareous structures were stained in an alcoholic solution of red alizarin for 24 hours, in a modification of the procedures described by Uzzel and Barry (1971) and Uzzel (1973). Hemipenian terminology follows Dowling and Savage (1960), Savage (1997) and Myers and Donnelly (2001, 2008). In the field temperature data were taken with a data logger model HOBO Pro; temperatures were recorded at continuous intervals of one hour. All specimens of *Bachia* used for comparisons are presently housed in MZUSP (Museu de Zoologia, Universidade de São Paulo) and CHUNB (Coleção Herpetológica da Universidade de Brasília).

## Results

### Taxon description

#### *Bachia oxyrhina*, sp. nov.

(Figs. 1, 2)

**Holotype:** MZUSP 98086 (Fig. 1), an adult male from Morro do Fumo, Estação Ecológica Serra Geral do Tocantins (10°51'58.41"S, 46°49'9.07"W), Mateiros municipality, state of Tocantins, Brazil, collected by the authors of this paper on February 15<sup>th</sup>, 2008. Field number PHV 2208.

**Paratypes:** MZUSP 98080 (11°6'7.92"S, 46°45'57.60"W), MZUSP 98082 (11°7'25.68"S, 46°47'26.88"W), MZUSP 98083 (Fig. 2A) (11°7'12.36"S, 46°47'12.48"W) (females); MZUSP 98081 (11°6'7.92"S, 46°45'57.60"W), and MZUSP 98084 (Fig. 2C) (11°18'41.29"S, 46°56'6.36"W) (males); all

collected by the authors of this paper between January 28<sup>th</sup> and February 4<sup>th</sup> 2008, all localities in Estação Ecológica Serra Geral do Tocantins, Almas municipality, state of Tocantins, Brazil.

**Etymology:** The specific name derives from the Greek “oxy” (sharp, spatulate, wedge shaped), and “rhino” (nose) being a reference to the pronounced, wedge shaped nose of this species, an adaptation to life in the sandy habitats where it occurs.

**Diagnosis:** (Table 1) A species of the *bresslaui* group having lanceolate dorsal and lateral body scales, quadrangular and juxtaposed smooth ventrals, tail scales lanceolate, imbricate, keeled, 1–1 femoral pores and 1–1 preanal pores in males (only preanal pores in females), interparietal, supraoculars and superciliaries present, 42–45 dorsals, 34–36 ventrals, and 29–30 scales around midbody. Snout highly prominent and wedge shaped, distinctively projecting over lower jaw. Fore limb and hind limb rudimentary, stiliform, ending in one apical scale. Five supralabials; fifth the largest and the highest, contacting or not parietal. Anterior portion of nasal scale fused with first supralabial. One enlarged temporal scale contacting or not postocular. Two supraoculars; second small, restricted to the lateral face of head, allowing extensive contact between parietal and first supraocular. Width of first supraocular less than 1/3 of the anterior margin of frontal.

**TABLE 1.** Comparative table of diagnostic characters in *Bachia* of the *bresslaui* group.

	<i>B. oxyrhina</i>	<i>B. bresslaui</i>	<i>B. cacerensis</i>	<i>B. micromela</i>
Prefrontals	absent	absent	absent	absent
Supralabials	five	six	six	six
First supralabial and nasal	fusionated	separated	separated	separated
Scales around midbody	29–30	33–35	35	38–40
Contact between supralabial and parietal	5 <sup>th</sup> supralabial	no contact	6 <sup>th</sup> supralabial, but not always in contact	5 <sup>th</sup> supralabial
Forelimb	one apical scale	one apical scale	four apical scales	one apical scale
Hindlimb	one apical scale	one apical scale	one apical scale	two apical scale

continued.

	<i>B. psamophila</i>	<i>B. panoplia</i>	<i>B. pyburni</i>	<i>B. scolecoides</i>
Prefrontals	absent	present in contact	present in contact	present and separated
Supralabials	six	six	six	six
First supralabial and nasal	separated	separated	separated	separated
Scales around midbody	35–38	43–47	41	36–40
Contact between supralabial and parietal	6 <sup>th</sup> supralabial	no contact	no contact	no contact
Forelimb	one apical scale	four reduced fingers	four free fingers	four reduced fingers
Hindlimb	four clawed toes	four reduced toes	four free toes	four reduced toes

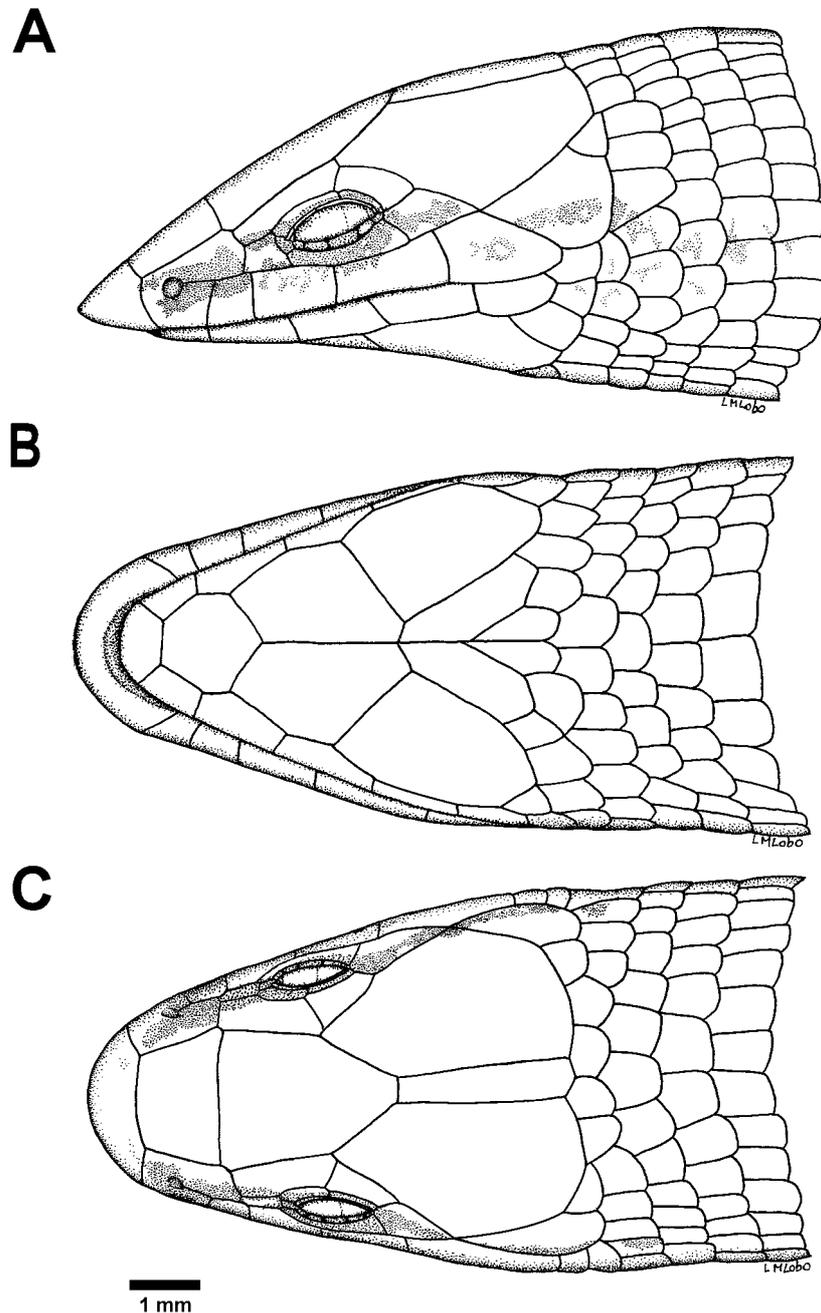
*Bachia oxyrhina* can be immediately distinguished from *B. panoplia* and *B. pyburni* by the absence of prefrontals, present and in contact at midline in both latter species. In *Bachia scolecoides*, prefrontals are also present but widely separated and reduced in size. Species of *Bachia* of the *bresslaui* group without prefrontals are *B. bresslaui*, *B. cacerensis*, *B. micromela*, *B. psamophila*, and *B. oxyrhina*. Except for *Bachia oxyrhina* that has five supralabials, all other species of *bresslaui* group have six. *Bachia oxyrhina* is also unique in having the anterior portion of nasal scale fused to first supralabial and the lower number of scales around body (29–30 vs. 33–47 in other species). *Bachia oxyrhina* resembles more closely *B. psamophila* and *B. micromela*, especially the former by its pronounced and prominent wedge shaped snout. Besides the above mentioned

characters *Bachia oxyrhina* differs from the latter species by presenting the second pair of chin shields broadly separated at midline (respectively in slight and broad contact at midline in *B. psamophila* and *B. micromela*). In *Bachia bresslaui*, *B. scolecoides*, *B. panoplia*, and *B. pyburni* there is no contact between supralabials and parietal. Contact between supralabials and parietal is variable in *Bachia cacerensis*, *B. psamophila*, *B. micromela*, and *B. oxyrhina*. In one of the three known specimens of *Bachia cacerensis* there is slight contact between parietal and 6<sup>th</sup> labial. In *Bachia psamophila* the 6<sup>th</sup> supralabial is the largest and highest and contacts the parietal; in *B. micromela* it is the 5<sup>th</sup> supralabial that contacts the parietal. The condition varies in *Bachia oxyrhina* where either it is the 5<sup>th</sup> supralabial that contacts punctually the parietal or their contact is prevented by a slight contact between postocular and temporal. This is a different condition than the one observed in *Bachia psamophila* where there are six labials and an enlarged postocular separates the 5<sup>th</sup> supralabial from parietal. *Bachia cacerensis* is unique in the *bresslaui* group in having four unclawed finger-like apical scales in the forelimb; all other species, *B. oxyrhina*, *B. psamophila*, *B. bresslaui* and *B. micromela* have just one apical scale in the forelimb, in the last species ending in an unguis sheath. The hind limb of *Bachia oxyrhina*, like those of *B. bresslaui* and *B. cacerensis* ends with one apical scale, whereas there are two in *B. micromela* and four clawed toes in *B. psamophila*. A comparative list of characters are shown in Table 1.

**Description of the holotype:** (Fig. 1) Body elongate, with a slight cervical constriction on head, snout highly prominent and wedge shaped, tail longer than body. Rostral broad, prominent, contacting first supralabial, nasal and frontonasal. Viewed from above the rostral is about twice as wide as high; on lateral view it projects broadly anteriorly toward, forming a horizontal surface ventrally, at the level of ventral surface of the upper lips. Frontonasal trapezoidal, wider than long, wider posteriorly, contacting rostral, nasal, first supraocular and frontal. Prefrontals absent. Frontal pentagonal, longer than wide, with anterior margin straight, as wide as and in broad contact with frontonasal; lateral margins straight to slightly concave, in contact on each sides with first supraocular; posteriorly angulose, broadly contacting parietals and in short contact with interparietal. Frontal more than four times wider than anterior supraocular. Frontoparietals absent. Interparietal narrow, longer than wide, subrectangular, slightly wider posteriorly, shorter than frontal and parietals. Parietals very large, longer than wide, slightly longer and wider than frontal, roughly pentagonal, their anterior margin deeply indented and in broad contact with frontal, externally contacting first and second supraoculars, the postocular, the sixth supralabial, a large and long temporal and the dorsals; internally it contacts frontal and interparietal. Posterior borders of interparietal and parietals and dorsals coincide with a slight transverse cervical constriction in the occipital region. Two supraoculars, first largest, about three times longer than wide, contacting frontal, frontonasal, nasal, loreal, first superciliary, second supraocular and parietal. Second supraocular smaller, above second superciliary, longer than wide, separated from frontal by the slight contact between parietal and first supraocular. Two superciliaries, the first longer, its sutures coincide with that between supraoculars. Nasal large, longer than high, their suture with posterior part of first supralabial complete, anteriorly to nostril fused to first supralabial forming an incomplete nasolabial. Nasal portion of this incomplete nasolabial clearly viewed from above; above first and second supralabials. Nostril in the first third of lower margin of nasal, deeply indenting the suture with the posterior part of first supralabial. Loreal roughly squared, in contact with nasal, first supraocular, first superciliary, preocular, subocular and second and third supralabials. Frenocular absent. Five supralabials, third and fourth under the orbital region, fifth the highest and largest, contacting punctually parietal. One long subocular, widest posteriorly. Eyelid present with an undivided semitransparent disc. A large and elongate postocular between fourth and fifth supralabials and parietal. An enlarged, longer than wide, temporal scale between parietal and fifth labial, in broad contact with parietal. Ear opening absent. All head scales smooth and juxtaposed with scattered sensorial organs.

Mental roughly trapezoidal, wider than long, slightly longer than the ventral surface of rostral. Postmental heptagonal, as wide as long. Two pairs of chin shields, both contacting infralabials; the anterior pair smaller, in broad contact at midline; second pair broadly separated by an enlarged pair of symmetric flat and diagonally disposed elongate pregonals. Five infralabials, first the smallest, second, third and fourth about the same

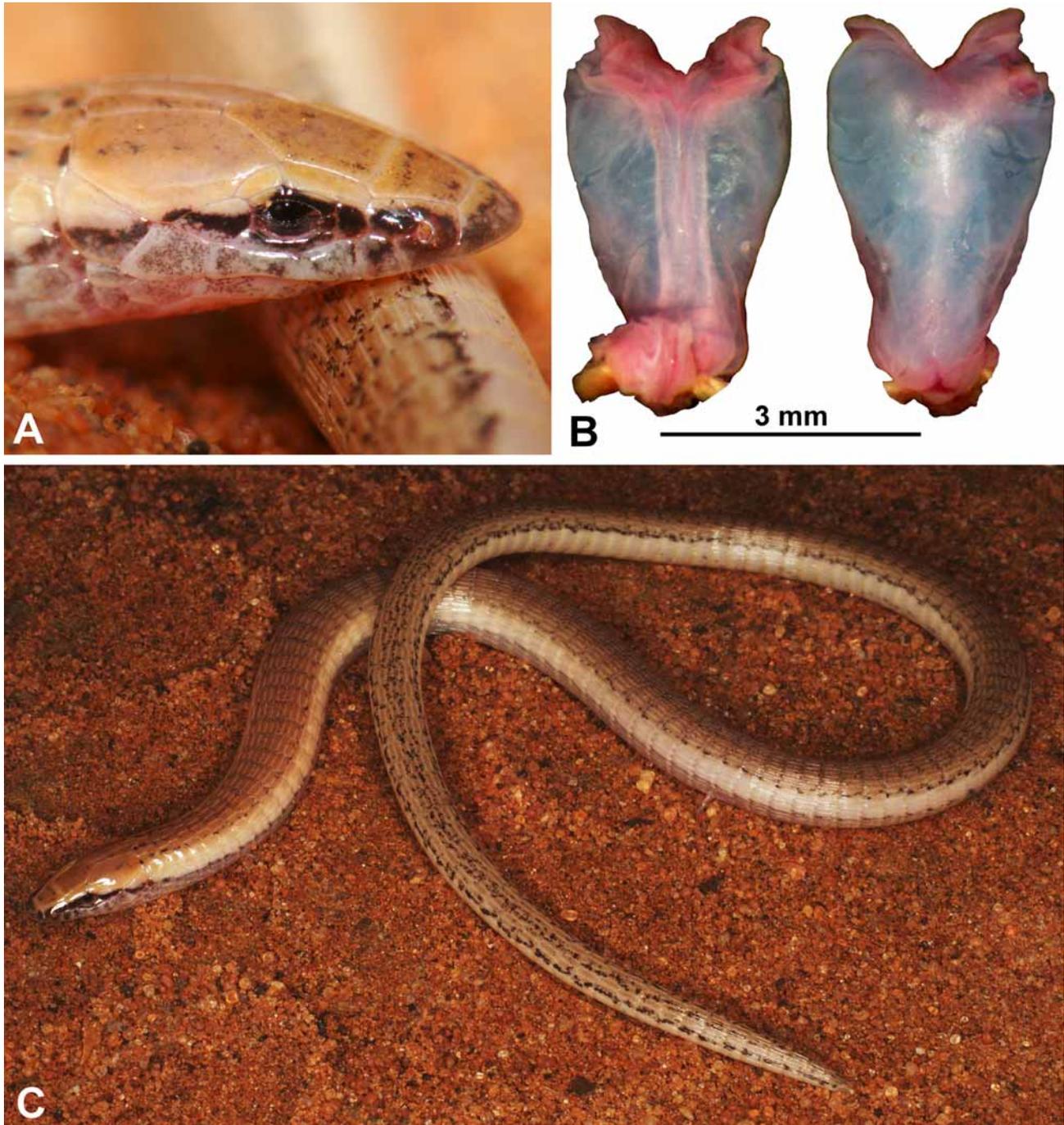
size. Gulars smooth, imbricate, rounded posteriorly, in eight transversal rows; scales of gular rows increasing gradually in size toward interbrachial region. Interbrachial region with four scales, the central ones largest, twice longer than wide. Lateral scales of neck subrectangular, smooth, imbricate, slightly rounded posteriorly and longer than wide, disposed in regular transverse rows and becoming gradually similar to adjacent dorsal or ventral scales. Collar fold absent.



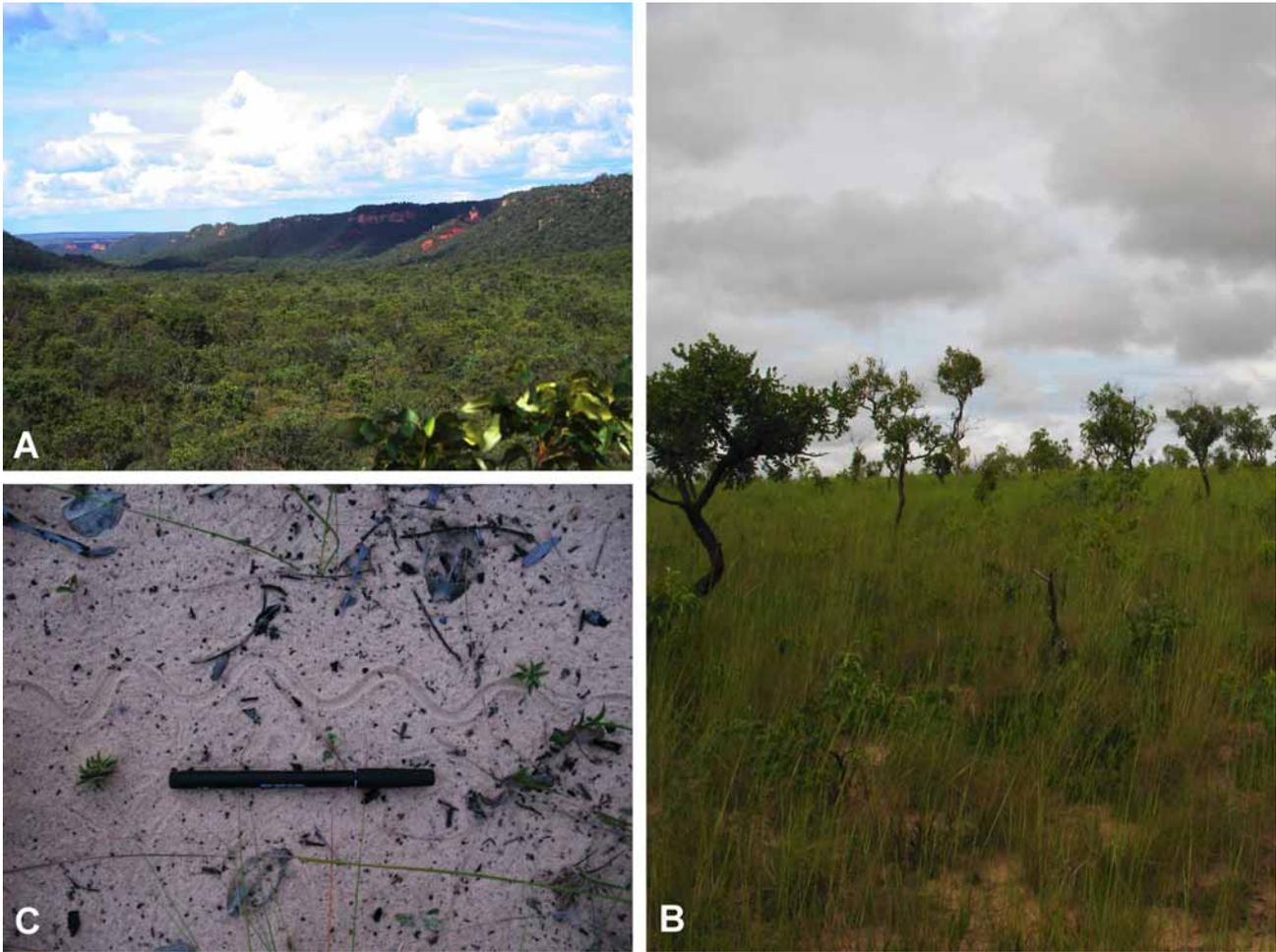
**FIGURE 1.** Lateral (A), ventral (B), and dorsal (C) views of the head of the holotype of *Bachia oxyrhina* **sp. nov.** (MZUSP 98086).

Dorsal scales imbricate and disposed in regular transversal rows; smooth, subrectangular and wider in occipital region, becoming progressively narrower, more elongate and rounded towards the level of the forelimbs and then on longer, hexagonal, lanceolate, strongly keeled, with lateral sides almost juxtaposed. Forty-five transverse rows between interparietal and the level of hind limbs. Lateral scales about the same size as dor-

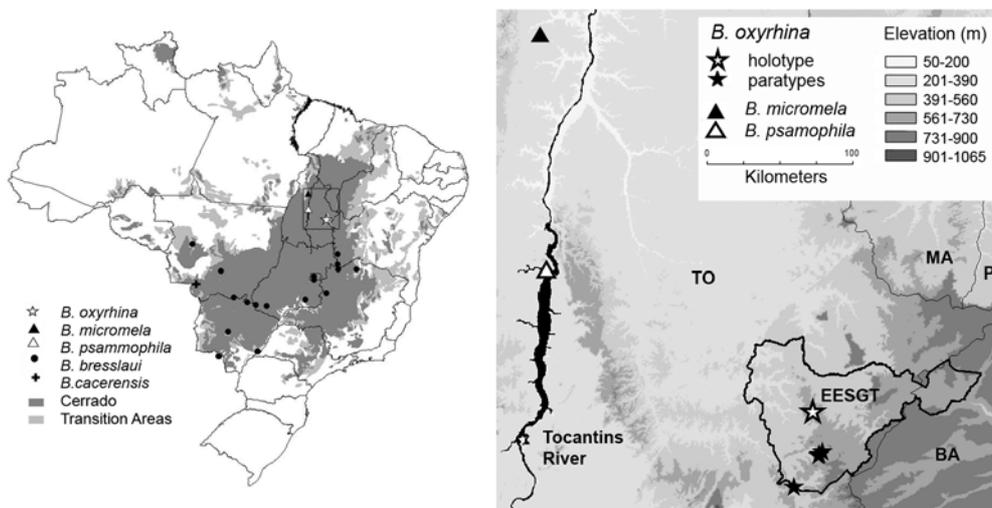
sals but smooth and less acuminate; those closer to ventrals slightly wider. A distinctive area with granular scales surrounds the area of arm insertion and the posterior part of leg insertion. Thirty scales around mid-body. Ventral scales smooth, longitudinally imbricate, laterally juxtaposed, almost squared just after the interbrachial row, becoming gradually longer than wide, rounded posteriorly, those after midbody narrower; 34 transverse rows from interbrachials (excluded) to preanals. Five scales in the posterior part of preanal plate, central one largest. One preanal and one femoral pore on each side.



**FIGURE 2.** *Bachia oxyrhina* sp. nov.: (A) Close-up of the head (MZUSP 98083), note the absence of suture between anterior part of nasal scale and first supralabial; (B) sulcate (left) and assulcate (right) sides of the left hemipenis; and (C) paratype in life (MZUSP 98084).



**FIGURE 3.** Habitat and track of *Bachia oxyrhina* sp. nov.: (A) general physiognomy of the habitats at EESGT where specimens were found; (B) aspect of an opened Cerrado (“campo sujo”) with scattered trees and areas of bare sand; (C) tracks in white sand.



**FIGURE 4.** Distributional records of *Bachia* species from Brazilian Cerrados: *Bachia bresslaui*, *B. cacerensis*, *B. micromela*, *B. psammophila*, and *B. oxyrhina* sp. nov.

Scales of tail similar to midbody dorsals, keeled, lanceolate, strongly imbricate.

Fore limbs rudimentary, stiliform, covered by smooth and imbricate scales, ending in a single apical scale.

Fore limb length equal to width of one row of lateral scales. Hind limb also stiliform but larger than fore limb, covered by smooth, large and imbricate scales ending by one apical scale; length equivalent to one and one-half scale rows. One femoral pore present at each side.

Background dorsal and lateral surfaces of body and tail almost uniformly cream to light brown with scattered melanophores. Ventral parts of body and tail immaculate cream.

Hemipenes partially everted, bilobed, sulcus spermaticus central in position, extending from the base of organ to lobes, sulcate and assulcate faces smooth and without papillae or spines.

Measurements of the holotype: Snout-vent-length: 65 mm; tail length (regenerated): 85 mm.

**Variation:** the type series is fairly homogeneous, showing little variation in number of dorsal scales (42–45), ventral scales (34–36), scales around body (29–30), and gular scale rows (6–8). Like the holotype all other specimens have the first supralabial partially fused with nasal, two superciliaries, five supralabials, five infralabials, five preanal scales, one preanal pore, and both fore and hind limb ending by one apical scale. All males have one femoral pore at each side; these are absent in females. In two specimens (MZUSP 98080 and 98081) the first supraocular is fused to the loreal on the left side. There is also some variation regarding contact between labials and parietal. Like in the holotype, in general the fifth supralabial punctually contacts the parietal except for some cases when there is a contact between postocular and temporal. This is the case in MZUSP 98081, on the right side of the holotype, where there is a slight contact between postocular and temporal, and in MZUSP 98082 and 98083 where this contact is larger. Maximum snout-vent length varies between 61–80 mm, the largest specimen is a female. Although the holotype is almost homogeneously immaculate cream, other specimens show in general two symmetrical dorsolateral light stripes two to two and one-half scales wide, and extending from the parietal scale to the end of tail, showing a darker overall color pattern. Between them there is a conspicuously wider but irregular brown dorsal stripe also extending from the posterior border of the interparietal scale to the tip of the tail. Longitudinal dark and light stripes are more conspicuous anteriorly where the light stripes are limited below and above by a darker border. Lateral parts of body are cream with a scattered light brown reticulum.

Hemipenes of one of the paratypes (MZUSP 98084) were partially everted during preservation and the left hemipenis was prepared (Fig. 2B). The organ is relatively small, extending along approximately four sub-caudal rows (4 mm). It is slightly bilobed, with the distal tip of the retractor muscle divided. The hemipenial body is globose, slightly Y-shaped, ending in two small and symmetric lobes surrounded by a thin and fleshy fold. The sulcus spermaticus is broad, central in position, originates at the base of the organ, and proceed in a straight line towards the lobes. At the distal tip of the hemipenial body the sulcus is divided in two branches. In the lobes, branches of the sulcus run among folds in an S-shape condition, ending at their tip. Sulcate and assulcate faces of the organ are completely smooth, with no evident plicae, papillae, ridges, calyces, mineralized spines or spinules, even after immersion on an Alizarin Red solution for 24 hours. The absence of hemipenial ornamentation is similar to the condition reported for *Bachia trisanale* and *B. intermedia* (Presch 1978).

**Distribution and natural history:** The study area is situated near the borders of states of Tocantins, Maranhão, Piauí, and Bahia and is usually referred to as the Jalapão region. The Jalapão, comprising approximately 53300 km<sup>2</sup>, consists of extensive quartzitic sand depressions resulting from erosion of arenitic plateaus of the Serra Geral and Chapada das Mangabeiras, and is drained by headwaters of the Tocantins and São Francisco river basins (SEPLAN 2003). Isolated and highly eroded sandstone relicts are frequent in the depositional plains, and represent evidence of the formerly continuous plateau (Ribeiro *et al.* in press). The Jalapão is considered one of the three best preserved areas in the Cerrado domain, Central Brazil (Cavalcanti & Joly 2002). Estação Ecológica da Serra Geral do Tocantins (EESGT) is a conservation unit created in 2001 that protects 7163.06 Km<sup>2</sup> of the depositional plains and part of the Serra Geral, being the second largest federal protected area in the Cerrado. Vegetation in Jalapão and EESGT is typical of the Cerrado domain, and is characterized by extensive grasslands, open savannas and typical “cerrado” savannas (campo sujo, campo cer-

rado and cerrado *sensu stricto*, respectively, Oliveira-Filho & Ratter 2002) (Figs. 3A, 3B), interspersed by palm marshes (dominated by *Mauritia flexuosa* palms) and gallery forests along water courses.

Two main regions were sampled at EESGT: a southern, lower portion, located mostly at Almas municipality, state of Tocantins, and a northeastern portion, located at Formosa do Rio Preto municipality, in state of Bahia, in the higher portions of EESGT on the Serra Geral plateau. Nine pitfall-trap lines, containing five sets of traps each, were installed in each region. Each set of traps consisted in four 35 liter buckets arranged in Y shape and connected by drift fences. A total of 180 buckets were used in each site, which remained opened for nine consecutive days at the southern (27/January to 04/February/2008) and at the northeastern sites (08–16/February/2008), totaling an effort equivalent to 3240 buckets/day. The traps covered the main physiognomies present in EESGT region, ranging from grasslands, with few scattered small trees, to typical Cerrado, with discontinuous herbaceous layer and leaf litter patches. Palm marshes and gallery forests were also sampled. In addition, active search was performed around the lines and along the roads that cross the EESGT. Although we saw tracks of *Bachia oxyrhina* (Fig. 3C) along the different sampled habitats at the southern part of EESGT, except in palm marshes and gallery forests, only four specimens were collected in pitfall traps, all at lower elevations in the south-central part of the station (Fig. 4). Two additional individuals were collected manually by digging through the sand surface, one in the southern site, and another in the central part of the station, adjacent to “Morro do Fumo”, one of the relictual and highly eroded sandstone plateaus of the area. Although sandy soil grasslands and denser savanna habitats, similar to those of the southern site were sampled with similar effort in the northeastern part of the station, no specimens or tracks were found. The absence of *Bachia oxyrhina* at the northeastern site and characterized by higher elevations, suggests that the species is restricted to the southern part of the Jalapão. This is reinforced by the absence of the species in all other previous herpetological surveys conducted at the northern part of Jalapão region (Vitt *et al.* 2002; Vitt *et al.* 2005; Mesquita *et al.* 2006; Nogueira 2006). The single previous lizard sampling within EESGT was conducted in March–April 2003 by one of us (CN) as part of a study on Cerrado lizard diversity (Nogueira 2006; Nogueira *et al.* in press), in the northernmost limits of the protected area, all north of the Morro do Fumo site, in depressions associated with the Rio Novo drainage, one of the main watercourses in the Jalapão. Using the same overall sampling method (35 liter bucket traps with drift fences, in different habitat types), 490 lizard specimens of 14 species were collected (see results in Nogueira *et al.* in press), after 3600 bucket/days of pitfall trapping and manual collection in fifteen days of fieldwork. In this previous sampling, no specimens of *Bachia* were obtained. Furthermore, no tracks were observed at these sites within the Rio Novo depressions, suggesting that the new species is rare or absent outside the southern portion of EESGT, which was previously unsampled.

*Bachia oxyrhina* seems to inhabit the superficial layer of sandy soils, as many tracks can be easily found at exposed sandy soils in the station. Frequently, tracks were observed on open ground heading from one bush to another, indicating sub-superficial ground locomotion. During the survey, we measured temperatures hourly using a HOBO data logger, with a sensor placed 1 cm deep in the exposed sand, next to one of the lines where two specimens of *Bachia oxyrhina* were captured in pitfall traps. Mean temperature was 26.32°C, ranging from 21.33°C to 42.46°C (sd = 4.83°C, n = 192). These data represent a gross estimate of the temperatures that the species may encounter in the sand.

One *Scotinus* sp. larva (Tenebrionoidea, Coleoptera) was regurgitated by the holotype during fixation.

The fact that only four individuals were obtained with pitfall-traps, despite the relatively large effort, is not surprising given that individuals of the genus *Bachia* are usually not abundant in herpetological surveys (Colli *et al.* 1998; Nogueira 2006; Pavan 2007; Rodrigues *et al.* 2007). However, as many tracks were seen through great part of the station it is difficult to say if this species is rare. Considering that it was raining during part of the time that the pitfalls remained open, we prefer do not use our pitfall sampling results to infer the real density of this species.

## Discussion

In the absence of an explicit phylogeny it is impossible to be certain regarding the relationships of *Bachia oxyrhina*. The molecular tree obtained by Kohsdorf and Wagner (2006) includes 15 taxa, but only *Bachia bresslaui* and *Bachia scolecoides* of the *bresslaui* group. *Bachia bresslaui* was recovered at the base of the tree whereas *Bachia scolecoides* was nested at the most derived node, sister to *B. huallagana* from the *dorbignyi* group. These two last species were also recovered as sister to *Bachia alleni* from the *heteropa* group in the topology (*B. alleni* (*B. scolecoides* + *B. huallagana*)), and both nodes were strongly supported. These results indicate that *Bachia scolecoides* could be misplaced in the *bresslaui* group. In fact, *Bachia scolecoides*, *Bachia pyburni*, and *Bachia panoplia* are the only species with prefrontal scales included in the group. Species of the *bresslaui* group lacking prefrontals are *Bachia oxyrhina*, *Bachia bresslaui*, *Bachia cacerensis*, *Bachia micromela* and *Bachia psamophila*. Patterns of limb morphology are distinctive between these species. *Bachia cacerensis* is unique in having four unclawed finger-resembling apical scales on the fore limb. *Bachia bresslaui*, *Bachia micromela*, *Bachia oxyrhina*, and *Bachia psamophila* have a very different fore limb ending in a single apical scale. Differences are more pronounced in the hind limb where *Bachia psamophila* is the only species having four clawed toes; in *Bachia micromela* the hind limb ends in two apical scales, and only one in *Bachia bresslaui* and *Bachia cacerensis*. Despite the differences in hind limb morphology *Bachia oxyrhina* phenotypically is more similar to *Bachia psamophila*. In both species the second pair of chin shields is separated or in slight contact at midline, whereas they are in broad contact in the other species. However, the most striking similarity between *Bachia psamophila* and *Bachia oxyrhina* is their wedge shaped snout, a clear adaptation to subaerial locomotion in sandy habitats (Rodrigues 1991; Rodrigues *et al.* 2007). The fact that two fossorial species with a highly projecting snout and a distinctive hind limb morphology live in geographically close and ecologically similar habitats is intriguing. Are they in fact closely related? Do they have similar microhabitat preferences and modes of locomotion or do they forage differently in similar habitats? Although distinctive patterns of limb reduction in species of *Bachia* living in the same habitat have been generally hypothetically associated with different locomotor strategies caused by the use of different microhabitats (see Kohsdorf & Wagner 2006), other causes can be invoked to account for this pattern.

*Bachia cacerensis*, *B. bresslaui*, *B. psamophila*, *B. micromela*, and *B. oxyrhina* are associated with distinct geographic regions of the Brazilian Cerrados (Fig. 4). *Bachia bresslaui* is widely distributed, *Bachia cacerensis* is restricted to the Pantanal area and the three other species are restricted to sandy habitats in the central part of state of Tocantins. *Bachia oxyrhina* is known only from sandy habitats at Estação Ecológica Serra Geral do Tocantins, a protected area in the Cerrados on the headwaters of tributaries from the east bank of the Rio Tocantins. *Bachia psamophila* and *Bachia micromela* were described recently from sandy habitats on the west bank of the Rio Tocantins. It is interesting to note that the last three species were recently collected and are possibly endemic to isolated sandy habitats. The possible restriction to isolated blocks of sandy depositional soils would agree to former descriptions of Cerrado lizard abundance and distribution patterns, largely dependent on the patchy horizontal structure of natural habitat mosaics (see Colli *et al.* 2002; Nogueira 2006; Pavan 2007; Nogueira *et al.* in press.), and strongly influenced by drastic variations in vegetation structure, topography and elevation. However, further detailed sampling is still necessary to understand the limits of the local distribution of *Bachia* in the Jalapão region, characterized by the complex contact of plateaus and depositional depressions. Although similar sandy habitats in the Caatingas of northeast Brazil have been recognized as an area rich in endemic squamates (Rodrigues 1996; Rodrigues & Juncá 2002), this has not been the case for the Cerrados (but see indications in Colli *et al.* 2002; Colli *et al.* 2003). The recently discovered new species of *Bachia* from sandy areas within the Cerrados suggests that these habitats may be richer than previously thought and should be the target of special concern in surveys and conservation measures.

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## Appendix 1. Specimens examined

*Bachia bresslaui*: MZUSP 4737 São Paulo, Brazil; MZUSP 10300 Utiariti, Mato Grosso, Brazil; MZUSP 78211 Bataguacu, Mato Grosso do Sul, Brazil; MZUSP 91658–91659 Brasília, Distrito Federal, Brazil; MZUSP 94473–94474 Parque Nacional Grande Sertão Veredas, Formoso, Minas Gerais, Brazil; MZUSP 95396–95399 Sonora, Mato Grosso do Sul, Brazil; *Bachia micromela*: MZUSP 91315–91318, 91030–91031 Guaraí, Tocantins, Brazil; *Bachia oxyrhina*: MZUSP 98080–98084 EESGT, Almas, Tocantins, Brazil; MZUSP 98086 Estação Ecológica Serra Geral do Tocantins, Mateiros, Tocantins, Brazil; *Bachia panoplia*: MZUSP 57329, 57561–57562, 57638–57639, 57852, 58814 Manaus, Amazonas, Brazil; *Bachia psamophila*: CHUNB 24209, MZUSP 95079–95080 UHE Luis Eduardo Magalhães, Tocantins, Brazil; *Bachia scolecoides*: MZUSP 3289–3295, 3337–3344 Rio Teles Pires, Mato Grosso, Brazil; MZUSP 38374 Sinop, Mato Grosso, Brazil; MZUSP 82525–82526 Fazenda Iracema, Claudia, Mato Grosso, Brazil.