



***Liolaemus goetschi* (Iguania: Liolaemidae): redescription and phylogenetic relationships within the *L. boulengeri* group**

JAVIER NORI^{1,5}, CRISTIAN SIMÓN ABDALA^{2,3,4} & GUSTAVO JOSÉ SCROCCHI^{2,3}

¹Centro de Zoología Aplicada, Facultad de Ciencias Exactas, Físicas y Naturales, Universidad Nacional de Córdoba. Rondeau 798, Córdoba (5000), Argentina. Museo Patagónico de Ciencias Naturales. Av. Roca 1250, General Roca, Río Negro Argentina. 54–2941–420030. E-mail: javiernori@gmail.com

²Consejo Nacional de Investigaciones Científicas y Técnicas, CONICET

³Instituto de Herpetología, Fundación Miguel Lillo Facultad de Ciencias Naturales e IML. Miguel Lillo 251. 4000. Tucumán. Argentina. 54- 381- 4230056

⁴Facultad de Ciencias Naturales e IML. Miguel Lillo 205. 4000. Tucumán. Argentina

⁵Corresponding author. E-mail:javiernori@gmail.com

Abstract

The genus *Liolaemus* is a widely distributed and very diverse natural group of lizards. The *L. boulengeri* group is characterized by the presence of a patch of enlarged scales on the posterior medial surface of the thigh. *Liolaemus goetschi*, which belongs to this group, was described by Müller and Hellmich in 1938 based on few specimens collected from Laguna Playa (Río Negro Province, Argentina). Those specimens were deposited in museums in Munich (Germany) and Breslau (Poland). The type material of *L. goetschi* deposited in Poland was lost and because the material in Germany is of difficult access, many populations of other species have been confused with *L. goetschi* in subsequent works. In this work, *L. goetschi* was redescribed by using the characters currently designated for the group and the known distribution of the species was extended. The taxonomic status and phylogenetic relationships of *L. goetschi* within the *L. boulengeri* clade was also analyzed, especially with respect to *L. melanops* and *L. martorii*.

Key words: *Liolaemus goetschi*, *L. boulengeri* group, type locality, morphological characters, Río Negro, Argentina

Resumen

El género *Liolaemus* es un grupo natural de saurios muy diverso y ampliamente distribuido. El grupo de *L. boulengeri* se caracteriza por la presencia de un parche de escamas agrandadas en la región postero-medial del muslo. A dicho grupo pertenece *L. goetschi*, especie descrita por Müller y Hellmich en 1938 en base a unos pocos especímenes colectados en Laguna Playa (Río Negro, Argentina). Dichos ejemplares fueron depositados en colecciones herpetológicas de los museos de Munich (Alemania) y Breslau (Polonia). Desafortunadamente, el material depositado en Polonia fue perdido, y debido al difícil acceso al material de Alemania, varios autores no pudieron estudiarlo y varias poblaciones de otras especies fueron confundidas con *L. goetschi* en trabajos posteriores. En el presente trabajo se redescrive la especie en base a los caracteres corrientemente utilizados para el grupo y se amplía su distribución conocida. Además, se analiza el status taxonómico de *L. goetschi* y sus relaciones filogenéticas principalmente con *L. melanops* y *L. martorii*.

Introduction

The genus *Liolaemus* is a very diverse group of saurians composed of more than 200 described species, with more species being described currently (Abdala & Lobo 2006; Scolaro & Cei 2006; Avila *et al.* 2007; Pincheira-Donoso *et al.* 2007; Abdala & Quinteros 2008; Abdala *et al.* 2008; Quinteros *et al.* 2008). The genus has a wide latitudinal and altitudinal distribution, encompassing a vast portion of South America, from

the Atlantic to the Pacific coasts, and from Peru to Tierra del Fuego, the southernmost portion of the continent. It inhabits diverse phytogeographical regions of Argentina, Bolivia, Brazil, Chile, Paraguay, Peru and Uruguay (Abdala 2007). The genus includes insectivorous, herbivorous, and omnivorous species (Espinoza *et al.* 2004). The variety in color pattern, size and morphology makes the study of the genus even more attractive.

Within *Liolaemus*, several phylogenetic hypotheses have been proposed (Laurent 1985; Etheridge 1995; Schulte *et al.* 2000; Lobo 2001, 2005; Morando *et al.* 2004; Avila *et al.* 2006; Abdala 2007). The *Liolaemus boulengeri* group of species was characterized by the presence of a patch of enlarged scales on the posterior medial surface of the thigh (Etheridge 1995) and by the hypertrophy of the puboischiotibialis muscle (Abdala *et al.* 2006). However, based on a total evidence phylogenetic analysis, Abdala (2007) indicated that the presence of a femoral patch is the apomorphy that characterizes the *L. boulengeri* group. At present, more than 70 species are included in this large group.

Within the *Liolaemus boulengeri* group, the *L. goetschi* group includes medium to large-sized oviparous and insectivorous species related to psammophilous habitats (Abdala 2007). The *L. goetschi* group is currently composed of the *L. cuyanus* and *L. fitzingeri* groups plus *Liolaemus josei* (Abdala 2007). The group of *L. cuyanus* includes *L. goetschi*, a species described by Müller and Hellmich (1938) based on six specimens collected from Laguna Playa (Río Negro Province) and deposited at the herpetological collections of Zoologische Staatssammlung München (ZSM), Munich (male holotype and a female paratype) and at the Museum of Natural History Wrocław University (MNHHWU), Breslau (two male and two female paratypes). Unfortunately, part of the individuals of the type series of *Liolaemus goetschi* are lost: at our request of the type material, Dr. Renata Brasinska (*in litt.*), curator of the herpetological collection from the MNHHWU replied: "I believe that all the Herpetological Types that we had have been lost, destroyed or their labels lost". The other part of the type series (deposited in Munich) does not seem to be available as the curator of the ZSM never replied to our requests.

The lack of the type material led to *Liolaemus goetschi* being confused with other lizard species, as can be shown in several studies (Cei & Scolaro 1977, 2003; Pincheira-Donoso *et al.* 2008). At present, specimens labeled as *L. goetschi* in scientific collections do not correspond to the species and have not been collected from the type locality or neighboring sites.

Using the precipitin serological technique, Cei and Scolaro (1977) synonymized *Liolaemus goetschi* (represented by specimens captured near Catriel, Río Negro, at sites far from the type locality) with *L. melanops* (Burmeister 1888), a widely distributed polymorphic species (north of Chubut River, Sierra Colorada and Valdés Peninsula). The synonymy proposed by Cei and Scolaro (1977) was based on two facts: the populations they considered *Liolaemus goetschi* could not be distinguished from the material they considered *L. melanops* and the close phylogenetic relationship was indicated by serological tests. Twenty-six years later, Cei and Scolaro (2003) revalidated *L. goetschi* as a species different from *L. melanops*, but did not provide supporting evidence.

More recently, Pincheira-Donoso *et al.* (2008) proposed a possible synonymy between *Liolaemus goetschi* and *L. martorii*, a species described by Abdala (2003) that inhabits the area near the locality of Las Grutas (Río Negro), more than 300 km away from the known distribution of *L. goetschi*. The description of *L. martorii* by Abdala (2003) did not include a comparison with *L. goetschi*, since at that moment the latter was considered a synonym of *L. melanops* (Cei & Scolaro 1977).

In this work, a representative sample of *L. goetschi* was collected from the type locality and neighboring areas. Since the taxonomic status of this species has been problematic, it has been redescribed on the basis of the characters currently used for the group, and its known distribution has been extended. In addition, this reference material was used to study the validity of the species, and a new phylogenetic analysis was conducted to clarify its phylogenetic relationship within the *L. boulengeri* group as well as its taxonomic relationship with *L. melanops* and *L. martorii*.

Materials and methods

Nine females and 11 males of *Liolaemus goetschi* were studied (18 of them collected from Laguna Playa). The specimens were deposited in herpetological collections of Fundación Miguel Lillo (FML) (Tucumán, Argentina) and Museo Patagónico de Ciencias Naturales (MPCN) (General Roca, Río Negro, Argentina). In addition, we examined: 13 individuals of *L. martorii* (holotype and paratypes) from the FML collection, 15 specimens of *L. cf. cuyanus* (considered *L. goetschi* by Cei and Scolaro, 1977) and 3 individuals of *L. melanops* (from the type locality: Sierra Colorada, Chubut) from the collection of the Instituto de Biología Animal (IBA) (Facultad de Ciencias Agrarias, Universidad Nacional de Cuyo, Mendoza, Argentina). Nine specimens of *L. melanops* were also examined from the collection of the Museo de Ciencias Naturales de Salta (MCN) (Salta, Argentina). The material examined is listed in Appendix 1.

The characters considered were those currently studied in *Liolaemus*, which were described or cited mainly by Laurent (1985), Etheridge (1993, 1995, 2000), Cei (1986), Lobo (2001), and Abdala (2002, 2003, 2005). Neck fold terminology follows Frost (1992).

Description of coloration in life was based on field observations and photographs taken at the moment of capture. Terminology for body color pattern follows Lobo and Espinoza (1999) and Abdala (2007). Scale observations were made using a stereoscope (10 – 40x) and body measurements were taken with a caliper to the nearest 0.02 mm. Specimens were captured by noose, fork or by hand (avoiding the use of aggressive methods to maintain the integrity of the samples), then euthanased with pericardic injection of sodium pentotal (Abbot®), fixed in 10% formalin and maintained in 70% ethanol. Internal characters were analyzed using simple anatomical preparations. Behavioral data were recorded from observation of live individuals during capture.

To establish the phylogenetic position of *Liolaemus goetschi*, 128 morphological characters of *L. goetschi* individuals were replaced in the matrix used by Abdala (2007) in the morphological analysis and analyzed using TNT (Goloboff *et al.* 2003). The phylogenetic analysis was made under parsimony optimality criterion, under equally weighted and implied weighting (Goloboff 1993) with a concavity value $k = 3$. Optimal trees were searched using branch swapping (TBR - Tree Bisection Reconnection) with 1000 replications and saving 20 trees for each replication.

Results

Redescription (based on 20 specimens)

Liolaemus goetschi Müller and Hellmich, 1938

(Fig. 1–3)

1938. *Liolaemus goetschi*. Müller and Hellmich. Zoologischer Anzeiger, 123(5–6): 130–142.
1977. *Liolaemus melanops*. Cei, J. M. and J. A. Scolaro. Physis (Buenos Aires), 36: 225–226.
2003. *Liolaemus goetschi*. Cei and Scolaro. Facena, 19: 163.
2006. *Liolaemus goetschi*. Avila *et al.* Biol. J. Linnean Soc., 89: 241–275.
2007. *Liolaemus goetschi*. Abdala. Zootaxa, 1538: 1–84.
2008. *Liolaemus goetschi*. Pincheira Donoso, *et al.* Zootaxa, 1800: 1–85.
2010. *Liolaemus goetschi*. Nori *et al.* Check List, 6(1): 6–4.

Holotype. ZSM 4. Adult male, Laguna Playa, approximately 20 km north of General Roca, Río Negro Province, Argentina, W. Goetsch, 1938.

Paratype. ZSM 5. Adult female, Laguna Playa, approximately 20 km north of General Roca, Río Negro Province, Argentina, W. Goetsch, 1938.

Type locality. In the original description of *Liolaemus goetschi*, the authors designated Laguna Playa as the type locality of *L. goetschi* (approximately 20 km north of General Roca city, the site where Prof. Dr. Goetsch collected all the individuals corresponding to the type series) as the type locality of *L. goetschi*.



FIGURE 1. Dorsal view of adult male of *Liolaemus goetschi* from the type locality



FIGURE 2. Ventral view of adult male of *Liolaemus goetschi* from the type locality

Because the toponym “Laguna Playa” is not included in maps and records of the area and is unknown to local people, we conducted extensive surveys among rural people to locate the site. Finally, an elderly inhabitant of the nearest city (General Roca) informed us about the place and following his directions, we were able to find the exact place, located at 30° 52’ 59” S and 67° 34’ 08” W. The *Liolaemus goetschi* individuals were collected in subsequent intensive field surveys.

Diagnosis. *Liolaemus goetschi* belongs to the *L. boulengeri* group because of the presence of the femoral patch of enlarged scales in the posterior surface of the femur (Etheridge 1995). Within this group, *L. goetschi* is distinguished from the *L. anomalus* group because of the hypertrophy of the puboischiotibialis muscle

(Abdala *et al.* 2006), higher percentage of tail autotomy, tail longer than snout-vent length (SVL), head longer than wide, outer cilliaris not projecting and higher number of preloacal pores in males. It also differs from the species of the *L. wiegmanni* group in having a row of lorilabials between subocular and supralabials and four scales surrounding the mental (Etheridge 2000).



FIGURE 3. Dorsal view of adult female of *Liolaemus goetschi* from the type locality

Liolaemus goetschi differs from species of the *L. laurenti* group (Abdala 2007), *L. abaucan*, *L. albiceps*, *L. calchaquí*, *L. chacoensis*, *L. crepuscularis*, *L. darwini*, *L. espinozai*, *L. grosseorum*, *L. irregularis*, *L. koslowskyi*, *L. laurenti*, *L. lavillai*, *L. olongasta*, *L. ornatus*, *L. quilmes* and *L. uspallatensis* in having posterior teeth with strongly cusped crowns and expanded margins, and in the presence of barely evident sexual dichromatism (Abdala 2007). Females of *L. goetschi* lack preloacal pores; this character distinguishes the species from *L. albiceps*, *L. calchaquí*, *L. crepuscularis*, *L. irregularis*, *L. lavillai* and *L. ornatus* because a high percentage of females of all these species have 1–6 preloacal pores (Abdala 2007). Within the *L. melanops* group (Abdala 2007), *L. goetschi* differs from *L. canqueli*, *L. fitzingerii*, *L. melanops*, *L. rothi*, *L. sagei*, and *L. xanthoviridis* in having a shorter snout-vent-length (SVL) (max SVL 74.25 mm vs. 89.00–106.00 mm) and because of the presence of pre and postscapular spots (absent in these species). It also differs from *L. canqueli* and *L. melanops* because of the absence of the cephalic melanism typical of these species. It differs from *L. rothi* and *L. sagei* in the more conspicuous gular melanism (Abdala 2007) and from *L. morenoi* in its smaller size and lower number of scales around the midbody (72–85 Mean = 79.00 vs. 62–72 Mean = 66.35). *Liolaemus goetschi* differs from *Liolaemus inacayali* by the presence of pre and postscapular spots and a lower number of scales from occiput to thigh (73–84, Mean = 77.50 vs. 83–96, Mean = 88.75) (Abdala 2003). It differs from *L. cheuachekenk* in having a shorter maximum SVL (74.25 mm vs. 98.30 mm), in the presence of four to six scales in contact with the mental scale (*L. cheuachekenk* always presents four), in the absence of abdominal and pectoral melanism and in the presence of a different color pattern (Avila *et al.* 2008). *L. goetschi* differs from *L. puelche* in its smaller size (max SVL 74.25 mm vs. 89.00 mm in *L. puelche*), lower number of scales around midbody (62–72, Mean = 66.35 vs. 67–76, Mean = 70.75), gular melanism and two series of well defined black paraventral spots, absent in *L. puelche* (Avila *et al.* 2007).

Within the *Liolaemus cuyanus* clade (Abdala 2007), composed of *L. mapuche*, *L. cuyanus*, and *L. donosobarrosi*, *L. goetschi* differs from the first two species in having smaller SVL (max SVL 74.25 mm vs. 79.00 and 102.00 mm, respectively) and a clearly different color pattern that never has a black antehumeral arch (Abdala 2002). It differs from *L. donosobarrosi* in having longer SVL (max SVL 74.25 mm vs. 60.80 mm), a lower number of scales around the midbody (62–72, Mean = 66.30 vs. 79–95, Mean = 85.40) and a different color pattern (Abdala 2005, 2007).

Liolaemus goetschi differs from *L. boulengeri*, *L. josei*, *L. lobo*, *L. senguer*, *L. tehuelche* and *L. telsen*, in having a faint prescapular spot and a larger postscapular spot; two black spots usually band- or line- shaped on each side of the gular region; belly in males and females white or light pink, never yellow, red or bright blue;

anterior throat in males never melanic and sexual dichromatism absent or barely marked. It also differs from *L. martorii* in having a longer SVL (max SVL 74.25 mm vs. 67.10 mm), and four to six scales in contact with mental scale (*L. martorii* always has four); *L. goetschi* also has a higher number of light blue scales in tail and body; also scapular spots and spots on the sides of body that are larger and more marked (Table 1).

TABLE 1. Main differences between *Liolaemus goetschi*, *L. melanops* and *L. martorii*.

Character	<i>L. goetschi</i> (n = 20)	<i>L. martorii</i> (n = 13)	<i>L. melanops</i> (n = 13)
Maximum SVL	74.25 mm	67.10 mm	79.66 mm
Cephalic melanism	Absent	Absent	Present
Light blue scales on body sides	Abundant	Scarce	Variable
Size and color of scapular spots of body	Large and marked	Middle-sized and light	Variable
Number of scales in contact with the mental	4 to 6	4 (always)	6 (always)
Tail length	93.00 to 105.90 mm, (Mean = 98.20 mm)	86.10 to 92.30 mm, (Mean = 87.30 mm)	81.90 to 116.50 mm, (Mean = 106.10 mm)
Head length	13.40 to 17.50 mm, (Mean = 15.50 mm)	13.00 to 15.80 mm, (Mean = 14.60 mm)	13.30 to 16.70 mm, (Mean = 14.60 mm)
Hand length	7.60 to 9.90 mm, (Mean = 8.26mm)	6.90 to 8.20 mm, (Mean = 7.40 mm)	7.40 to 10.90 mm, (Mean = 8.48 mm)
Gular scales	30 to 36, (Mean = 32.80)	32 to 39, (Mean = 34.6)	33 to 42, (Mean = 36.5)
Dorsal body scales	68 to 78, (Mean = 72.70)	64 to 80, (Mean = 76.20)	73 to 84, (Mean = 77.50)

External morphology. Maximum SVL 74.25 mm (56.20 mm – 74.25 mm; Mean = 65.80 mm); tail length (93.00 mm – 105.90 mm; Mean = 98.20 mm); 1.4 times longer than SVL. Head 1.28 times longer (12.10 mm – 17.55 mm; \bar{x} = 14.54 mm) than wide (9.20 mm – 12.55 mm; Mean = 11.31 mm). Head height (6.70 mm – 14.10 mm, Mean = 8.59 mm). Humerus length (7.10 mm – 10.70 mm, Mean = 8.27 mm). Radius length (6.60 mm – 9.20 mm; Mean = 8.11 mm). Hand length (7.60 mm – 9.90 mm, Mean = 8.26 mm). Tibial length (10.00 mm – 14.15 mm, Mean = 11.68 mm).

Dorsal head scales smooth, convex and bulged. Scale organs distributed in postrostrals, internasals, frontonasals and prefrontals. Rostral pentagonal wider than long. Two postrostrals in contact with anterior supralabials. 15–18, (Mean = 16.25) dorsal head scales, from rostral to occiput (Hellmich Index). Nasal scales subpentagonal and in dorsolateral position. Eighth to 12 scales surrounding nasal. Frontal scale irregularly shaped, slightly longer than prefrontals. Interparietal pentagonal with a conspicuous pineal eye and surrounded by seven scales. Two parietals of irregular shape and larger than interparietals. Interparietal in contact with 6–10 (Mean = 7.30) scales. 9–14 (Mean = 12.30) circumorbitals. 6–8 (Mean = 7.15) laterally expanded supraoculars. Two rows of small scales between supraoculars and supercilliaris. 6–10 (Mean = 7.80) elongated and overlapped supercilliaris. One preocular longer than wide; one elongated subocular and one small postocular. A single row of 6–7 (Mean = 6.9) convex lorilabials. Supralabials 7–10 (Mean = 8.50) subquadrangular and elongate. Temporal scales 17–22 (Mean = 19.10) smooth and juxtaposed. Auditory meatus 1.86 times higher (2.30 mm – 4.00; Mean = 3.08) than wide (1.30 mm – 2.10 mm; Mean = 1.68 mm) surrounded by small granular scales. Mental scale pentagonal, wider than high in contact with 4–6, (Mean = 4.70) scales. Infralabials, 6–8, (Mean = 6.80) large and subquadrangular. Gular scales 30–36 (Mean = 32.80) smooth and imbricate. Y-shaped horizontal fold. Dorsal scales at midbody subtriangular, moderately imbricate and keeled, arranged in 22 longitudinal rows. Ventral scales along body midline: 79–89 (Mean = 74.15), smooth and moderately imbricate, subtriangular, of equal size or slightly larger than dorsal scales at midbody. 11–15 pigals (Mean = 12.55). 4–8 (\bar{x} =4.70) precloacal pores in males, absent in females. 62–72 (Mean = 66.35) scales around midbody. 68–78 (Mean = 72.70) dorsal scales of midbody from occiput to hind limbs.

Suprahumeral and supraradial keeled and imbricate. Supratarsals smooth and imbricate. Infratarsals strongly imbricate. Supracarpals smooth and imbricate. Infracarpals keeled and imbricate. Supradigital lamellae smooth and imbricate. Infradigital lamellae tricarinate and imbricate. Fourth finger with 17–22 (Mean = 19.30) scales. Suprafemorals imbricate and rhomboidal. Infracarpals smooth, imbricate and rhomboidal. Supratibials keeled and imbricate. Bulged femoral patch with 20–25 scales. Infratibials and supradigitals smooth and imbricate. Infradigitales tricarenate.

Coloration. Males and females with slightly different coloration pattern. In most males, numerous light blue scales can be observed on the sides of tail and fewer on the sides of body and head. In females, these colors are absent in the scales. Dorsal color of females is more yellowish and usually white immaculate ventrally.

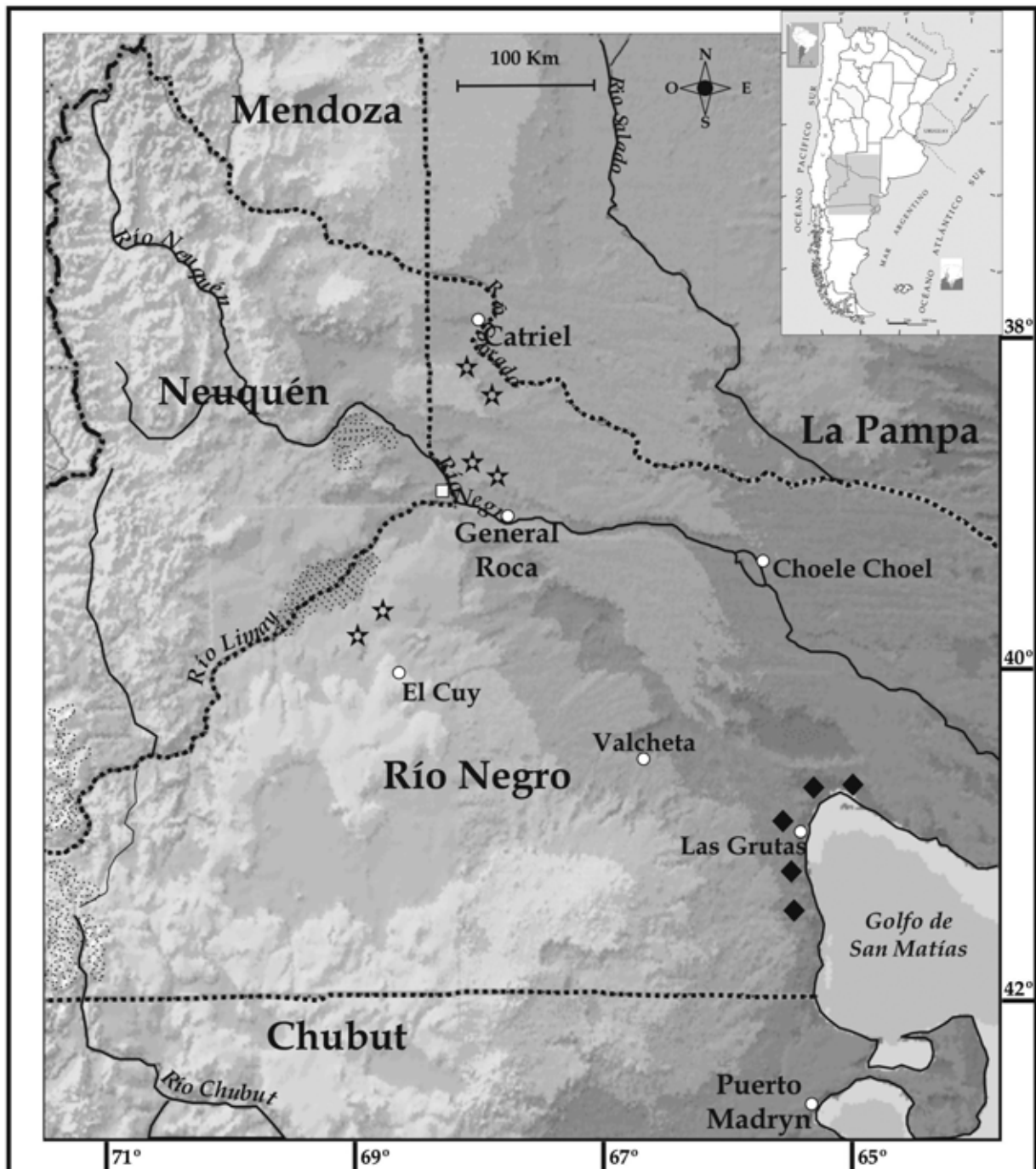


FIGURE 4. Map showing the known distribution of *Liolaemus goetschi* and *L. martorii*. Stars: localities where *L. goetschi* were located. Rhombuses: localities where *L. martorii* were located.

Dorsum of head brown, with irregularly spread black spots. Nasal scale slightly lighter. A black band extends from the posterior zone of the eye to the upper lip margin. This band is bordered anteriorly and posteriorly by white spots. Also, a dark line posterior to the eye is present. Dorsal background coloration light brown. Also, has pre and postscapular spots, the latter larger than the former. Four series of black subquadrangular spots are present, two paravertebral and two lateral; both edged posteriorly by a white band. Nine to 12 black paravertebral spots are present, which are larger and more marked than the lateral spots. Paravertebral spots extend to the dorsal tail proximally to fuse, forming irregular spots less marked than those in the body. Anteriorly to the paravertebral spots, a reddish subquadrangular spot may be present. In many specimens, the vertebral region has isolated yellowish scales.

Sides of body brown, slightly lighter than dorsum. Lateral region of tail and dorsal region of limbs light brown, similar to that of the body sides and slightly lighter than dorsum. Background of throat, chest and belly white or light pink. Ventral gular region is melanic or dark, reticulate anteriorly, variegated with gray to black lines.

Natural history. This is a typical psammophylus lizard of the Monte phytogeographical region (Cabrera, 1976). Vegetation in the area is typical of the Monte, with dominance of *Atriplex lampa*, *Cercidium praecox*, *Larrea divaricata*, *L. nítida* and *L. cuneifolia*. *Liolaemus goetschi* seems to be most related to *Larrea* species. The species is difficult to observe and capture; individuals were found mainly at the time of the day when sand surface temperatures reach the highest values, between 13:00 and 15:00 hours. It is a relatively quiet species that, when chased, tends to hide and stay still or seek refuge in small caves. Most of the species studied in the group are oviparous and omnivorous (Abdala 2007); we suppose that this species shares the same characteristics. During field work, we observed some specimens feeding on ants and insect larvae.

Distribution (Fig. 4). *Liolaemus goetschi* inhabits the province of Río Negro. This species was found in its type locality (Laguna Playa), in Cerro Policia Town (Nori *et al.* 2010) and at 20 and 50 km south of the locality of Catriel.

The specimens collected south of Catriel did not show morphological differences that enabled us to assume that they belong to a species different from the species of those specimens collected in Laguna Playa. All the individuals are representatives of *Liolaemus goetschi*. Müller and Hellmich (1938) mentioned the existence of *Liolaemus* populations south of Catriel that might correspond to the same species. This assumption is supported by the specimens studied in the present work.

Phylogenetic position. The results of the phylogenetic analysis based on the morphological data matrix provided by Abdala (2007) and the incorporation of the 128 characters of *Liolaemus goetschi* from the type locality are presented in Figure 5. Here *Liolaemus goetschi* is included in the *L. telsen* group, which comprises: *L. boulengeri*, *L. goetschi*, *L. josei*, *L. lobo*, *L. martorii*, *L. tehuelche*, *L. telsen* and *L. senguer*. In our analysis, *L. goetschi* and *L. martorii* appear as sister species; this hypothesis suggests a close phylogenetic relationship between the two species. *L. telsen* group is part of the *L. melanops* group, which is included in the *L. chacoensis* group, all of them within the *L. boulengeri* group.

Discussion

The status of *Liolaemus goetschi* has been a matter of controversy since it was first described. The species has not been recorded in the type locality or neighboring areas after its description. Laguna Playa (the type locality) used to be frequently visited by inhabitants of General Roca years ago; at present, however, the site is no longer common and has turned into an unknown place for the local people.

Although *Liolaemus goetschi* was confused with *L. melanops* (Cei & Scolaro 1977), after comparing the specimens of *L. melanops* with those of *L. goetschi* from the type locality, we concluded that both species exhibit evident differences in lepidosis, body measurements and color patterns (Table 1). These differences lead us to disagree with the hypothesis of Cei and Scolaro (1977) and to provide the evidence needed for the revalidation of *L. goetschi* proposed by Cei and Scolaro (2003) and therefore to state that both species (*L. goetschi* and *L. melanops*) are valid. The specimens studied by Cei and Scolaro (1977), identified as *L.*

goetschi, were studied in this work and the results show that they do not belong to *L. goetschi*, but are probably close to *L. cuyanus*.

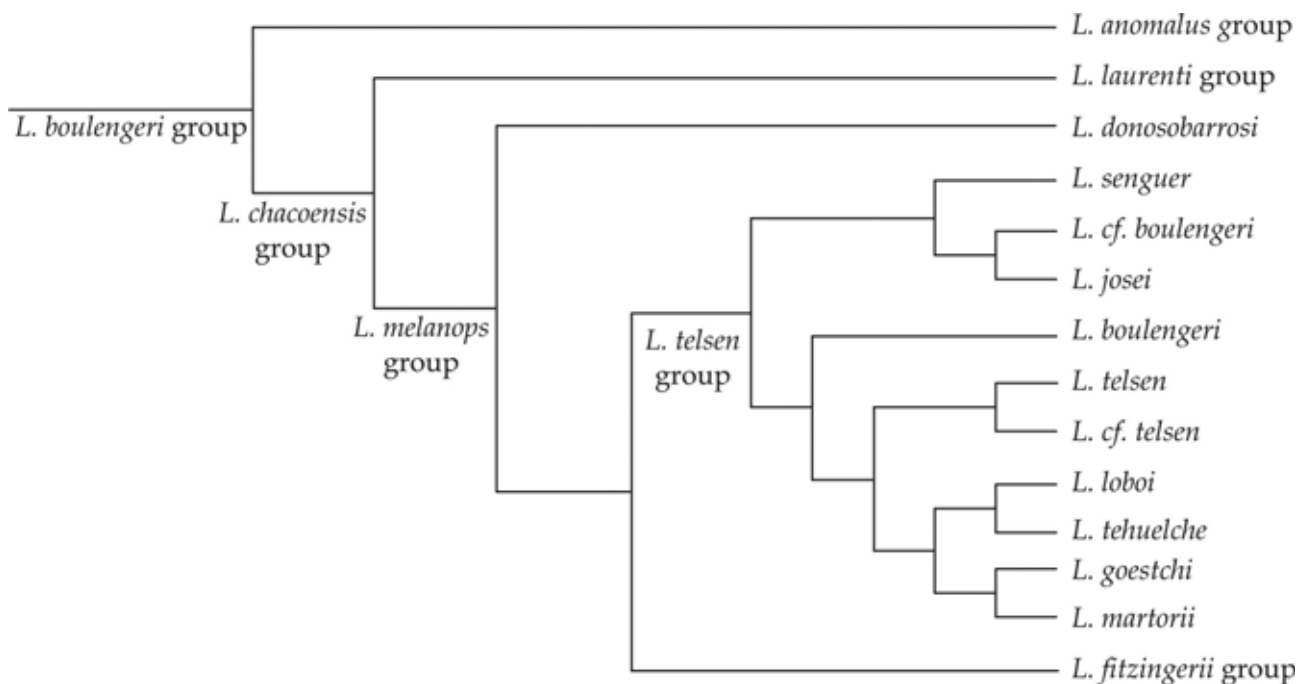


FIGURE 5. Relationships between the species of the *Liolaemus melanops* group, based on the phylogenetic analysis of the morphological data matrix of Abdala (2007), with new evidences of *L. goetschi* provided in this work.

In Pincheira-Donoso *et al.* (2008), one of the authors suggested synonymizing *Liolaemus martorii* with *L. goetschi*. He argued that distribution, morphology and coloration of both species exhibit strong overlap; however, this author did not carry out any analysis to support this hypothesis. Based on the comparison of *L. goetschi* specimens (from Laguna Playa) with the type series of *L. martorii*, we can confirm that, while *L. martorii* is phylogenetically close to *L. goetschi*, both are valid species. Comparisons reveal clear differences in scalation, coloration and morphometry (Table 1) and their known distribution areas are more than 300 km apart (Figure 4). These facts provide further support to our hypothesis.

In a phylogeographic analysis of the *Liolaemus boulengeri* clade, Avila *et al.* (2006) states that individuals of three different populations of *L. martorii* present morphological differences (in size and coloration) and differences in their haplotypes from individuals of central areas of the province of Río Negro (populations 5-8). The latter possess the ancestral haplotype of the “*melanops* complex” and the rest of the species included in the group (*L. morenoi*, *L. canqueli*, *L. martorii*) would have originated through a process of allopatric divergence. Avila *et al.* (2006) did not include *L. goetschi* in their analysis; however, they recovered *L. martorii* as sister taxa of a population (used as terminal) of specimens collected a few kilometers south of the type locality of *L. goetschi* (population 7). These specimens probably correspond to *L. goetschi*, this phylogeographic hypothesis being consistent with our hypothesis since both suggest that *L. goetschi* and *L. martorii* are discrete and sister species.

The consensus on the phylogeny of the *Liolaemus boulengeri* clade based on molecular and morphological evidence (Abdala 2007) indicates that *Liolaemus goetschi* (represented by the same specimens of *L. cf. cuyanus* used by Cei & Scolaro, 1977) belongs to the *L. cuyanus* clade within the *L. goetschi* clade. In the present study, the phylogenetic analysis based on morphological data of *L. goetschi* specimens from their type locality and neighboring areas suggests that the species would correspond to the *L. telsen* clade. In the analysis based on morphological evidence in the above mentioned work, using the same methodology (and characters) Abdala (2007) realized that the *Liolaemus telsen* group comprises the same species that in our analysis but that *L. goetschi* belongs to another group (*L. cuyanus* group). This is clear evidence of the confusion with the taxonomic status of *L. goetschi*.

The present study contributes to elucidate the problematic taxonomic status of *Liolaemus goetschi* and related species previously confused with it (*L. melanops* and *L. martorii*) (Cei & Scolaro 1977, 2003; Abdala 2007; Pincheira-Donoso *et al.* 2008) as well as its relationships within the *L. boulengeri* group, whose phylogeny is not yet fully resolved.

Acknowledgments

We would like to thank: Sebastián Quinteros, Paola Carrasco, Gerardo Leynaud, Samanta Cairo and Nicolás Pelegrin for discussing several aspects of the paper and making valuable comments; Lina D. Moreno, Matias Sanchez, Rodrigo Uribe, María J. Arellano and Cecilia Nori for providing invaluable help during field trips; Pablo Chafrat and Jaime Pietro for the photos of *L. goetschi* and the Dirección de Fauna de la Provincia de Río Negro for issuing the collection permits. We also thank Members of the Centro de Zoología Aplicada (CZA), Museo Patagónica de Ciencias Naturales (MPCN) and Fundación Miguel Lillo (FML) for their logistic support, as well as Jorgelina Brasca and María E. Periago who improved the English style.

References

- Abdala, C.S. (2002) Nuevo *Liolaemus* (Iguania: Liolaemidae) perteneciente al Grupo *boulengeri* de la provincia de Neuquén, Argentina. *Cuadernos de Herpetología*, 16 (1), 3–13.
- Abdala, C.S. (2003) Cuatro nuevas especies del género *Liolaemus* (Iguania: Liolaemidae), pertenecientes al grupo *boulengeri*, de la Patagonia, Argentina. *Cuadernos de Herpetología*, 17 (1–2), 3–32.
- Abdala, C.S. (2005) Dos nuevas especies del género *Liolaemus* (Iguania: Liolaemidae) y redescipción de *Liolaemus boulengeri* (Koslowky, 1898). *Cuadernos de Herpetología*, 19 (1), 3–33.
- Abdala, C.S. (2007) Phylogeny of the *boulengeri* group (Iguania: Liolaemidae, *Liolaemus*) based on morphological and molecular characters. *Zootaxa*, 1538, 1–84.
- Abdala, C.S. & Lobo, F. (2006) Description of a new Patagonian lizard species of the *Liolaemus silvanae* group (Iguania:Liolaemidae). *South American Journal of Herpetology*, 1, 1–8.
- Abdala C.S. & Quinteros, A.S. (2008) Una nueva especie de *Liolaemus* (Iguania: Liolaemidae) endémica de la sierra de Fiambalá, Catamarca, Argentina. *Cuadernos de Herpetología*, 22 (1), 35–47.
- Abdala, C.S., Quinteros, A.S. & Espinoza, R.E. (2008) Two New Species of *Liolaemus* (Iguania: Liolaemidae) from the Puna of Northwestern Argentina. *Herpetologica*, 64(4), 458–471.
- Abdala, V., Abdala, C.S. & Tulli, M.J. (2006) Three traditional muscular characters in the phylogeny of *Liolaemus* (Squamata: Tropicoduridae) a reappraisal. *Zootaxa*, 1205, 55–68.
- Avila, L.J., Morando, M. & Sites, J.W. Jr. (2006) Congeneric phylogeography: hypothesizing species limits and evolutionary processes in Patagonian lizards of the *Liolaemus boulengeri* group (Squamata: Liolaemini). *Biological journal of the Linnean Society.*, 89, 241–275.
- Avila, L.J., Morando, M., Perez, C.H.F. & Sites, J.W. Jr. (2007) A new species of *Liolaemus* Reptilia: Squamata: Liolaemini) from southern Mendoza province, Argentina. *Zootaxa* 1452, 43–54.
- Avila, L.J., Morando, M. & Sites, J.W. (2008) New species of the iguanian lizard genus *Liolaemus* (Squamata, Iguania, Liolaemini) from Central Patagonia, Argentina. *Journal of Herpetology*, 42 (1), 186–196.
- Burmeister, C.V. (1888) Algunas noticias sobre la fauna de la Patagonia. *Anales del Museo Buenos Aires*, 3, 237–252.
- Cabrera, A.L. (1976) *Regiones fitogeográficas Argentinas*, 2nd Edition. Enciclopedia Argentina de Agricultura y Jardinería, Buenos Aires, 81 pp.
- Cei, J.M. 1986. *Reptiles del centro, centro-oeste y sur de la Argentina. Herpetofauna de las zonas áridas y semiáridas.* Museo Regionale di Scienze Naturali, Torino, Monografie 4: 527 pp.
- Cei, J.M. & Scolaro, J.A. (1977) Herpetología patagónica. XIII. La identidad de *Liolaemus goetschi* y de la forma *melanops* del grupo *Liolaemus fitzingeri*, en Río Negro y Chubut. *Physis (Buenos Aires)*, 36, 225–226.
- Cei, J.M. & Scolaro, J.A. (2003) Rectificación taxonómica y nomenclatural del presente status del taxón *Liolaemus melanops* Burmeister 1888. *Facena*, 19, 163–164.
- Espinoza, R.E., Wiens, J.J. & Tracy, C.R. (2004) Recurrent evolution of herbivory in small, cold-climate lizards: breaking the ecophysiological rules of reptilian herbivory. *Proceedings of the National Academy of Sciences, USA*, 101(48):16819–24.
- Etheridge, R. (1993) Lizards of the *Liolaemus darwini* complex (Squamata: Iguania: Tropicoduridae) in northern Argentina. *Bolletino del Museo Regionale di Scienze Naturali, Torino*, 11, 137–199.

- Etheridge, R. (1995) Redescription of *Ctenoblepharys adspersa* Tschudi, 1845, and the taxonomy of Liolaeminae (Reptilia: Squamata: Tropicuridae). *American Museum Novitates*, 3142, 1–34.
- Etheridge, R.E. (2000) A review of the *Liolaemus wiegmanni* group (Squamata, Iguania, Tropicuridae), and a history of morphological change in the sand-dwelling species. *Herpetological Monographs*, 14, 293–352.
- Frost, D.R. (1992) Phylogenetic analysis and taxonomy of the *Tropicurus* group of lizards (Iguania: Tropicuridae). *American Museum Novitates*, 3033, 1–68.
- Goloboff, P. (1993) Estimating character weights during tree search. *Cladistics*, 9, 83–91.
- Goloboff, P., Farris J. & Nixon, K. (2003) *T.N.T.: Tree Analysis Using New Technology*. Program and documentation, available from the authors, and at www.zmuc.dk/public/phylogeny.
- Laurent, R.F. (1985) Segunda contribución al conocimiento de la estructura taxonómica del género *Liolaemus* Wiegmann (Iguanidae). *Cuadernos de Herpetología*, 1, 1–37.
- Lobo, F. (2001) A phylogenetic analysis of lizards of the *Liolaemus chiliensis* group (Iguania: Tropicuridae). *Journal of Herpetology*, 11, 137–150.
- Lobo, F. (2005) Las relaciones filogenéticas dentro del grupo *chiliensis* (Iguania: Liolaemidae: *Liolaemus*): sumando nuevos caracteres y taxones. *Acta Zoológica Lilloana*, 49(1-2), 67–89.
- Lobo, F. & Espinoza, R.E. (1999) Two new cryptic species of *Liolaemus* (Iguania: Tropicuridae) from northwestern Argentina: resolution of the purported reproductive bimodality of *Liolaemus alticolor*. *Copeia*, 1, 122–140.
- Morando, M., Avila, L. J., Baker, J., & Sites Jr., W. (2004) Phylogeny and Phylogeography of the *Liolaemus darwini* complex (Squamata: Liolaemidae) Evidence for introgression and incomplete lineage sorting. *Evolution*, 58, 842–861.
- Müller, L. & Hellmich, W. (1938) *Liolaemus* -Arten aus dem Westlichen Argentinien (Ergebnisse der Argentinienreise von Prof. Dr. W. Goetsch, Breslau). I. *Liolaemus darwini* (Bell) und *Liolaemus goetschi* n. sp. *Zoologischer Anzeiger*, 123 (5–6), 129–142.
- Nori, J., Abdala C. S. & Scrocchi G. J. (2010). Reptilia, Iguania, Liolaemidae, *Liolaemus goetschi* Müller and Hellmich, 1938: Distribution extension. *Check List*, 6 (1), 6–4.
- Pincheira-Donoso D.J., Scolaro, J.A. & Schulte, A. (2007) The limits of polymorphism in *Liolaemus rothi*: Molecular and phenotypic evidence for a new species of the *Liolaemus boulengeri* clade (Iguanidae, Liolaemini) from boreal Patagonia of Chile. *Zootaxa*, 1452, 25–42.
- Pincheira Donoso, D., Scolaro, J.A. & Sutra, P. (2008) A monographic catalogue on the systematics and phylogeny of the South American iguanian lizard family Liolaemidae (Squamata, Iguania). *Zootaxa*, 1800, 1–85.
- Quinteros, A.S., Abdala, C.S., Diaz Gomez, J.M. & Scrocchi, G.J. (2008) Two new species of *Liolaemus* (Iguania: Liolaemidae) of central west Argentina. *South American Journal of Herpetology*, 3, 101–111.
- Scolaro, J.A. & Cei, J.M. (2006) A new species of *Liolaemus* from central steppes of Chubut, Patagonia Argentina (Reptilia:Iguania: Iguanidae). *Zootaxa*, 1133, 61–68.
- Schulte, J. A., Macey, J. R., Espinoza, R. E. & Larson, A. (2000). Phylogenetic relationships in the iguanid lizard genus *Liolaemus*: multiple origins of viviparous reproduction and evidence for recurring andean vicariance and dispersal. *Biological Journal of the Linnean Society*, 69, 75–102.

Appendix 1. Specimens examined.

Acronyms: FML: Fundación Miguel Lillo; MPCN: Museo Patagónico de Ciencias Naturales; IBA: Instituto de Biología Animal; MCN: Museo de Ciencias Naturales de la Universidad Nacional de Salta.

Liolaemus cf. cuyanus: IBA 1169 (1–8); 975 (1–6; 8): 4 km north of Catriel, Río Negro, Argentina.

Liolaemus goetschi: FML 21511; 21501–21507; MPCN 057–065: Laguna Playa (30°52'59" S; 67°34'08"W), approximately 20 km north of General Roca, Río Negro, Argentina; FML 21508. 20 km South of Catriel, National Route 151, Río Negro, Argentina. FML 21509–21510: 50 km S de Catriel, National Route 151, Río Negro, Argentina.

Liolaemus martorii: FML 13238 (Holotype); 13240–13243 (paratypes); 13247 (paratype); 13250 (paratype); 21215; 21231–21233; 15690: Sand dunes near the locality of Las Grutas, departament of San Antonio Oeste, Río Negro, Argentina; FML 02968 (paratype). Caleta de los Loros, Adolfo Alsina departament, Río Negro, Argentina.

Liolaemus melanops: IBA 1138. Sierra Colorada, Telsen Department, Chubut, Argentina. IBA 1324: Las Plumas, Río Chubut, departament of Mártires, Chubut, Argentina. IBA 943: Sierra Colorada, Quele Curá, 40 km northeast of Telsen, departament of Telsen, Chubut, Argentina. MCN 1297–306. Sierra Colorada, Telsen Departament 70 km to the North from the crossing of Provincial Routes 8 and 4.