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A new species of *Phymaturus* of the *patagonicus* clade (Squamata, Liolaemidae) from isolated plateau of southwestern Rio Negro Province, Argentina

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Abstract

A new *Phymaturus* species called *Phymaturus sinervoi*, is described in the present study. The new species is a member of the “*Phymaturus patagonicus*” group from Patagonia. It lives at about 1100 m of altitude in a volcanic rocky habitat near to Cari Laufquen plateau, in the southern-central steppe of Rio Negro Province, Argentina. The new species and the neighbouring related species of the genus from the “*patagonicus*” group are morphologically compared, and its distribution and natural history are pointed out.

Key words: *Phymaturus sinervoi*, Liolaemidae, Patagonian Reptiles, rock-dwelling lizards, Argentina

Introduction

Within this South American lizard family Liolaemidae, only three contrastingly different genera have been recognized, one being a monotypic lineage (*Ctenoblepharys*) and another (*Liolaemus*, with >220 species), one of the most extraordinary examples of evolutionary radiation known among living vertebrates (Pincheira-Donoso *et al.* 2008c, Avila *et al.* 2010). The third genus, *Phymaturus*, shows an intermediate species richness with 35 species (Pincheira-Donoso *et al.* 2008c; Corbalán *et al.* 2009; Avila *et al.* 2011). Species numbers are not, however, the only contrasting features found among these lizard lineages. Indeed, while *Liolaemus* has started to be regarded as an interesting example of adaptive radiation given its dramatic diversity in phylogenetic, ecological and phenotypic features (Schulte *et al.* 2000; Espinoza *et al.* 2004; Pincheira-Donoso *et al.* 2008a, 2008b, 2009), *Phymaturus* has been suggested to be a more consistent candidate example of relatively poor diversification at the ecological and life-history dimensions, mediated by phylogenetic niche conservatism (Scolaro *et al.* 2008). These differences in the species richness between these two clades were even more accentuated until recently, when the diversity of *Phymaturus* (in contrast to *Liolaemus*) remained substantially more underestimated, being known only for a few species (Cei, 1986; Etheridge 1995). In the recent years, several new *Phymaturus* species have started to be proposed from different areas of the Andes and Patagonia, which has resulted in the discovery of a fascinating diversity, especially at the level of patterns of coloration (Lobo & Quinteros 2005b, 2010; Pincheira-Donoso *et al.* 2008c; Fig. 1). Within *Phymaturus* (Cei 1986; Etheridge 1995) two groups have been recognized: the *palluma* (= *flagellifer*) group, with larger species, found mainly on both sides of the central Andes slopes, from southern Puna regions and Famatina mountain range, to north-western Patagonia. On the other hand, the *patagonicus* group, smaller in size, inhabits mainly the extra-Andean outcrops and volcanic plateaus of central Patagonia. Espinoza *et al.* (2004), in a phylogenetic study combining molecular and morphological data, also recognize two groups, but Lobo and Quinteros (2005a) found mixed results in a morphological study, with the *patagonicus* group recovered as paraphyletic in some analyses. However, Etheridge (1995) provided strong evidence about the monophyly of this genus based in several characters, including wide and flattened head and body, tail with regular whorls of spiny

scales, lateral nuchal skin folds with fat-filled pouches, and a short interclavicular that appears to be exclusive of *Phymaturus*.

At the present time, the *palluma* group comprises 14 species while the *patagonicus* group contains 21 described species: *P. patagonicus* Koslowsky 1898, *P. spurcus* Barbour 1921, *P. indistinctus* Cei & Castro 1973, *P. payunia* Cei & Castro 1973, *P. somuncurensis* Cei & Castro 1973, *P. zapalensis* Cei & Castro 1973, *P. nevadoi* Cei & Roig 1975, *P. calcogaster* Scolaro & Cei 2003, *P. excelsus* Lobo & Quinteros 2005, *P. spectabilis* Lobo & Quinteros 2005, *P. tenebrosus* Lobo & Quinteros 2005, *P. ceii* Scolaro & Ibarquengoytía 2007, *P. manuelae* Scolaro & Ibarquengoytía 2008, *P. desuetus* Scolaro & Tappari 2009, *P. videlai* & *P. castillensis* Scolaro & Pincheira Donoso 2010, *P. etheridgei* Lobo *et al.* 2010, *P. felixi* Lobo *et al.* 2010, *P. sitesi* and *P. delheyi* Avila, Pérez, Pérez & Morando 2011. Recently, Lobo *et al.* 2010 suggested synonyms for some species based on the colour variation of isolated individuals from a very polymorphic population of this group. We are in accordance with Avila *et al.* 2011 that until more detailed studies with conclusive scientific evidence are available, we are willing to accept the validity of all the species mentioned above.

A much more complete picture of the evolutionary origin and history of the genus *Phymaturus* has been recently proposed (Díaz-Gómez 2009; Corbalán *et al.* 2011). *Phymaturus* species are primarily characterized by (i) stout and flattened body shapes, (ii) consistent preference for rocky microhabitats, (iii) herbivorous diets (or almost entirely herbivorous diets with some species occasionally feeding on insects, Scolaro *et al.* 2008), and (iv) viviparous reproductive mode, as well as many other features of their life history (Cei, 1986; Lobo & Quinteros 2005b; Ibarquengoytía *et al.* 2008; Pincheira-Donoso *et al.* 2008c; Boretto & Ibarquengoytía 2009). The genus is widely distributed from the highlands of the Andes in Catamarca (Argentina) to the southern border of Chubut. Most species are endemic, although two of them have extended their distributions to Andean and Patagonian areas of the Chilean border and four new species have been recently found in central Chile (Núñez *et al.* 2010).

A number of recent phylogenetic hypotheses have repeatedly supported the idea that the genus *Phymaturus* consists of two major clades, one primarily inhabiting the northern areas of the genus distribution (*flagellifer* = *palluma* group), and the other one (*patagonicus* group) in central and southern Argentine Patagonia (Cei 1986; Espinoza *et al.* 2004; Lobo & Quinteros 2005b; Pincheira-Donoso *et al.* 2008c; Díaz-Gómez 2009; Scolaro 2010; Avila *et al.* 2011). Interestingly, this phylogenetic evidence has also revealed that several morphological traits previously used to infer evolutionary relationships among *Phymaturus* lineages have the potential to predict the phylogenetic structure of the genus with a considerable extent of accuracy at the higher hierarchical taxonomic levels, as these traits had already suggested that the genus was diversified into these two main clades (Etheridge 1995).

Several of the recently recognized new species of the genus *Phymaturus* are the result of intense field exploration in unknown areas or in zones where enigmatic populations had been found in the past. In this study, we aim to investigate one population whose geographic isolation and patterns of coloration in adults and juveniles suggest divergence from the rest of *Phymaturus* species. In this paper, we carry out these analyses and conclude that this population represents one distinct *Phymaturus* species, which is thus here formally named.

Material and methods

To investigate the position of the above mentioned populations within the genus *Phymaturus*, we carried out initial exploratory analyses involving specimens from both sexes belonging to neighbouring known species of the *patagonicus* group (Appendix; Fig. 1). However, given that most species of this lineage are substantially isolated geographically from the new species here studied and from *P. patagonicus*, our quantitative comparative analyses were performed only among four species. We measured different morphological traits recognized to provide information on species delimitations among Liolaemidae lizards, and within *Phymaturus* (Donoso-Barros 1966; Cei 1986; Etheridge 1995, 2000; Lobo & Quinteros 2005b; Pincheira-Donoso *et al.* 2007; Scolaro *et al.* 2008). All quantitative traits were measured using a precision calliper (0.1 mm), and a dissection stereomicroscope for other observations and scale counts. Data were collected from adult individuals of both sexes, which were categorized as sexually mature after analyzing the presence of mature gonads and secondary sex characters.

According to the standard measurement variables proposed for studies in the genus *Phymaturus* (Etheridge 1995, Lobo & Quinteros 2005b) a total of 23 continuous and meristic traits were measured. These variables were employed to run several discriminant analyses (SPSS v. 15.0 2006; Zar 2009), in order to investigate multivariate

patterns of differentiation among the new species and species of the *patagonicus* clade. This new species occur at the medium-range of the distribution of the *patagonicus* clade, and are strongly isolated, by 50–60 kilometres, from most species of this lineage (see Fig. 1). Our multivariate analyses focused on these four species occurring at the neighbouring geographical area (the new species being *P. ceii*, *P. etheridgei* and *P. spectabilis*). The discriminant factorial analysis was performed, considering 22 variables in the comparison between *Phymaturus* species. The neperian logarithm of the variables was used in order to reduce skewness (Zar 2009). Variables showing significant differences between groups were analyzed for normality by means of Snedecor's *F*-test. When normal Gaussian distributions were observed, the comparison between means was made by employing general linear models. When character distributions were not normal, the Mann-Whitney *U*-test or *z*-test was used. For comparative purposes, arithmetic mean and standard deviations (SD) are given (Table 1).

TABLE 1. *Phymaturus sinervoii*: means, standard deviations (SD) and ranges of the main morphometric characters. Measurements in mm and scale numbers; ratios as percentage.

Variable	Males (N = 14)			Females (N = 12)			Comparison	
	Mean	Range	δ	Mean	Range	δ	<i>t</i>	<i>P</i>
Snout-vent length	90.6	84.8-98.7	3.76	92.9	79.8-103.9	6.93	n.s.	
Entire Tail length	104.4	100.4-107.5		-	-			
Axilla-groin distance	45.2	42.0-48.1	1.81	51.4	39.6-59.3	5.59	-3.91	0.001
Head length	17.1	16.0-18.9	0.72	16.9	15.6-18.0	0.74	n.s.	
Head width	16.7	15.5-17.6	0.61	15.7	14.6-17.1	0.73	3.56	0.002
Eye-nose distance	5.6	4.5-6.5	0.61	5.3	4.6-6.4	0.49	n.s.	
Forelimb length	32.7	31.0-35.0	1.02	32.0	29.7-36.1	1.95	n.s.	
Hindlimb length	47.8	45.4-52.4	2.09	47.2	44.9-48.9	1.31	n.s.	
Fourth finger length	11.9	10.5-12.5	0.50	12.0	10.2-17.3	1.80	n.s.	
Fourth toe length	15.6	14.0-18.3	1.24	15.5	13.6-16.9	1.06	n.s.	
Head dorsal scales	21	18-24	1.79	22	20-23	0.98	n.s.	
Surrounding interparietal	6.7	6-8	0.61	7.4	6-9	0.99	-2.20	0.04
finger subdigital lamellae	23.4	22-26	1.22	24.3	22-28	1.56	n.s.	
4° toe subdigital lamellae	27.9	27-29	0.83	28.0	26-30	1.13	n.s.	
Lorilabial rows	1.9	1-3	0.31	2	-	-		
Subocular scales	1	1	-	1	1	-		
Supralabial scale number	8.8	8-10	0.75	7.9	7-9	0.43	3.69	0.001
Infralabial scale number	7.8	7-9	0.57	7.6	7-8	0.51	n.s.	
Scales contacting mental	4.9	4-6	0.86	4.5	4-6	0.80	n.s.	
Precloacal pore number	8.9	6-13	2.40	0.2	0-2	0.58		
Scales around midbody	225.6	213-248	8.74	235	232-243	11.20	n.s.	
Ventral scales	175.5	162-190	7.28	176.6	157-197	11.65	n.s.	

The herpetological collection where the holotype and paratypes are deposited is in Museo de La Plata (Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, provincia de Buenos Aires; MLP-R).

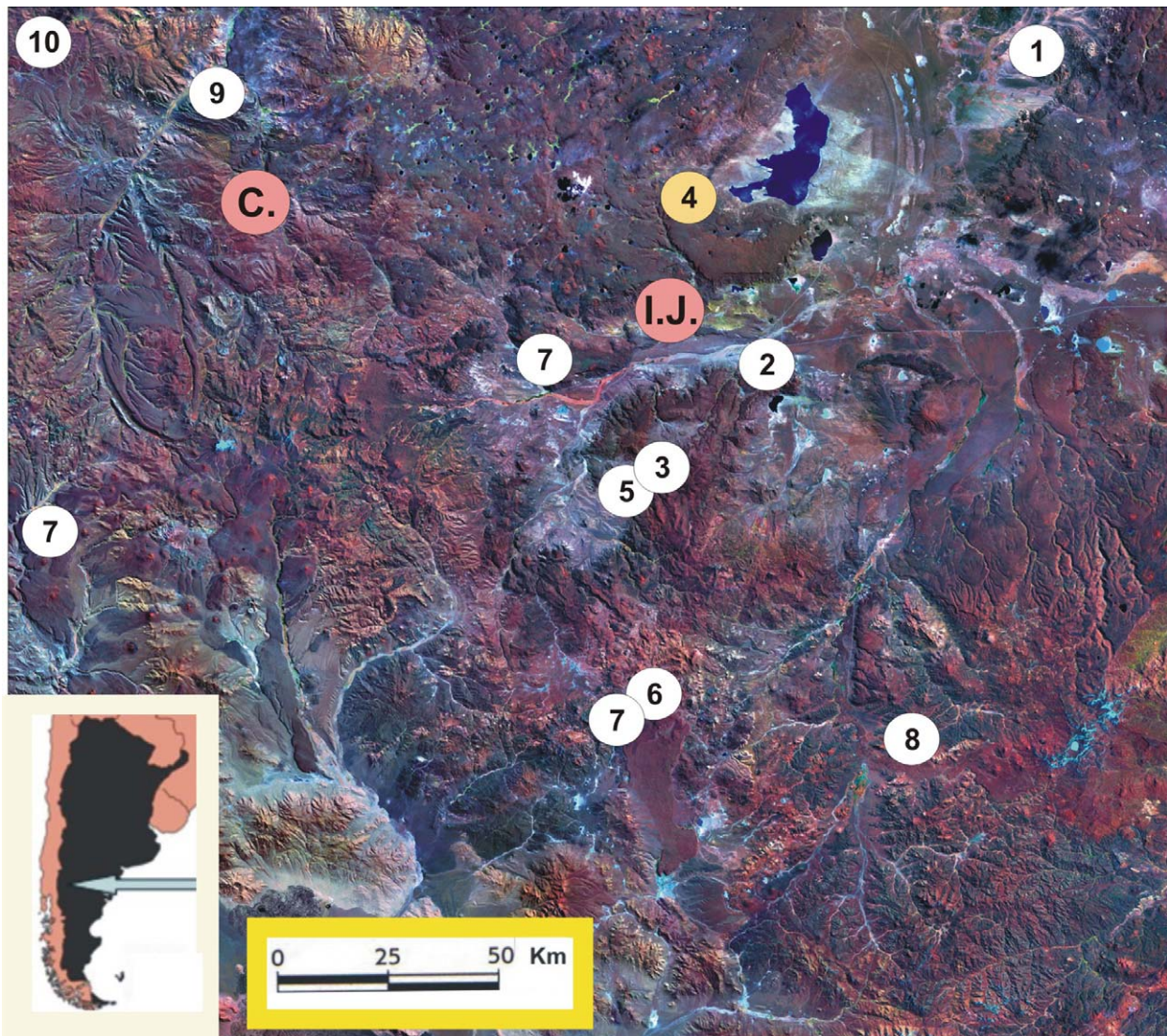


FIGURE 1. Geographic distribution of all neighboring known members of the *patagonicus* clade of the Comallo (CO.)-Ingeniero Jacobacci (I.J.) area of southern Rio Negro province (Argentina). Localities are indicated by numbers and represent: *P. ceii* (1), *P. desuetus* (2), *P. agilis* (3), *P. sinervoii* sp. nov. (4), *P. spectabilis* (5), *P. excelsus* (6), *P. spurcus* (7), *P. etheridgei* (8), *P. manuelae* (9) and *P. tenebrosus* (10).

Results

Statistical analyses

Quantitative analyses on morphological traits revealed significant differences between the new *Phymaturus* species and *P. etheridgei*, *P. ceii* and *P. spectabilis* (Table 2). Three stepwise discriminant analyses were performed separately between *Phymaturus* sp. nov. versus the remaining species mentioned. The variance-covariance equality of matrices showed that morphological traits are normally distributed, and there is homogeneity of variances among groups and means belonging to the same populations (*P. etheridgei* versus *Phymaturus* sp. nov., Box's test, $F = 0.42$, $P = 0.52$, Discriminant functions: Wilks' Lambda (λ) = 0.24, Chi-square (χ^2) = 46.4, $P < 0.001$; *P. ceii* versus *Phymaturus* sp. nov., Box's test, $F = 0.37$, $P = 0.54$, Discriminant functions: Wilks' $\lambda = 0.24$, $\chi^2 = 48.4$, $P < 0.001$; *P. spectabilis* versus *Phymaturus* sp. nov., Box's test, $F = 1.20$, $P = 0.24$, Discriminant functions: Wilks' $\lambda = 0.22$, $\chi^2 = 76.2$, $P < 0.001$). Discriminant analysis of individual specimens resulted in a completely correct classification of cases (100%) in all of the analyses performed (Fig. 2).

TABLE 2. Patterns of morphological variation in morphometric and meristic traits among four geographically neighbour species of *Phymaturus* of the *patagonicus* clade. For all traits Mean \pm Standard Deviations are shown. Significant statistical differences among the new species and *P. etheridgei*, *P. ceii* and *P. spectabilis* ($P < 0.05^*$, $P < 0.01^{**}$, $P < 0.001^{***}$), are indicated with asterisks.

Traits	<i>P. sp.nv.</i> (<i>N</i> = 26)	<i>P. etheridgei</i> (<i>N</i> = 10)	<i>P. ceii</i> (<i>N</i> = 25)	<i>P. spectabilis</i> (<i>N</i> = 38)
Snout-vent length	91.7 \pm 5.5 ***	84.5 \pm 3.1	86.0 \pm 3.7	83.2 \pm 5.8
Axilla-groin distance	48.1 \pm 5.0 **	45.5 \pm 2.4	46.1 \pm 3.6	43.8 \pm 4.9
Head length	17.0 \pm 0.7 ***	15.4 \pm 0.7	17.3 \pm 1.1	16.4 \pm 1.3
Head width	16.2 \pm 0.8 ***	14.9 \pm 0.6	15.7 \pm 0.6	14.5 \pm 1.0
Eye-nose distance	5.5 \pm 0.6	6.4 \pm 0.5	6.6 \pm 0.7	6.4 \pm 0.6
Forelimb length	32.4 \pm 1.5	31.4 \pm 1.3	30.9 \pm 1.5	30.7 \pm 2.2
Hindlimb length	47.5 \pm 1.8 ***	44.3 \pm 2.3	46.5 \pm 2.3	44.8 \pm 3.0
Fourth finger length	11.9 \pm 1.3 ***	9.2 \pm 0.6	10.8 \pm 1.2	10.2 \pm 1.0
Fourth toe length	15.6 \pm 1.1 ***	12.7 \pm 1.0	13.4 \pm 3.0	14.2 \pm 1.3
Dorsal head scales	21.2 \pm 1.5	21.3 \pm 0.9	20.9 \pm 1.1	20.9 \pm 1.0
Fourth finger lamellae	23.8 \pm 1.4 **	23.8 \pm 0.8 **	22.9 \pm 1.4	22.3 \pm 1.7
Fourth toe lamellae	28.0 \pm 0.9	28.0 \pm 0.9	27.8 \pm 1.5	27.0 \pm 2.0
Scales around mental	4.7 \pm 0.8 *	5.2 \pm 0.8	5.1 \pm 0.8	4.3 \pm 0.6
Subocular scales	1.0 \pm 0.0	1.2 \pm 0.4	1.0 \pm 0.0	2.8 \pm 0.8 ***
Lorilabial rows	2.0 \pm 0.1	2.0 \pm 0.0	2.0 \pm 0.0	2.2 \pm 0.4 *
Supralabial scales	8.2 \pm 0.8 ***	7.0 \pm 0.7	8.3 \pm 0.6	8.6 \pm 0.7 *
Infralabial scales	7.7 \pm 0.7	7.6 \pm 0.5	7.9 \pm 0.8	8.4 \pm 0.5
Scales around pineal	7.0 \pm 0.9	6.5 \pm 0.9	7.0 \pm 0.8	6.9 \pm 0.8
Rostral-interparietals	16.0 \pm 1.1	15.6 \pm 1.4	16.0 \pm 1.0	15.7 \pm 1.1
Scales around midbody	227.0 \pm 9.9	225.9 \pm 4.2	231.2 \pm 9.3	221.7 \pm 14.1
Ventral scales	175.9 \pm 9.5	185.2 \pm 8.2 **	181.9 \pm 9.5 *	167.9 \pm 8.8
Precloacal pores males	8.8 \pm 2.2	8.5 \pm 2.0	8.6 \pm 2.5	10.0 \pm 2.0

The discriminant analyses between *Phymaturus sp. nov.* and *P. etheridgei* showed significant divergence in snout-vent length ($t = 4.95$, $P < 0.001$), head length ($t = 6.38$, $P < 0.001$), head width ($t = 5.55$, $P < 0.001$), hindlimb length ($t = 4.00$, $P < 0.001$), fourth finger length ($t = 8.76$, $P < 0.001$), fourth toe length ($t = 7.59$, $P < 0.001$) and supralabial scale number ($t = 4.76$, $P < 0.001$), all with major expression in *Phymaturus sp. nov.* except for ventral scale number ($w = 415$, $P < 0.01$) which shows major expression in *P. etheridgei*. Comparisons between *Phymaturus sp. nov.* and *P. ceii* shows significant differences in snout-vent length ($t = 4.31$, $P < 0.001$), head length ($t = 2.77$, $P < 0.001$), forelimb length ($t = 3.52$, $P < 0.001$), fourth finger length ($t = 3.26$, $P < 0.001$), fourth toe length ($t = 3.33$, $P < 0.001$) and fourth finger lamellae ($t = 2.43$, $P < 0.01$), all with major expression in *Phymaturus sp. nov.* except for ventral scale number ($w = 543$, $P < 0.05$) which shows major expression in *P. ceii* (see Table 2 for details).

Contrasts between *Phymaturus sp. nov.* and *P. spectabilis*, reveals significant differences in snout-vent length ($t = 5.66$, $P < 0.001$), head length ($t = 2.20$, $P < 0.05$), head width ($t = 7.29$, $P < 0.001$), forelimb length ($t = 3.34$, $P < 0.01$), hindlimb length ($t = 4.22$, $P < 0.001$), axilla-groin distance ($t = 3.22$, $P < 0.01$), fourth finger length ($t =$

5.70, $P < 0.001$), fourth toe length ($t = 4.10$, $P < 0.001$), fourth finger lamellae ($t = 3.65$, $P < 0.001$), fourth toe lamellae ($t = 2.26$, $P < 0.01$), scales around mental ($w = 785$, $P < 0.05$), ventral scale number ($w = 710$, $P < 0.01$), all traits with major expression in *Phymaturus* **sp. nov.** except for supralabial scale number ($w = 637.5$, $P < 0.05$), infralabial scale number ($w = 542$, $P < 0.001$), subocular scales ($w = 351$, $P < 0.001$) and lorilabial rows ($w = 675$, $P < 0.05$), which shows major expression in *P. spectabilis*.

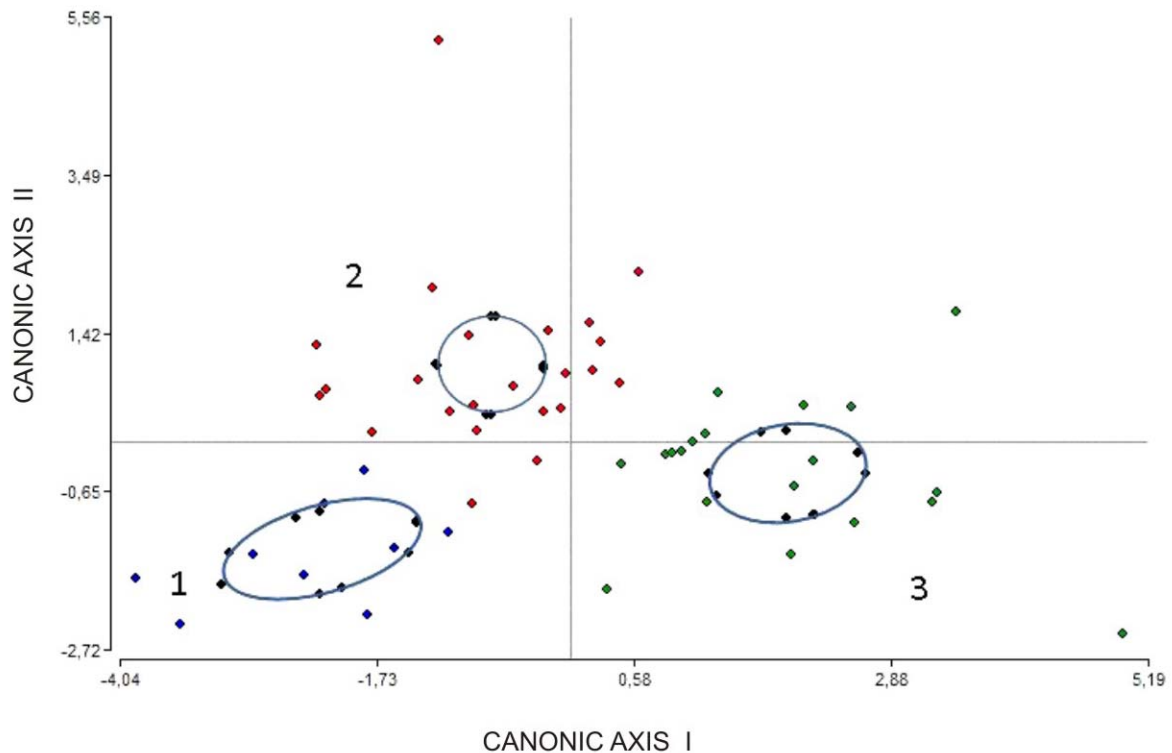


FIGURE 2. Ellipses of equiprobability for all the cases ($P < 0.05$): **1.** *Phymaturus etheridgei*, **2.** *Phymaturus ceii* and **3.** *Phymaturus sinervoii* **sp. nov.**

Species accounts

Phymaturus sinervoii **sp. nov.**

(Figures 3 and 4)

Type material. Holotype: MLP-R. 5660, adult male, collected in rocky outcrops (1000 m asl) of Cari Laufquen basaltic Tableland in Abi-Saad farm (41°02'12"S, 70°24'30.6"W), adjacent to Provincial Road 6, 61 km north of Ingeniero Jacobacci town, Rio Negro Province, Argentina. Collected by J.A. Sclaro, B. Sinervo, F. Méndez de la Cruz, J. Gutiérrez and N. R. Ibarzüengoytía, December 14, 2010.

Paratypes: MLP-R. 5661, adult male; MLP-R. 5662, adult female; MLP-R. 5663, adult female; MLP-R. 5664, adult male; JAS-DC 1887, adult female; JAS-DC 1896, adult male; UNCo-PH 1899, adult male; UNCo-PH 1839 adult female; UNCo-PH 1894, adult female; UNCo-PH 1895, adult male; UNCo-PH 1902, adult male. The same data as detailed for the holotype.

Etymology. The species name is dedicated to honour our friend and colleague Dr. Barry Sinervo from the Department of Ecology and Evolutionary Biology, University of California (USA), Santa Cruz; an evolutionary biologist and herpetologist who has enthusiastically and generously collaborated in many research projects in Patagonian herpetofauna for the last years.

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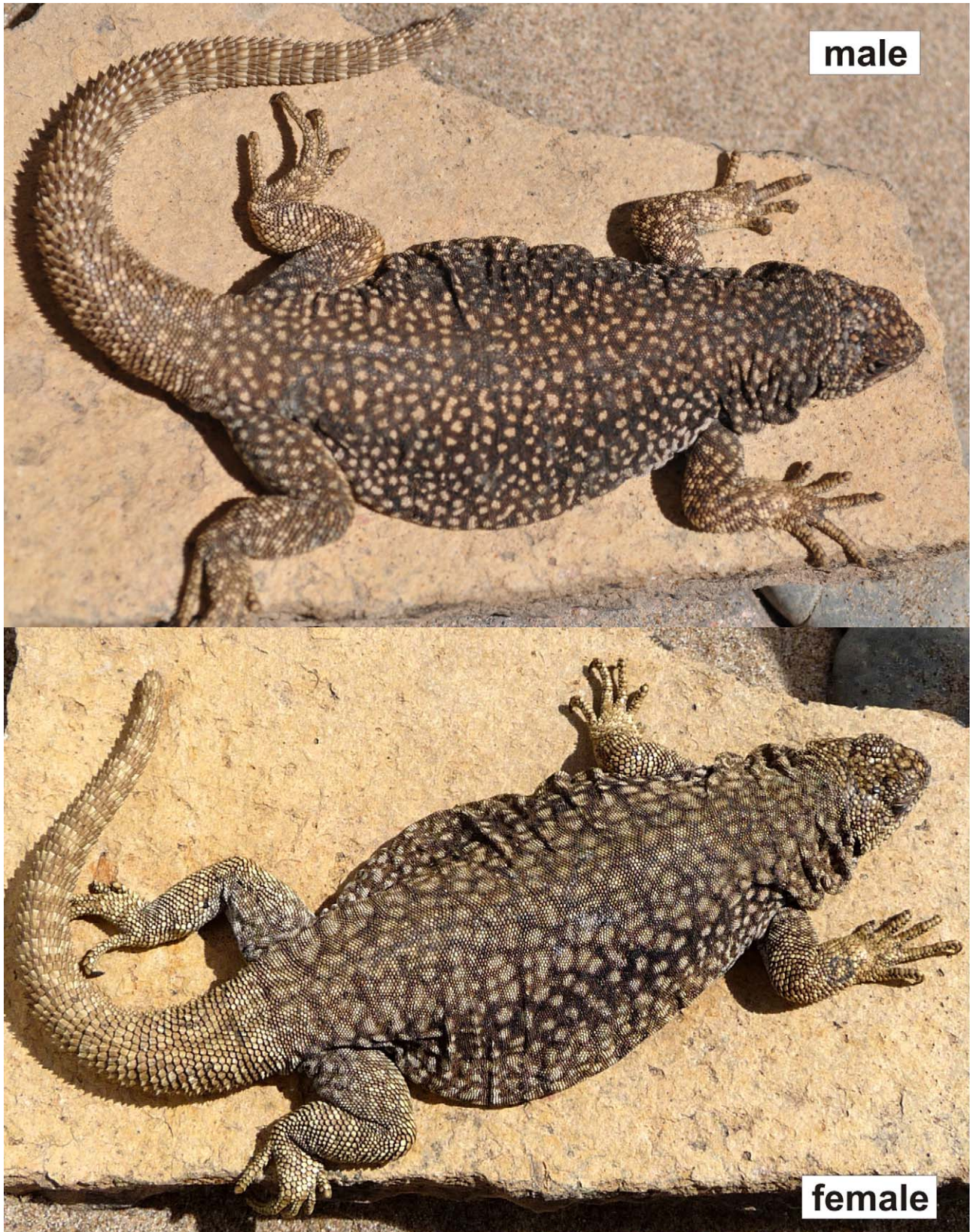


FIGURE 3. Adult male holotype of *Phymaturus sinervoi* alive from type locality, Río Negro, dorsal view, and adult female paratype of *Phymaturus sinervoi* alive from type locality, Río Negro, dorsal view. Photo: J.A. Scolaro, 21-12-2010.

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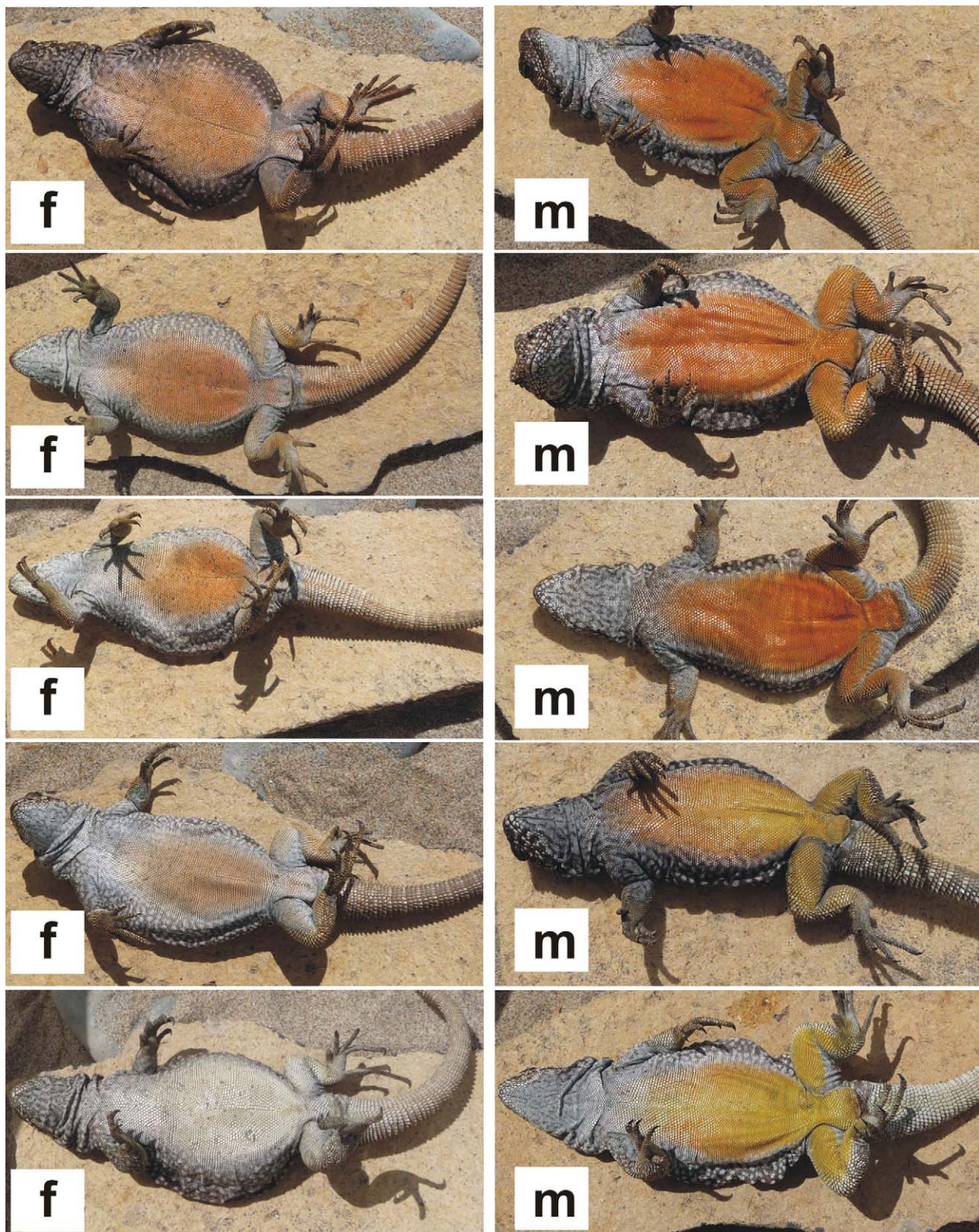


FIGURE 4. *Phymaturus sinervoi* variations of ventral view in males (left pannels) and females (right pannels). Photos: J.A. Scolaro, 31-01-2011.

Diagnosis. *Phymaturus sinervoi* is a member of the *patagonicus* group, distinguished from the neighbouring *Phymaturus* species by a peculiar colour pattern similar in both sexes (Fig. 3). The new species can be distinguished from the *palluma* = *flagellifer* group by having flat imbricate superciliaries rather than being rectangular and non-overlapping; slightly spiny and non-rugose caudal scales in verticilles (as seen among

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members of the *palluma* group). However, its subocular scale is not fragmented and it is separated from supralabials by two rows of lorilabials, as in most species of the *patagonicus* clade, but not seen in the majority of members of the *palluma* group. From the three geographically closer species, *P. etheridgei*, *P. ceii* and *P. spectabilis*, the new species *P. sinervoi* can be differentiated by its pattern of coloration (Fig. 5) as well as the morphological differences in snout-vent length, head length and width, hind or forelimb, finger and fourth toe length, axila-groin distance, finger lamellae, and in scales number, such as in supralabial, infralabial, lorilabial, scales around mental, subocular, and ventral scales (see results detailed above). *P. sinervoi* shows mainly a major body size and larger limbs, but minor number of ventral scales, when compared with *P. ceii* and *P. etheridgei*. The same results are obtained when compared with *P. spectabilis*, but showing a minor number of subocular and lorilabial rows of scales.

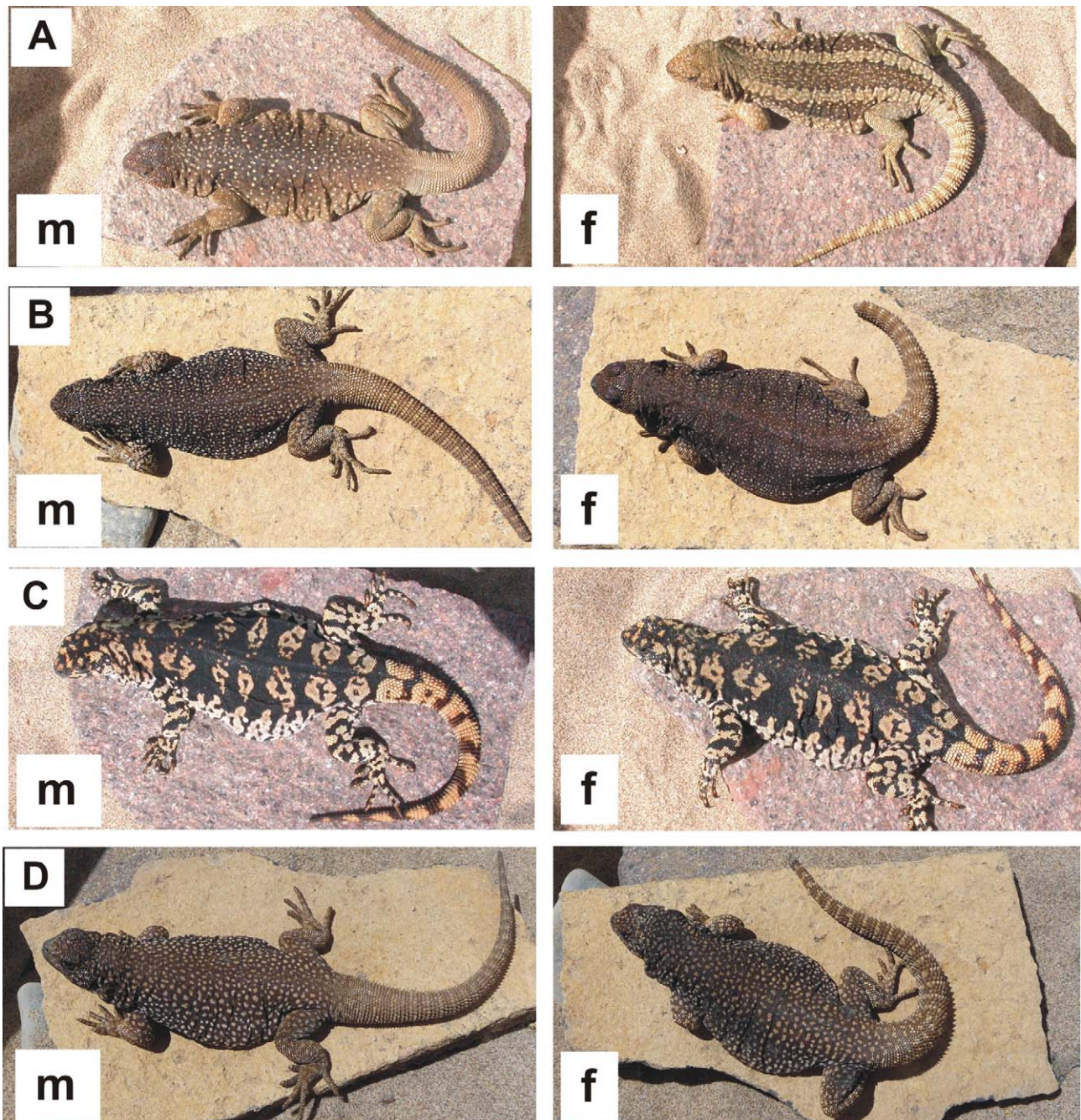


FIGURE 5. Comparative dorsal views of males (m, left pannels) and females (f, right pannels) between four neighbouring *Phymaturus* species: (A) *P. ceii*, (B) *P. etheridgei*, (C) *P. spectabilis* and (D) *P. sinervoi*.

Description of the holotype. A medium-sized lizard; snout-vent length (SVL) 90.4 mm; tail 100.4 mm; head length 16.0 mm; head width 16.5 mm; eye-nose distance 6.0 mm; forelimb length measured from the insertion of the limb into the body wall to the end of the claw of the fourth finger, 32.0 mm; hind limb length measured from the insertion of the limb into the body wall to the end of the claw of the fourth toe, 45.5 mm; axilla-groin distance 42.0 mm (45.5% of SVL); fourth finger length 10.5 mm; fourth toe length 14.3 mm; scales in dorsal head 23; scales around midbody 248; ventral scales between mental and precloacal pores 190; scales between rostral and frontal 17; supralabial scales 9-9; infralabial scales 8-8; subdigital lamellae on fourth finger 23; subdigital lamellae on fourth toe 27; precloacal pores 10; cephalic scales subhexagonals/pentagonals, smooth; supraorbital semicircles with large bulky scales, rounded, without azygous, incomplete posteriorly on both sides; no distinct rounded supraoculars; 10–11 imbricate and enlarged upper ciliaries; subocular scales rectangular, almost irregular but not fragmented, shorter than eye diameter, separated from supralabials by 2-2 irregular rows of lorilabials; preocular in contact with first lorilabial row; canthal separated from nasal by two scales; temporals smooth and rounded irregularly coniform, in 8–9 scales from auditory opening to the subocular; external auditory meatus enlarged, subellipsoidal longitudinally, with 4–5 very protruding or conically enlarged scales on its anterior border; diminute granular scales on posterior border; rostral undivided, wider twice than higher, separated by one row of medium scales from nasals; nasal large and surrounded by nine small scales; nasals separated by four small irregular scales; nostril rounded and large, over the centre of nasal scale; parietals irregular and smooth with evident subhexagonal interparietal, surrounded by seven scales; nuchals strongly conical organized in 15–16 irregular rows; post-auricular folds very developed with smooth conical scales; mental subpentagonal shorter than width, but higher than rostral, in contact with four irregular rectangular scales; two rows of 5–6 bilateral postmentals decreasing behind; dorsal scales smooth, conics, small and juxtaposed; mid-dorsal scales slightly rounded and smooth, decreasingly smaller and evidently conical toward the flanks; ventro-laterals and ventrals larger than dorsals, almost pentagonal, imbricate and smooth; two gular folds with rounded, small scales; 79 gulars between auditory meatus; caudal scales quadrangular and regularly imbricate in verticils, proximally large, conical and smooth on dorsum, or slightly keeled, distally more rectangular and strongly keeled; scales on forelimbs sub-triangular and smooth in the upper side, granular, rounded and subconical in the under side; scales in hind limbs strongly conical and strongly keeled in the dorsum but larger subpentagonal, imbricate and flat in the under side; in the femoral region, small granular, rounded and smooth scales in the lower side; infracarpals and infratarsals with round margins, becoming more keeled to the base of fingers and toes. Subdigital lamellae of fingers keeled; fourth toe and finger claws very developed, almost 3–4 mm of long. Ten orange-yellowish precloacal glands on the scales of the cloacal region in one divided row.

Coloration. Colour pattern is similar in both sexes. The general pattern is characterized by irregularly spread pale-creamy or grey spots on a darker brownish dorsal background. These multiple clear spots are conspicuous between the dorsal area of the head, flanks, dorsal limbs, until the base of the tail, where they disappear gradually on the dorsal tail background. On the neck and fore-back, several black stripes result in a partially greyish background. The dorsal tail shows variations from entirely brown to several alternate rings (20–23) of soft light brown of one scale among dark brown rings of two scales.

On the ventral surface, the background colour varies from pale-grey, yellow, brick-red to intense orange. Colour pictures of males and females are shown in Figure 4.

Morphological variation. The sample analyzed comprised 14 adult males and 12 adult females (for means and SD see Table 1). Analyses show slight size differences between the sexes, females being slightly larger in SVL (79.8–103.9) than males (84.8–98.7; Table 1). Axilla-groin distance larger in females ($P < 0.001$, Student t test: range 39.6–59.3 mm; mean = 51.4 mm, SD = 5.6, representing 53.0–58.2% of SVL); in males ranged = 42.0–48.1 mm (mean = 45.2 mm; SD = 1.8, representing 46.5–54.6% of SVL). In both sexes, head length ranged 15.6–18.9 mm, representing 16.7–20.8% of SVL. Head width ranged 14.6–17.6 mm, with significant differences between sexes, having the males larger head width ($P < 0.002$, t Student test). Eye-nostril distance ranged 4.5–6.5 mm. Tail length ranged 100–108.0 mm, representing 1.11–1.20 times of SVL. Forelimb length ranged 29.7–36.1 mm. Mean of hindlimb length in males was 47.8 mm, but in females 47.2 mm. Scales around midbody ranged 213–248 in both sexes combined. Dorsal head scales ranged 18–24. Ventrals ranged 157–197. Precloacal glands observed only in males, and ranged 6–13. Subocular scales not fragmented. Two rows of lorilabials between suboculars and supralabials. Scales surrounding interparietal 6–9. Scales contacting mental 4–6. Scales between rostral-interparietal 14–18. Fourth finger subdigital lamellae number 22–28. Fourth toe subdigital lamellae number 26–30. Supralabials more abundant in males (ranged = 8–10) than in females (ranged = 7–9; $P < 0.05$, t Student test).

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FIGURE 6. Comparative dorsal views of males of *P. sinervoi* (above) and *P. nevadoi* (below), both specimens from respective type locality.

Geographic distribution. *Phymaturus sinervoi* has been found in an isolated biotope of the tableland of the type locality, which limits with the paleo-endorreic Cari Laufquen Grande Lagoon in the north-western side, and with sandy steppe in the south-western side, which constitute a natural barrier for the species (Fig. 1). The new species, according to the saxatil character of the species, inhabits the outcrops on the foothills of the Cari Laufquen Plateu, which shows a slight increase in height towards the south, as the result of profuse basaltic lava flows of

vulcanism in the Tertiary. Plateaus are observed in staggering, product pyroclastic intercalations result of the basaltic pulses (Training Collon Cura) (Coira, 1979). Considering the high sampling effort done for the present study we can conclude the type locality is isolated geographically and ecologically from other *Phymaturus* species. The type locality limits North-East with the lagoon and is surrounded by steppe shrubs typical of the low Austral Monte, where *Phymaturus* doesn't advance. We also explored northward along the number 6 provincial route by sampling outcrops dispersed in the middle sandy steppe and the South-East side where only few outcrops were found, without findings of *P. sinervoi*. Toward the South, there is the Jacobacci town and outcrops, several times surveyed, are inhabited by *P. spectabilis*, *P. agilis*, *P. excelsus*, and *P. spurcus*, all in varying degrees of volcanic plateaus isolation between them (see Scolaro & Ibagüengoytia 2007, Scolaro *et al.* 2008).

Natural history. The biotope of *P. sinervoi* is located inside the arid district of the Monte Austral, a steppe showing open ground, with gravel and effusive rocks. The dominant landscape is the barren steppe, with shrubby, low herbaceous coverage, with bare soil percentages above 50%. The dominant vegetation is composed by cushion bushes and sparse large clumps, the floristic physiognomy dominion are low shrubby steppes (with *Nassauvia glomerulosa* "colapiche", *Chuquiraga opositifolia* "quilimbay", *Mulinum spinosum* "neneo", *Senecio filaginoides* "charcao", *Stillingia patagonica* "mata loca", *Junellia* spp., *Amsinkia calycina* "ortiga", *Acaena splendens* "abrojo", *Perezia* spp., *Ephedra* spp. "solupe", *Fabiana patagonica*, *Grindelia coronensis* "melosa", *Austrocactus patagonicus* "cactus"), and mean shrubby-grass steppes (with *Prosopis denudans* "algarrobillo patagónico", *Lycium chilense* "yaoyín", *Lycium gillesianum*, *Adesmia patagonica*, *A. volckmanni* "mamuel choique", *Schinus johnstonii* "molle", and bund grasses (*Stipa papposa* "coirón", *Poa ligularis* "coirón poa", *Bromus catharticus*) (Cabrera 1971; León *et al.* 1988).

Phymaturus sinervoi selects rocky microhabitats that occur in an isolated basaltic plateau, at elevations over 1000 m. The geological history of this geographical zone has originated several similar altitudinal plateaus, where this and other lizard species tend to live relatively isolated (Scolaro 2006). Other reptile species coexisting with *P. sinervoi* are the iguanids *Liolaemus elongatus*, *L. bibronii*, *L. rothi*, *L. inacayali*, *L. casamiquelai*, *L. ceii*, *Diplolaemus sexcinctus* and the gekkonid *Homonota darwini*. The colubrid snakes *Philodryas patagoniensis* and *Philodryas trilineata*, and the viperid *Bothrops ammodytoides* are also common in the same locality, representing potential predators.

Our field and lab observations reveal that *P. sinervoi* is viviparous, as observed in all the other species of the genus. In captivity, two females gave birth to one and two fully developed offspring respectively early in February 2011. In the field, this species is often found eating plants, as also observed in other members of the genus, *i.e.* *Lycium chilense* and *Lycium gillesianum* to feed on fresh fruits and flowers, and over the herbaceous species *Amsinkia calycina* (Scolaro *et al.* 2008). In lab, specimens were feed with mealworms (*Tenebrio molitor*).

Discussion

We have presented morphological and biogeographical evidence to support the designation of one new *Phymaturus* species of the *patagonicus* group from Argentina, named herein as *P. sinervoi*. As a result of our study, the richness of the genus *Phymaturus* reaches a total of 36 species, and a richness of 22 species only for the *patagonicus* lineage, which contrasts with the 14 species known for the sister clade *flagellifer*, now named *palluma* (Pincheira-Donoso *et al.* 2008c).

A fundamental question behind the study and proposition of candidate new species is whether the integrated biological features of these populations are consistent with the occurrence of speciation events that should have taken place to originate them, considered as a true different species. According to Scolaro and Pincheira-Donoso (2010) we have followed some criterion to reduce the risk of erroneously inflating clades' diversity, which can have serious and multiple negative consequences (Isaac *et al.* 2004). In general, these signals should be able to suggest that (i) the new species and any potentially related species have followed evolutionary histories in different directions, and that (ii) gene exchange among these species is likely to be substantially or entirely interrupted, which can occur in sympatry if signals of strong assortative mating resulting from ecological or sexual mechanisms are observed. In the case of the *Phymaturus* species herein proposed, these signals appear to occur. Firstly, geographical signals of geographic isolation are prominent in *P. sinervoi*, which occurs in an area with no contact with other species of the genus, considering the extensive explorations carried out by this group from 1987 up to today. As stated in the diagnosis of this species, this isolation is very notable (the separation range reaches at least 50 kilometres in a straight line from the closer neighbouring species of the *patagonicus* clade). Even the dorsal pattern observed in *P. sinervoi* exhibits similarities only with *P. nevadoi* (Fig. 6), we discard the relationship with this species because the characteristic endemism of the genus *Phymaturus* and the geographical and ecological barriers that separate both species. *P. nevadoi* is an endemism isolated in a volcano surrounded by sandy

semidesertic areas and localized northernmost of the Superior Valley of Río Colorado and the Payunia region. In contrast, *Phymaturus sinervoi* lives in the austral Patagonian steppe, southernmost of the Río Negro superior Valley. In addition, *P. sinervoi* shows remarkable overall differences in dorsal pattern, size and scales number from the neighboring species (Fig. 5). While *P. ceii* is sexually dichromatic in contrast with the monochromatism found in *P. sinervoi*, there is no overlap between the coloration observed in *P. etheridgei*, *P. spectabilis* and more distant species of this clade as *P. patagonicus* or *P. indistinctus*. This would suggest that patterns of coloration of these species may have been subjected to (and are maintained by) divergent selection regimes (Losos 2009).

Despite the fact that this and several previous studies have contributed to increase the knowledge about *Phymaturus* lizards, which for decades were relegated to a secondary position after the prominent *Liolaemus* genus, several aspects of the biology of these peculiar reptiles remain to be studied. Recent research on phylogeography, reproductive and thermal biology (Piantoni *et al.* 2006; Ibarquengoytía *et al.* 2008; Boretto & Ibarquengoytía 2009; Díaz-Gómez 2009; Corbalán *et al.* 2011) has appeared to provide valuable new information that will be useful to further investigate the genus *Phymaturus* from a broader perspective.

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Appendix

Specimens examined and localities

Specimen numbers preceded by the acronym are housed in the following collections: IBA, Instituto de Biología Animal, Mendoza, Argentina; MLP-R and MLP-S, Colección Herpetológica del Museo de La Plata, Buenos Aires, Argentina; JAS-DC, J.A. Scolaro-Diagnostic Collection, CENPAT-CONICET, Puerto Madryn, Argentina; JMC-DC, J. M. Cei-Diagnostic Collection, Facultad de Ciencias Naturales, Universidad Nacional de San Luis, Argentina; UNCo-PH, Universidad Nacional del Comahue, Colección Herpetológica, Bariloche, Río Negro.

Phymaturus ceii: Río Negro, Chasicó, 1150 m asl, south of El Cuy Plateau: MLP-R 5289 (Holotype), MLP-R 5290-93 (Paratypes); JAS-DC 1000, 1002-09, 1018-24, 1026-29, 1031. ***Phymaturus patagonicus***: 40 km west Dolavon, Chubut: IADIZA-CH 00080; JAS-DC 813-820; IBA-R 0789; JMC-DC 335-336, 760, 842-845, 1300. ***Phymaturus spectabilis***: Ruta provincial 6, Km 24, Ing. Jacobacci, Río Negro: JAS-DC 1033-38, 1041-1042, 1047-52, 1054-59, 1061-63, 1066, 1091. ***Phymaturus etheridgei***: Pje. Quetrequil, Ruta Provincial 76, Km 39 SE of Jacobacci, Río Negro: JAS-DC 1907-1916.