

## A REVISION OF *ODONTOPHRYNUS BARRIOI* (ANURA: NEOBATRACHIA): MORPHOLOGY, OSTEOLOGY, VOCALIZATIONS, AND GEOGRAPHIC DISTRIBUTION

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**ABSTRACT:** The present paper provides diagnostic characters from external morphology and osteology that reinforce the specific recognition of the frog *Odontophrynus barrioi*, describes its advertisement and encounter calls, and extends its distribution range. *Odontophrynus barrioi* is distinguished from all other species of the genus principally by the large size of adults, great number of irregularly arranged postorbital and temporal glands, lack of both a light vertebral line and keratinous spines, alary process of the premaxilla short and wide, pterygoid process of the maxilla well developed, and high preorbital process of the maxilla. The advertisement call consists of a trill of a single repeated and pulsed note with a low dominant frequency. The encounter call consists of only one note of similar frequency as the advertisement call, but longer in time duration. We report new records of *O. barrioi* from Catamarca, La Rioja, and San Juan Provinces (Argentina), that increase considerably the range of this previously poorly known species.

**KEYWORDS:** Anura, Neobatrachia, *Odontophrynus barrioi*, external morphology, osteology, advertisement call, encounter call, geographic distribution, Argentina.

### INTRODUCTION

Frogs of the genus *Odontophrynus* Reinhardt an Lütken, 1862 currently consist of ten species distributed in southern and eastern South America (Frost, 2006), which are arranged in four species groups based on external morphology: *americanus*, *cultripes*, *mora-toi*, and *occidentalis* (Savage and Cei, 1965; Cei, 1987; Caramaschi, 1996). The *Odontophrynus occidentalis* species group is characterized by possessing enlarged postorbital, temporal, and parotoid glands, and other glands on the tibia, upper eyelid, and anterior surface of the forearm (Savage and Cei, 1965; Cei, 1987). This species group is associated with arid and subarid environments from western and central Argentina, and it is represented by three species: the widely distributed *O. occidentalis* (Berg, 1896); *O. achalensis* di Tada, Barla, Martori and Cei, 1984, which occurs in Pampa de Achala and Sierra de Comechingones highlands; and *O. barrioi* Cei, Ruiz and Beçak, 1982, which is restricted to Sierra de Famatina highland.

Adult external morphology, osteology, and karyology, together with larval characters were proposed to distinguish *O. barrioi* (Cei and Crespo, 1982; Cei *et al.*, 1982; Ruiz *et al.*, 1982; Crespo and Cei, 1983; Cei, 1987). Since its description, this species was only

known from the type specimens which were collected at Aguadita springs, 30 km north of Famatina, Sierra de Famatina, La Rioja Province, Argentina (Cei *et al.*, 1982). Posteriorly, Lavilla and Cei (2001) recorded *O. barrioi* from Río El Carrizal, Condor Huasi, Catamarca Province, extending the species range northwards. However, Lavilla *et al.* (2002) doubted that the specimens from Río El Carrizal really belonged to *O. barrioi*. Besides the above mentioned works, there are no studies about this species and its ecology and life history remain little known. Consequently, *O. barrioi* has been considered as a poorly known species (Lavilla *et al.*, 2000; Lavilla *et al.*, 2002; IUCN *et al.*, 2006).

During a revision of several herpetological collections we found specimens belonging to *O. occidentalis* from western Argentinean localities that possess morphological characters resembling *O. barrioi*. In addition, during a field trip to the type locality of *O. barrioi* we collected new specimens and recorded the advertisement and encounter calls of this species. In this paper, we: 1) review the diagnostic characters of *O. barrioi* and provide new ones in order to improve its diagnosis; 2) describe the advertisement and encounter calls; and 3) extend the distribution range of this species.

## MATERIAL AND METHODS

Type specimens of *O. barrioi* (MZUSP 57635, 57637-57639, MACN 38691) and *O. occidentalis* (MACN 380) were studied. Besides, specimens from 61 localities that embrace the distribution range of the three species of the *O. occidentalis* group were examined (see Appendix). Characters from external morphology and osteology presented by Cei *et al.* (1982), Crespo and Cei (1983), and Cei (1987) were reviewed. Nineteen measurements were taken by one of us (SDR) by using a Vernier caliper (to the nearest 0.05 mm) under a stereomicroscope (see Table 1). Specimens were considered as males when they possessed both a pigmented vocal sac and clearly developed nuptial pads on the thumbs. Traditional morphometric studies were performed using multivariate statistical methods (Reyment *et al.*, 1984; Bookstein *et al.*, 1985). Principal Component Analysis (PCA) were used to explore the morphometric variation independently of taxonomic assignment of specimens. MANOVA and Discriminant Analysis (forward stepwise method) were performed to test morphometric differences among the three species of the *O. occidentalis* group. Normality and homoscedasticity were evaluated by using the Lilliefors and the Bartlett tests, respectively. All analyses were performed from log<sub>10</sub>-transformed data by using the software STATISTICA 6.0 (StatSoft, 2001). We included only males because females were poorly represented in the herpetological collections. Osteological observations were made on nine cleared-and-stained adult specimens, which were prepared following the technique of Taylor and Van Dyke (1985). Drawings were made under a camera lucida attached to a Carl Zeiss stereomicroscope. Osteological nomenclature followed Lynch (1971) and Duellman and Trueb (1994).

On 1 and 2 March 2004, calls of *O. barrioi* were recorded at the type locality (Aguadita springs, Cuesta La Aguadita, 30 km north of Famatina, Km 36.5 of the Provincial Road 11, 28°45'S, 67°36'W, Famatina Department, La Rioja Province). Calls were recorded with a Panasonic RQ-L309 tape recorder equipped with a GBR EM-2000A unidirectional microphone. Water and air temperatures ( $\pm 1^\circ\text{C}$ ) were measured near each recorded male. Series of 4-21 advertisement calls of six different specimens were analyzed. Also, a series of 8 encounter calls of one specimen were measured. Vocalizations were analyzed with software Sound Forge 5.0 (Sonic Foundry, 2001) and Syrinx 2.3s (Burt, 2003) using a frequency of 44.1 kHz, 16 bit resolution. The nomenclature of the eleven mea-

sured bio-acoustical variables followed Duellman and Trueb (1994) (see Table 3).

## RESULTS

## External morphology

We reevaluated the diagnostic characters proposed by Cei *et al.* (1982) on type specimens of *O. barrioi* in order to improve the diagnosis of this species. In agreement with those authors, we found that the type specimens have: 1) nostrils nearer to the snout than to the eyes, in lateral profile; 2) lateral fringes poorly or not developed on fingers; 3) metatarsal tubercle shovel-like, moderately developed; and 4) short fore and hind limbs. Unlike other characters described by the above mentioned authors, we found that the type specimens of *O. barrioi* have (character states from original description in dashes): 5) eye length (mean = 6.0 mm) greater than eye-nostril distance (mean = 4.5 mm) – not equal –; 6) interorbital distance (mean = 9.0) equal or longer (depending on the landmarks) than the upper eyelid width (mean = 4.9) – not a half –; 7) tibia (mean = 19.5) shorter than femur (mean = 20.9) – not equal –; and 8) head length (mean = 19.4) approximately one third or more of the snout-vent length (mean = 50.6) – not a quarter –. However, all of these external morphological characters (1-8) do not diagnose *O. barrioi*, because we also found the same variations in the examined specimens of both *O. achalensis* and *O. occidentalis* (see Table 1).

As pointed out by Cei *et al.* (1982), we found that 9) large size of the adults; 10) presence of irregularly arranged rounded dorsal glands; and 11) lack of a light vertebral stripe, are diagnostic characters for *O. barrioi*. Furthermore, we found new ones: 12) presence of a great number of closely arranged post-orbital, temporal, and parotoid glands; 13) absence of keratinous spines; 14) presence of a well developed gland between the eye and the maxilla; and 15) presence of 1-3 medium sized glands (in the middle of the scapular region). Characters 9-14 differentiate type specimens of *O. barrioi* from *O. achalensis* and characters 9-12 and 14-15 differentiate *O. barrioi* from *O. occidentalis*.

Specimens collected by us at the type locality, and those studied in the herpetological collections from other Argentinean localities in the provinces of La Rioja, Catamarca, and San Juan presented the characters 9-15 mentioned, and consequently they were assigned to *O. barrioi*. Intrapopulation variation was

TABLE 1. Measurements of males of *Odontophrynus barrioi*, *O. occidentalis*, and *O. achalensis*. Values (in mm) are as mean  $\pm$  SD (range).

Variable	<i>O. barrioi</i> (n = 36)	<i>O. occidentalis</i> (n = 58)	<i>O. achalensis</i> (n = 20)
Snout-vent length (SVL)	57.21 $\pm$ 4.6 (46.5 – 67.5)	49.56 $\pm$ 5.04 (40.35 – 63)	44.97 $\pm$ 2.68 (39.9 – 49.4)
Head length (HL)	20.38 $\pm$ 1.54 (16.65 – 23.4)	19.10 $\pm$ 1.65 (15.7 – 22.4)	16.65 $\pm$ 0.91 (14.7 – 18.75)
Head width (HW)	25.34 $\pm$ 1.35 (21.85 – 27.45)	22.65 $\pm$ 2.35 (17.8 – 26.75)	19.46 $\pm$ 0.93 (18.05 – 21.6)
Internarial distance (IN)	3.45 $\pm$ 0.26 (3 – 4)	3.14 $\pm$ 0.33 (2.35 – 3.95)	2.89 $\pm$ 0.2 (2.55 – 3.3)
Interorbital distance (IO)	9.55 $\pm$ 0.64 (8.5 – 10.9)	8.53 $\pm$ 0.79 (6.7 – 10.7)	7.78 $\pm$ 0.42 (6.5 – 8.5)
Eye to nostril distance (EN)	4.73 $\pm$ 0.44 (4.1 – 5.7)	4.19 $\pm$ 0.35 (3.45 – 4.9)	3.68 $\pm$ 0.26 (3.25 – 4.15)
Upper eyelid length (EL)	7.72 $\pm$ 0.53 (6.75 – 9)	6.87 $\pm$ 0.67 (5.4 – 8.45)	6.56 $\pm$ 0.39 (5.85 – 7.6)
Upper eyelid width (EW)	5.45 $\pm$ 0.5 (4.45 – 6.5)	4.76 $\pm$ 0.48 (3.85 – 6.05)	4.33 $\pm$ 0.28 (3.8 – 4.75)
Eye diameter (ED)	6.47 $\pm$ 0.46 (5.6 – 7.95)	5.86 $\pm$ 0.62 (4.55 – 7)	5.46 $\pm$ 0.46 (4.85 – 6.3)
Maxilla to nostril distance (MN)	5.56 $\pm$ 0.41 (4.4 – 6.35)	5.11 $\pm$ 0.44 (4.1 – 6)	4.67 $\pm$ 0.3 (4.25 – 5.4)
Maxilla to posterior border of eye distance (ME)	8.3 $\pm$ 0.78 (7 – 9.9)	7.36 $\pm$ 0.74 (5.7 – 8.9)	6.35 $\pm$ 0.49 (5.45 – 7.15)
Arm length (AL)	30.36 $\pm$ 2.2 (25.05 – 33.8)	24.42 $\pm$ 1.97 (20.25 – 28)	21.96 $\pm$ 0.65 (20.7 – 23.3)
Third finger length (TFL)	8.12 $\pm$ 0.82 (6.1 – 10.6)	6.48 $\pm$ 0.56 (5 – 7.8)	5.53 $\pm$ 0.28 (4.75 – 6)
Femur length (FL)	24.72 $\pm$ 2.05 (19.95 – 28)	20.61 $\pm$ 1.92 (15.9 – 24.4)	18.77 $\pm$ 1.15 (17.2 – 20.7)
Tibia length (TL)	21.69 $\pm$ 1.46 (18.35 – 23.6)	18.29 $\pm$ 1.72 (14.6 – 21.3)	16.95 $\pm$ 0.77 (15.7 – 18.8)
Foot length (FOL)	39.01 $\pm$ 2.88 (33.05 – 42.15)	32.21 $\pm$ 2.51 (27.25 – 36.75)	29.05 $\pm$ 1.21 (27.35 – 32)
Fourth toe length (FTL)	14.37 $\pm$ 1.36 (12.1 – 17.25)	11.08 $\pm$ 1.05 (8.9 – 13.85)	10.29 $\pm$ 0.86 (8.5 – 12.3)
Inner metatarsal tubercle length (MTL)	5.99 $\pm$ 0.51 (4.9 – 6.85)	5.28 $\pm$ 0.48 (4.1 – 6.5)	4.45 $\pm$ 0.38 (3.7 – 5.2)
Inner metatarsal tubercle width (MTW)	3.38 $\pm$ 0.4 (2.7 – 4.35)	2.91 $\pm$ 0.32 (2.4 – 3.65)	2.65 $\pm$ 0.2 (2.35 – 3.05)

observed in shape, size, and number of the dorsal glands: 1-2 enlarged parotoid glands; lesser number of postorbital, temporal, and parotoid glands; short light vertebral stripe on the urostyle region (not very clear); and 2-3 small size glands between the eye and the maxilla. Specimens from Mutquín (28°19'S, 66°10'W, Catamarca Province), were unique in having some keratinous spines on the dorsum. As was pointed out by Ceï *et al.* (1982) and Ceï (1987), dorsal color pattern distinguishes *O. barrioi* from the other two species of the *O. occidentalis* group. In life, specimens from the type locality have light brown background; a series of dark brown warts, generally

associated with brown spots (greenish in some specimens); and two diffuse, dark brown blotches behind the nostrils. The iris is gold, marbled with dark brown; and showing an intense concentration of pigment at its anterior and posterior borders.

#### Morphometrics

Morphometric variation of the *O. occidentalis* species group was studied by means of the first three principal components of the PCA, which explained 84% of the total variance. Generally, the first principal component is considered to be related with differ-

ences in size and the others with differences in shape (Reyment *et al.*, 1984; Bookstein *et al.*, 1985). The variables of more contribution in accounting for separation along the principal components are: arm length, foot length, third finger length, fourth toe length, eye to nostril distance, internarial distance, upper eyelid length, and eye diameter. A plot of PC 1 vs. PC 2 (Fig. 1A) shows that there is considerable separation of specimens of *O. barrioi* from *O. achalensis*, but modest separation of *O. barrioi* from *O. occidentalis* and of *O. occidentalis* from *O. achalensis*. Specimens of *O. achalensis* are on positive values of PC 1, but a complete overlap exists with some specimens of *O. occidentalis*. Type specimens of *O. barrioi* and those from Catamarca, La Rioja and San Juan Argentinean Provinces are on negative values of PC 1, but overlap on more high values of PC 1 and PC 2 with specimens of *O. occidentalis*. Plot of the PC 2

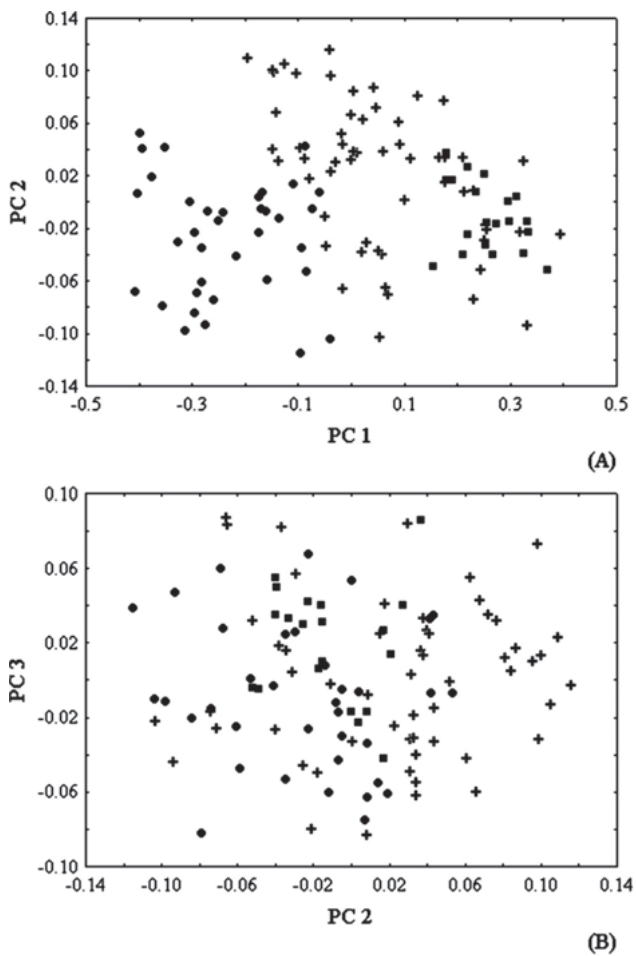


FIGURE 1. Plots of the PC 1 vs. PC 2 (A) and of the PC 2 vs. PC 3 (B) of the Principal Component Analysis showing specimens of *Odontophrynus barrioi* from Catamarca, La Rioja, and San Juan Provinces (circles), *O. achalensis* (squares), and *O. occidentalis* (crosses).

vs. PC 3 (Fig. 1B) shows a complete overlap among specimens belonging to different populations of the *O. occidentalis* species group.

Morphometric differences among the three species of the *O. occidentalis* group based on our assignment by external morphology, were tested by means of MANOVA and Discriminant Analysis. These analyses were performed by using raw data because all variables followed a normal distribution (Lilliefors test,  $P > 0.05$ ) and presented homoscedasticity (Bartlett test,  $P > 0.05$ ) within species. The MANOVA indicated significant differences of the variables among the adults of the three species of the *O. occidentalis* group (Wilks' lambda = 0.061,  $F(28,194) = 21.14$ ,  $P < 0.05$ ). The classification matrix showed the percent of specimens that were correctly classified: 91% for *O. occidentalis*, and 100% for both *O. achalensis* and *O. barrioi*; these results support the assignment of the specimens from Catamarca, La Rioja, and San Juan Argentinean Provinces to *O. barrioi*. The variables incorporated in the model, the classification functions, and the standardized coefficients for the roots of the Discriminant Analysis are in Table 2. Differences in arm length, head length, fourth toe length, inner metatarsal tubercule length, eye to nostril distance, and tibia length are the most important variables to discriminate among the three species of the *O. occidentalis* group. The canonical discriminant scores of the roots for *O. barrioi*, *O. achalensis*, and *O. occidentalis* are plotted in Fig. 2. Adult males of *O. barrioi* can be distinguished from *O. achalensis* and *O. occidentalis* by its larger size (see Table 1 for

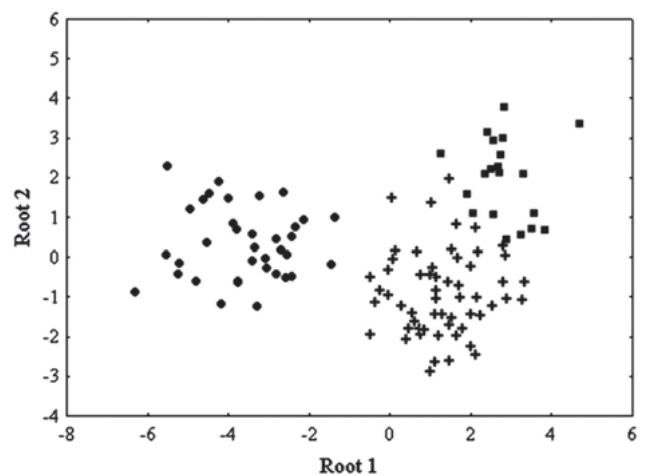


FIGURE 2. Plot of the two roots of the Discriminant Analysis showing specimens of *Odontophrynus barrioi* (circles), *O. achalensis* (squares), and *O. occidentalis* (crosses).

TABLE 2. Summary of the Discriminant Analysis between the measurements of *Odontophrynus barrioi*, *O. occidentalis*, and *O. achalensis*. Abbreviations as in Table 1.

Variables incorporated in the model			Classification function			Canonical discriminant	
Variable	Wilks' lambda	p-level	<i>O. occidentalis</i>	<i>O. barrioi</i>	<i>O. achalensis</i>	Root 1	Root 2
AL	0.094	0.00	920.16	1232.02	906.79	-1.790	0.810
HL	0.074	0.00	788.31	699.85	730.88	0.396	-0.906
FTL	0.080	0.00	269.09	360.42	271.32	-0.637	0.371
MTL	0.069	0.00	-278.21	-325.38	-323.26	0.189	-0.699
EN	0.073	0.00	311.71	388.06	280.75	-0.592	-0.079
TL	0.068	0.00	-1215.77	-1253.95	-1125.98	0.489	0.843
ED	0.066	0.02	-753.27	-767.97	-709.95	0.243	0.478
HW	0.067	0.01	116.55	92.82	51.66	-0.029	-0.817

descriptive statistics of the three species of the *O. occidentalis* group).

### Osteology

Lynch (1971) provided a complete osteological description of the genus *Odontophrynus* based on specimens of *O. occidentalis* among other species. Crespo and Cei (1983) proposed that *O. barrioi* could be distinguished from other species of the *O. occidentalis* group by means of ratios based on osteological characters on metamorphosed specimens. Unlike Crespo and Cei (1983), we found that the following ratios do not diagnose adult specimens of *O. barrioi*: tibiofibula length/fourth toe length; sacrum width/total length; sacrum width/vertebral column length; and skull length/total length. The osteology is quite homogeneous among the three species of the *O. occidentalis* group. Our findings indicate that *O. barrioi* can be distinguished from both *O. achalensis* and *O. occidentalis* as follows (Fig. 3): 1) skull more ossified

(nasals larger, bearing a well developed keel; palatines stronger, bearing a well developed ridge; both epiotic eminences and crista parotica relatively broad); 2) frontoparietals are mostly in median contact, not exposing the frontoparietal fontanelle; 3) short and wide alary process of the premaxilla; 4) high preorbital process of the pars facialis of the maxilla, less convex than in the other two species; 5) well developed pterygoid process of the pars palatina of the maxilla; 6) sphenethmoid well ossified, ventrally reaching the anterior margin of optic foramen; and 7) medial ramus of pterygoid in broad contact with otic capsule.

### Vocalizations

Calling males of *O. barrioi* were found in an area of ca. 30 x 100 m in the bed of the Aguadita stream (which dries seasonally). Vegetation of this site consists mainly of grasses, *Cortadeira* spp., *Salix* spp., and *Larrea* spp. Adults of *Rhinella arenarum* (Hensel); *Rhinella spinulosus spinulosus* (Wieg-

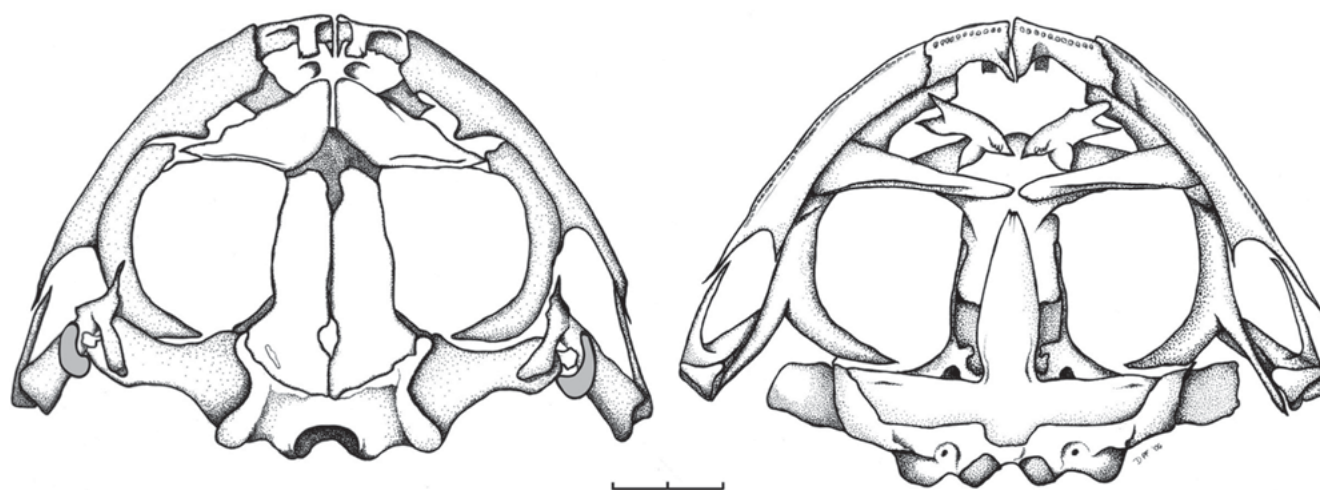


FIGURE 3. Dorsal (left) and ventral (right) views of skull of *Odontophrynus barrioi*, MLP A. 3872. Scale bar = 5 mm.

mann); and *Hypsiboas riojanus* (Koslowsky) were found in syntopy with *O. barrioi*. There were several puddles and small streams produced by natural springs, where *O. barrioi* breeds. Males of this species vocalized within the water, hidden among rocks and vegetation, each one placed approximately 5 m from other conspecific males. The highest number of calling males ( $N = 10$ ) was found on 1 March, between 9 and 11 p.m., with air temperature of 15 to 21°C. The advertisement call (Fig. 4, Table 3) consists of a note repeated for about 3 to 21 times (mean = 6). The notes are pulsed and consist of 6 to 23 pulses per note (mean = 10). The call is not frequency modulated.

On 1 March we found three males in a puddle of approximately 0.50 x 1 m (0.15 m depth), which were closely placed to each other (0.2 m). One male was silent all the time, whereas a second male always started its advertisement call before a third male started calling. On two occasions, a different vocalization was emitted by the third male. This call (Fig. 4, Table 3) consisted of only one note with 23 to 35 pulses, without frequency modulation (see Table 3). In spite of no aggressive or territorial behaviors among males were observed, we consider this vocalization as an encounter call following definitions of McDiarmid and Adler (1974), Wells (1977), and Zug *et al.* (2001).

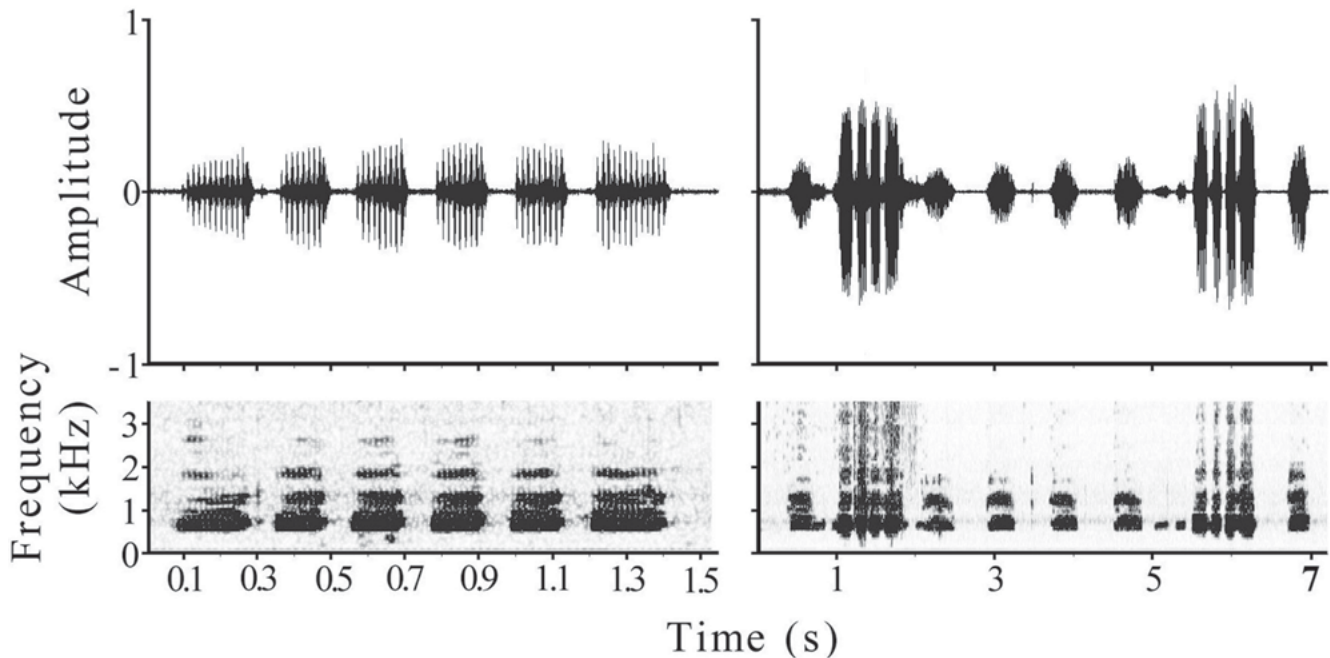


FIGURE 4. Oscillogram and spectrogram of advertisement call (left), and encounter call (right) of *Odontophrynus barrioi*. Note that the figure shows four encounter calls between two advertisement calls.

TABLE 3. Summary of bio-acoustical variables of advertisement and encounter calls of *Odontophrynus barrioi*. Values are as mean  $\pm$  SD (range).

Variable	Advertisement call	Encounter call
Call duration (ms)	1173 $\pm$ 470 (703 – 2056)	355 $\pm$ 63 (286 – 498)
Note duration (ms)	141 $\pm$ 8 (132 – 150)	–
Interval between notes (ms)	67 $\pm$ 8 (55 – 78)	–
Pulse duration (ms)	10 $\pm$ 1 (8.3 – 11)	8.2 $\pm$ 2.1 (3.1 – 17.9)
Interval between pulses (ms)	5 $\pm$ 1 (3.7 – 7)	5.0 $\pm$ 1.8 (1.3 – 10.5)
Number of notes / call	6 $\pm$ 1.9 (4.1 – 9.5)	–
Number of pulses / note	10 $\pm$ 0.6 (9.4 – 11.9)	–
Number of pulses / call	58 $\pm$ 17 (39 – 90)	27.1 $\pm$ 3.5 (23 – 35)
Number of notes / second	5.2 $\pm$ 0.45 (4.6 – 5.8)	–
Pulses / second	51.7 $\pm$ 5 (44.6 – 57)	76.8 $\pm$ 3.4 (70.3 – 80.5)
Dominant frequency (Hz)	641 $\pm$ 55 (568 – 730)	625 $\pm$ 31 (560 – 668)

## DISCUSSION

Our revision of the external morphology and osteology of *O. barrioi* revealed some differences with regard to the characters states previously proposed by Cei *et al.* (1982), Crespo and Cei (1983), and Cei (1987). We found that some of them were erroneously described (e.g., the interorbital distance), and others are really not diagnostic because we also found them in both *O. achalensis* and *O. occidentalis* (e.g., nostrils nearer to the snout than to the eyes). Three characters (fourth finger does not cross the groin when forelimb adpressed, tarso-metatarsal articulation does not reach between tympanum and eye when hindlimb adpressed, and heels in contact with hindlimbs bent at right angles to body) were difficult to evaluate and compare due to the different state of preservation of the specimens.

In agreement with the above mentioned authors, we confirmed some diagnostic characters, and we propose new ones. In summary, *O. barrioi* can be diagnosed by the following combination of characters: 1) presence of irregularly arranged rounded dorsal glands; 2) lack of a light vertebral stripe; 3) presence of a great number of closely arranged post-orbital, temporal, and parotoid glands; 4) absence of keratinous spines; 5) presence of a well developed gland between the eye and the maxilla; 6) presence of 1-3 medium size mid-scapular region glands; 7) light brown background with dark brown spots; 8) snout-vent length, arm length, tibia length, fourth toe length, head length, and head width larger than both *O. occidentalis* and *O. achalensis*; 9) skull more ossified; 10) frontoparietals in median contact; 11) short and wide alary process of the premaxilla; 12) high preorbital process of the pars facialis of the maxilla; 13) well developed pterygoid process of the pars palatina of the maxilla; 14) sphenethmoid well ossified, ventrally reaching the anterior margin of optic foramen; and 15) medial ramus of pterygoid in broad contact with otic capsule.

The advertisement call of *O. barrioi* is a trill constituted by a repeated and pulsed note, with similar structure to the calls of both *O. achalensis* and *O. occidentalis* (Barrio, 1964; Straneck *et al.*, 1993; Salas and di Tada, 1994; Martino and Sinsch, 2002). Nonetheless, the advertisement call of *O. barrioi* differs by having a longer note duration and a lower dominant frequency than the calls of the other species. The encounter call, when compared with the advertisement call, has a similar frequency, but differs by having only one note of longer duration and a greater pulse

number. This kind of call constitutes the first record for the genus *Odontophrynus*.

Wells (1977) argued that at low densities, males of explosive breeders often space themselves around breeding sites and call from stationary positions, just as was observed in the population of *O. barrioi* at Aguadita springs. Consequently, active searching may be rare or absent, and females can approach males at their calling sites and select them as mates. In this context, the encounter call could be important in close male-male communication when the resident (assumed to be the third male mentioned above) detects an intruder (assumed to be the second male mentioned above) as a potential competitor (McDiarmid and Adler, 1974). Thus, the encounter call could be a mechanism to maintain spatial separation among males (Wells, 1977; Duellman and Trueb, 1994).

The silent male possibly used a "parasitic" strategy (Wells, 1977). The release call of *O. occidentalis* described by Barrio (1964) from San Agustín del Valle Fértil (San Juan Province) is similar in several temporal and spectral characteristics when compared to the encounter call of *O. barrioi* described by us. We found in the herpetological collection created by Avelino Barrio only one male specimen (CENAI 348) collected by this herpetologist at San Agustín del Valle Fértil. Our finding indicates that this specimen, and as a consequence, the call described by Barrio (1964), belongs to *O. barrioi*.

Since its original description, *O. barrioi* was considered endemic to the Sierra de Famatina, La Rioja Province (Cei *et al.*, 1982; Cei, 1987). Based on our morphological, morphometric, and osteological studies we find that *O. barrioi* is known from 15 localities from Catamarca, La Rioja, and San Juan Argentinean Provinces (see Fig. 5 and Appendix for new localities). All these localities are situated in the Monte Biogeographic Province corresponding to the Chacoan Domain (Cabrera and Willink, 1973). Cei and Castro (1978a, b) recorded *O. occidentalis* from Río Las Tumanas and near Ischigualasto (San Juan Province). We did not find these specimens in any herpetological collection, but the specimen records could possibly be referred to *O. barrioi* based on geographic distribution. Villavicencio and Canovas (2001) recorded *Odontophrynus lavillai* Cei 1985 from Río Las Tumanas (San Juan Province); however, our study of the voucher specimen (IMCN-UNSJ 545) revealed that it is a juvenile of *O. barrioi*.

According to Ruiz *et al.* (1982), *O. barrioi* has a characteristic pattern of constitutive heterochromatin not found in other populations of the *O. occidentalis*

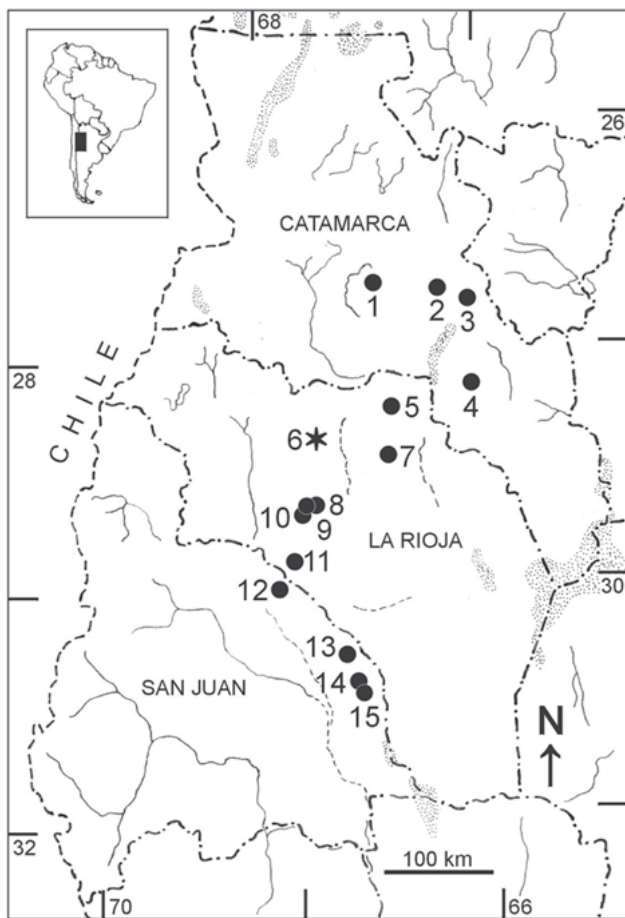


FIGURE 5. Geographic distribution of *Odontophrynus barrioi*. Localities are: 1) Río El Carrizal; 2) Km 51 Provincial Road 47, between Andalgalá and Capillitas; 3) Río Agua de las Palomas; 4) Mutquín; 5) Finca Aschá, near Aimogasta; 6) Aguadita springs (type locality); 7) Chuquis; 8) Cachiyuyal; 9) Cuesta de Miranda; 10) Km 527 National Road 40, near El Siciliano; 11) Parque Nacional Talampaya; 12) Ischigualasto; 13) San Agustín del Valle Fértil; 14) Río Las Tumanas; 15) Astica stream.

group. Moreover, Cei and Crespo (1982) found differences in larval morphology. Karyological and larval studies have not been carried out in the present work, but future analyses on these topics could provide more information about this species. The recognition of several new localities for *O. barrioi* increases considerably the range of the species and suggests that the conservation status of this previously poorly known species should be re-evaluated.

#### RESUMEN

El presente estudio proporciona caracteres diagnósticos de morfología externa y osteología que refuerzan el reconocimiento específico del anuro *Odontophrynus barrioi*, describe su canto nupcial y canto de en-

cuentro, y extiende su rango de distribución. *Odontophrynus barrioi* se diferencia de las otras especies del género principalmente por poseer tamaño mayor en los adultos, mayor número de glándulas postorbitales y temporales, distribuidas irregularmente, ausencia de línea vertebral y de espinas queratinosas, proceso alar de la premaxila corto y ancho, proceso pterigoideo de la maxila bien desarrollado, y proceso preorbital de la maxila alto. El canto nupcial consiste en un trino de una nota simple y repetida, con una frecuencia dominante baja. El canto de encuentro consiste en una única nota de frecuencia similar a la del canto nupcial, pero más larga en escala temporal. Reportamos nuevos registros de *O. barrioi* para las provincias de Catamarca, La Rioja y San Juan (Argentina), lo cual aumenta considerablemente el rango de esta especie escasamente conocida hasta el momento.

#### ACKNOWLEDGMENTS

We thank G. Carrizo (MACN); S. Kretzschmar, M. Cánepa, and E. Lavilla (FML); C. Mello and P. Narvaes (MZUSP); F. Lagiglia, R. Juárez, and I. Aguer (MHNSR); J. Villavicencio and G. Cánovas (UNSJ); E. Pereyra (IBA); and J. Williams and R. Almagro (MLP) for providing specimens and/or working space at their respective institutions. We thank W.R. Heyer and two anonymous referees for suggestions and comments on the manuscript. J.M. Cei and F. Videla provided information about the type locality of *O. barrioi*. D. Baldo, B. Blotto, L. Lanari, D. Podestá, and S. Barrionuevo collected specimens of *O. barrioi*. R. Herrera helped us with bio-acoustical analysis. We thank E. Lavilla, P. Narvaes, P. Camogli, C. Lanzone, R. Juárez, and I. Aguer for the accommodation during the development of this study. We thank the Servicio de Fauna Silvestre from La Rioja Province, Argentina, for providing collection permits. Financial support was provided in part by the PICT 01-03698 from the Agencia Nacional de Promoción Científica y Tecnológica from Argentina to NGB. This paper is the scientific contribution N° 798 of the Instituto de Limnología "Dr. R.A. Ringuelet".

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Received 01 April 2007

Accepted 27 July 2007

## APPENDIX

Abbreviations for institutions are: Centro Nacional de Investigaciones Iológicas, Buenos Aires, Argentina (CENAI, housed at MACN); Museo Argentino de Ciencias Naturales “Bernardino Rivadavia”, Buenos Aires, Argentina (MACN); Museo de La Plata, Buenos Aires, Argentina (MLP A.); Personal collection of J. D. Baldo donated to MLP (MLP DB.); Fundación Miguel Lillo, Instituto de Herpetología, Tucumán, Argentina (FML); Instituto de Biología Animal, Mendoza, Argentina (IBA); Museo de Historia Natural de San Rafael, Mendoza, Argentina (MHNSR); Instituto y Museo de Ciencias Naturales, Universidad Nacional de San Juan, San Juan, Argentina (IMCNUNSJ); Museu de Zoologia da Universidade de São Paulo, São Paulo, Brasil (MZUSP). Cleared and stained specimens are noted by CS, recorded specimens are noted by R.

*Odontophrynus barrioi*: Argentina: Catamarca Province: Andalgalá Department: Aconquija, Río Agua de las Palomas: FML 3245; Km 51 Provincial Road 47, between Andalgalá and Capillitas: FML 2182; Belén Department: Condor Huasi, Río El Carrizal: FML 3699 (7 specimens); Pomán Department: Mutquín: CENAI 1368-1371; La Rioja Province: Arauco Department: Aimogasta, Finca Aschá: MACN 24999; Castro Barros Department: Chuquis: MACN 37502-37503; Chilecito Department: Cachiyuyal: CENAI 642-647, 649, 1016-1018, 9823-9825, IBA 1645; Cuesta de Miranda: CENAI 255 (5 specimens); Famatina Department: Aguadita Springs, Cuesta La Aguadita, 30 km N Famatina: MZUSP 57635 (holotype), 57637-57639 (paratypes), MACN 38691 (ex MZUSP 57636) (paratype); MLP A. 3871, 3872-3873 (CS), 3874-3875, 3876-3878 (R), 3879-3880, 3883-3884 (R), 3885; General Lavalle Department: Km 527, National Road 40, near El Siliciano MLP DB. 2441, 3487; Independencia Department: Parque Nacional Talampaya: MLP A. 3718; San Juan Province: Jachal Department: Ischigualasto: MACN 12979-12982, 12983 (CS), 21433; Valle Fértil Department: Astica stream: MACN 35361; Río Las Tumanas: IMCN-UNSJ 545; San Agustín del Valle Fértil: CENAI 348.

*Odontophrynus achalensis*: Argentina: Córdoba Province: Hostería El Cóndor, Pampa de Achala: CENAI 2792, 2970-2973, 2975 (CS), 2976, 2977 (CS), 2978-2979; Pampa de Achala: MLP A. 694, CENAI 3542-3543, 3546, 3795-3797, 3862-3864, 4303, 4352, 4390-4391, 4484, MACN 24937, 33438-33439; Provincial Road 14, Ea Santo Tomás, 7 km Paraje El Cóndor: MLP A. 3926-3928.

*Odontophrynus occidentalis*: Argentina: Buenos Aires Province: Balneario Orense: CENAI 1652-1655, 1657-1659, 1663, MLP A. 1680; Claromecó: MACN 31951; Mascota: CENAI 1651; Monte Hermoso: CENAI 1660, MACN 28310; Córdoba Province: 2 km N Dean Funes: MACN 33914; Anisacate: IBA 1184; Capilla del Monte: MACN 20671, IBA 483; Cruz Chica: MACN 18337-18342; La Cumbre: MACN 24642-24644, 26228-26229 (CS), 26230-26231; Las Águilas stream: MLP A. 734; Mina Clavero: CENAI 3445, 3557, 4046, 5926-5927; Observatorio: MACN 34175-34176; Quebrada del Cóndor: MLP DB. 2615-2616; Río Ceballos: CENAI 7856; Río Cruz Grande: MACN 20601-20602, 20604-20605; Santa Rosa de Calamuchita: CENAI 91 (3 specimens), 209; Valle Hermoso: CENAI 74 (4 specimens); Chubut Province: Telsen MLP A. 3717; Verde stream and National Road 3: MACN 30346-30350; Mendoza Province: 5 km from Mendoza: IBA 2204 (15 specimens); Eugenio Bustos: IBA 2104; El Nihuil: MACN 29158, IBA 126 (3 specimens); La Primavera, 23 km E Mendoza: IBA 1346 (3 specimens); Los Toldos stream, 4 km W Los Toldos: IBA 2079 (2 specimens); Llanquanelo: MLP A. 596; Malargue: MLP A. 2142, IBA 1571 (4 specimens); San Rafael: MHNSR 50-51, 391, MLP A. 4382; Villa Atuel: MLP A. 3916 (CS); Neuquén Province: Río Agriero: CENAI 112; Agriero stream: MACN 380 (holotype of *O. occidentalis*); Bajada del Agriero: IBA 1314 (7 specimens); Río Negro Province: El Rincón: MLP A. 4384, 4385 (CS); General Conesa: MLP A. 2144; General Roca: CENAI 360-361; Meseta de Somuncurá: MACN 38689-38690; Nahuel Niyeu stream: MACN 28405; Valcheta stream: IBA 2036 (8 specimens); Viedma: MACN 29029; Villa Regina: MACN 31385; San Luis Province: Cerro Retana: MACN 38685-38687; El Trapiche: IBA 1315 (6 specimens); La Carolina: MACN 38688, 29866; Papagayo: MACN 29367-29368.