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Amphibian & Reptile Conservation
15(2) [Taxonomy Section]: 10–22 (e278).

urn:lsid:zoobank.org:pub:D8B4BDF6-C656-460B-83F9-321A8F75E77A

A new lizard of the *Liolaemus montanus* group that inhabits the hyperarid desert of southern Peru

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***Abstract.*—A new lizard of the genus *Liolaemus* is described from the Tacna region of southern of Peru. This species belongs to the *L. montanus* group and was initially thought to be *L. poconchilensis* and *L. insolitus*. However, a series of diagnostic characters differentiate it consistently from these two species and all other species of the genus. To determine the taxonomic status of these lizards, their phylogenetic relationships were analyzed, as well as their morphological and ecological characteristics. The results of the analysis support the conclusion that this population of lizards represents a new species to science, and that the new species is related to *L. nazca* and *L. chiribaya*. The new species has sexual dimorphism and is known from elevations of ca. 1,000 m above sea level in the hyperarid Pacific deserts, which are populated by scattered *Ephedra americana* and *Poissonia* sp. Due to its highly restricted range and observed habitat loss, we recommend this species be categorized as Critically Endangered.**

Keywords. Tacna, Liolaemidae, reptiles, South America, systematics, taxonomy.

***Resumen.*—Una nueva especie de lagarto del género *Liolaemus* es descrita para la Región Tacna, sur de Perú. Esta especie pertenece al grupo *L. montanus*, la que fue inicialmente confundida con *L. poconchilensis* y *L. insolitus*. Sin embargo, una serie de caracteres diagnósticos la diferencian consistentemente de estas y otras especies del género. Para determinar su estatus taxonómico, nosotros analizamos sus relaciones filogenéticas, así como sus características morfológicas y ecológicas. Nuestros resultados sustentan la conclusión que esta población es una nueva especie para la Ciencia, e indica que esta nueva especie está relacionada a *L. nazca* and *L. chiribaya*. La nueva especie presenta dimorfismo sexual, y es conocida en elevaciones cercanas a los 1,000 m sobre el nivel del mar, en el hiperárido desierto del Pacífico con matorral de *Ephedra americana* y *Poissonia* sp. Debido a su distribución restringida y la pérdida de hábitat observada, nosotros proponemos que sea incluida en la lista de especies amenazadas como En Peligro Crítico.**

Palabras clave. Tacna, Liolaemidae, lagartos, reptiles, sistemática, taxonomía.

Citation: Valladares-Faúndez P, Franco-León P, Jove Chipana C, Navarro Guzmán M, Ignacio-Apaza J, Apaza JI, Cáceres Musaja C, Langstroth R, Aguilar-Kirigin A, Gutierrez RC, Abdala CS. 2021. A new lizard of the *Liolaemus montanus* group that inhabits the hyperarid desert of southern Peru. *Amphibian & Reptile Conservation* 15(2) [Taxonomy Section]: 10–22 (e278).

Accepted: 5 November 2020; **Published:** 12 August 2021

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Introduction

The richness of reptile species in Peru has been quantified as 365 species (Carrillo de Espinoza and Icoechea 1995). However, since that date many new species have been described for the country (Lehr et al. 2019), particularly members of the genus *Liolaemus* (Laurent 1998; Lobo et al. 2007; Aguilar-Putriano et al. 2013, 2019; Gutiérrez et al. 2018; Villegas et al. 2020; Chaparro et al. 2020; Huamani-Valderrama et al. 2020), a group that is very widespread between central Peru and Tierra del Fuego of Chile and Argentina. In addition, some *Liolaemus* species described from northern Chile have subsequently been documented for Peru, such as *L. poconchilensis* (Langstroth 2011), *L. chungara*, and *L. pleopholis* (Valladares et al. 2021).

Lizards from the desert of the Pacific slope of northern Chile and southern Peru are generally characterized by the "phrynosaurine" morphotype (Valladares 2004), and they are recovered in the *L. reichei* clade in the phylogeny of Abdala et al. (2020). For example, *L. audituvelatus*, *L. balagueri*, *L. chiribaya*, *L. insolitus*, *L. nazca*, *L. poconchilensis*, *L. reichei*, *L. stolzmanni,* and *L. torresi* present eyelids with a conspicuous comb, eye diameter greater than length between anterior borders of eye and rostral, tail shorter than snout-vent length, head scales poorly differentiated, isognathus jaws, loreal region depressed and dorsal scales imbricate, smooth, and with small accompanying scales (i.e., heteronotes). In Peru, there are known to be four species of the *L. reichei* clade: *L. balagueri*, *L. insolitus*, *L. nazca,* and *L. poconchilensis*. Males of *L. balagueri* and *L. nazca* have a unique coloration pattern, with ocelli and green scales on both side of the body, while males of *L. chiribaya*, *L. poconchilensis,* and *L. insolitus* have blue and orange-to-red scales, and pronounced sexual dimorphism. They inhabit sandy or slightly rocky areas, and are associated with small and restricted vegetation patches. These species all inhabit coastal desert ecosystems of Chile and Peru with extreme aridity, very pronounced thermal fluctuations, and very scant precipitation (Hartley et al. 2005).

During a survey of the biodiversity of arid ecosystems in southern Peru, a small population of lizards with particular morphological characteristics was found. Initially they were thought to be *L. poconchiliensis* and *L. insolitus*, however their large size and color pattern indicated that this population constitutes a new species of *Liolaemus*. In the present paper, these lizards from the arid coastal desert of southern Peru are described as a new species, based on a detailed comparison with other species of the *L. montanus* group and their phylogenetic relationships, taxonomic position, and conservation status are then discussed.

Materials and Methods

Phylogenetic analyses. Phylogenetic analyses were performed using the morphological matrix of Abdala et al. (2020), which includes 329 characters and 105 terminals (including *Ctenoblepharys adspersa* and *Phymaturus palluma* as outgroup, and 103 terminals of the *Liolaemus montanus* group). Parsimony was used as the optimality criterion, only selecting the shortest trees or those with the fewest homoplasies. TNT 1.5 (Tree Analysis Using New Technology, version 1.5; Goloboff et al. 2003) was used to generate the phylogenetic hypotheses. Continuous characters were analyzed following Goloboff et al. (2006) and were standardized using *mkstandb.run*. For this analysis, the value of two was considered as the highest transformation cost. Heuristic search was used to find the shortest trees or those with the smallest number of steps. The matrix was analyzed under equal weight or under implied weight, and K values from three to 20 were used. One thousand replications were performed for each search, and 20 trees were saved per replicate. Symmetric resampling was used to obtain support values for the results obtained, with 500 replications and using a deletion probability of 0.33.

Morphology. The morphological characters traditionally used in *Liolaemus* taxonomy were examined in this study, including those of Laurent (1985), Cei (1986, 1993), Etheridge (1993, 1995, 2000), Lobo (2001), Abdala (2002, 2003, 2007), and Abdala et al. (2019, 2020). The terminology of Smith (1946) was followed for descriptions of squamation, and that of Frost (1992) for descriptions of neck-folding. Descriptions of body-color patterns follow Lobo and Espinoza (1999), Abdala (2007), and Abdala et al. (2020).

Measurements and scale counts were recorded from specimens fixed in 10% formalin and preserved in 70% ethanol. Body and scale measurements were taken with digital calipers to the nearest 0.02 mm. A binocular dissecting microscope (10–40X) was used to count and characterize the scales. Where bilateral, scale count and measurement data were taken from the right side of the lizards.

The holotype and paratypes were compared with other species from the *L. montanus* group (*sensu* Etheridge 1995 and Abdala et al. 2020). Specimens were measured (Table 1) and compared with other members of the *L. reichei* group from adjacent regions (Table 2). Descriptions of color in life for the new species were based on observations of freshly collected animals and photographs taken at the time of capture.

Ecology. The niche study for the new species was carried out by means of predictive modeling using the MaxEnt v3.4.1 software, which employs algorithms that predict the potential distribution of a species in relation to their environmental conditions (Phillips et al. 2006). It is considered one of the most efficient programs for assessing the potential niche of any species (Elith et al. 2006). The coordinates of the collected individuals were used along with nine other environmental variables (Table 3). The AUC statistic was used to validate the

Table 1. Morphological measurements (in mm) of four specimens of *Liolaemus basadrei* **sp. nov.** Specimen HP20CBT corresponds to the proposed holotype.

	HP20CBT	**HP21CBT**	**HP22CBT**	**HP23CBT**
Sex	**Male**	**Male**	**Female**	**Female**
Body length	90.6	88.2	63.6	78.7
Tail length	68	78.1	53.6	45.1
Head length	20.4	21	14	15.8
Head width	18.2	16	10.9	13.9
Forelimb length	28.4	31	23.2	26.6
Hindlimb length	43.2	42	35.7	40.8
Supralabials	10	8	9	9
Infralabials	6	7	6	7
Lorilabials	13	13	11	13
Scales around midbody	79	82	79	74
Scales of the body length	92	89	88	86
Precloacal pores	6	3	0	0

ecological niche model, where values of 0.5–0.7 indicate low confidence, values of 0.7–0.9 demonstrate a useful application in the model, and values greater than 0.9 suggest high confidence (Lobo et al. 2007). Likewise, the Jackknife test was applied, which allows assessment of the contribution of each variable individually (Shcheglovitova and Anderson 2013).

Conservation status. The conservation status of the species has been defined based on the variables considered in the Conservation Priority Index (CPI) of Cofré and Marquet (1999) and those of the *IUCN Red List of Threatened Species*. Some of the key variables considered in the CPI were: (a) number of different ecoregions where the species is found, taken as indicative of the degree of habitat specialization; (b) area of geographic distribution of the species (km^2); (c) average local abundance (individuals/km^2); (d) endemism, based on the number of countries where the species is present; (e) taxonomic singularity, based on the degree of monotypy at the levels of genus and family; (f) body mass; (g) effect of human activities; and (h) degree of protection, based on the percentage of area of the ecoregion inhabited by the species which lies within a protected area (such as national parks, national reserves, and natural monuments).

Table 2. Morphological measurements (in mm) of six *Liolaemus* species. The sequence of numbers corresponds to minimum, average (in parentheses), and maximum values found in the body measurements.

	L. basadrei **sp. nov.**	*L. insolitus*	*L. poconchilensis*	*L. chiribaya*	*L. torresi*	*L. reichei*
	(*n* = 4)	(*n* = 1)	(*n* = 4)	(*n* = 9)	(*n* = 8)	(*n* = 3)
Body length	63.6 (80.3) 90.6	67.7	47.17 (51.7) 53.83	49.6 (53.3) 68.8	53.8 (58.1) 64	41.5 (47.7) 50.8
Tail length	45.1 (61.2) 78.1	61.9	42.66 (47.2) 53.65	–	58.8 (57.4) 74	35.7 (39.5) 43.1
Head length	14 (17.8) 21	16.2	11.34 (13.1) 14.16	13 (14.8) 16.3	13 (13.6) 14.5	10 (10.9) 11.5
Head width	10.9 (14.8) 18.2	14.6	9.51 (10.9) 11.53	11.4 (12.8) 11.4	10.3 (11.02) 11.7	8.3 (8.5) 9.7
Forelimb length	23.2 (27.3) 31	31.4	22.2 (24.8) 27.5	20.4 (23.4) 25.8	26.3 (28.8) 30.5	21.4 (22.6) 24.4
Hindlimb length	35.7 (40.4) 43.2	44.1	31.15 (34.1) 32.62	30.9 (33.4) 34.8	38.6 (40.1) 42.2	30.1 (31.7) 33.4
Supralabials	8 (9) 10	9	12	7 (8.6) 10	10	9 (9) 9
Infralabials	6 (6.5) 7	–	8	–	7	6 (6.7) 8
Lorilabials	11 (12.5) 13	9	14	–	9	8 (8.7) 9
Scales around midbody	74 (78.5) 82	62	62	55 (61.7) 66	71	43 (45) 47
Scales of the body length	86 (88.8) 92	63	64	52 (57.4) 61	86	50 (51.7) 54
Precloacal pores	0 (2.3) 6	6	4	2 (3.7) 5	3	4

Table 3. Environmental variables and their contributions to the model of *Liolaemus basadrei* **sp. nov.** distribution, obtained using the MaxEnt algorithm.

Variables	Contribution to the model (%)
Precipitation	0.6
Average temperature	25
Climatic classification	4.8
Physiography	46.3
Slope	0.3
Geomorphology	0.4
Humidity	0
Soil type	0.8
Life zone	21

Images and maps. Photographs were taken of live specimens using a Canon EOS Rebel T7i digital camera. The distribution map was elaborated in QGIS free software, using the coordinates from the authors' own records, which were taken with a GPS device (datum WGS84), Garmin inReach Explorer.

Results

Phylogenetic analyses. The morphological phylogenetic analysis indicated that the new species belongs to the *Liolaemus reichei* clade of the *L. montanus* group, nested within a monophyletic subgroup that includes *L. audituvealtus*, *L. balagueri*, *L. chiribaya*, *L. insolitus*, *L. nazca*, *L. poconchilensis*, *L. reichei*, and *L. torresi* (Fig. 1).

Twenty trees were saved by each replicate. All resulting phylogenetic trees showed the same clades as observed in Fig. 1, and are supported by 25 synapomorphies, six continuous characters, and 21 discrete characters. All analyzes showed the new species as sister to the clade (*L. nazca* + *L. chiribaya*), and this clade is supported by 24 all continuous synapomorphies. This clade is at the same time a basal branching (according to Krell and Cranston 2004) of two large clades, one formed by species that inhabit Chile and the other by those that inhabit Peru (except for *L. balagueri*, which is sister species to the entire clade). These results were obtained in all trees with values of k = 3–20. Phylogenetic evidence indicates that the new species has no direct relationship with *L. insolitus*. The new species has a total of 26 autapomorphies, of which 13 are continuous and 13 are discrete.

Taxonomy

Liolaemus basadrei **sp. nov.**
(Fig. 2A–D)

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Holotype. HP20CBT, an adult male (Fig. 2A–B) from the east slope of an unnamed hill east of Locumba Valley, 17°44'38"S, 70°45'41"W; 897 m, Jorge Basadre Province, Tacna Region, Peru; collected on 25 January 2019, Pablo Franco, Pablo Valladares-Faúndez, Cesar Chipana, Marco Navarro and Javier Ignacio collectors.

Allotype. HP21CBT, an adult female (Fig. 2C–D), from the east slope of an unnamed hill east of Locumba Valley, 17°45'21"S, 70°45'51"W; 761 m, Jorge Basadre Province, Tacna Region, Peru; collected on 25 January 2019, same collectors.

Paratypes. Two adults: HP22CBT and HP23CBT, from the east slope of an unnamed hill east of Locumba Valley, one male and one female. From the high voltage tower to the Pan-American highway, on a steep slope (17°44'50"S, 70°46'06"W); 970 m, same collectors.

Diagnosis. *Liolaemus basadrei* **sp. nov.** belongs to the *L. montanus* group (*sensu* Etheridge 1995; Abdala et al. 2020). This species differs from the species of the *L. boulengeri* group of the *L. montanus* group series by the absence of a patch of enlarged scales on the posterior thigh of the hind limb in the new species (Etheridge 1995; Abdala 2007). In relation to the *L. montanus* group, *L. basadrei* **sp. nov.** differs from *L. andinus*, *L. annectens*, *L. cazianae*, *L. chlorostictus*, *L. dorbignyi*, *L. duellmani*, *L. eleodori*, *L. erguetae*, *L. erroneus*, *L. etheridgei*, *L. evaristoi*, *L. fabiani*, *L. famatinae*, *L. fittkaui*, *L. forsteri*, *L. foxi*, *L. gracielae*, *L. griseus*, *L. hajeki*, *L. halonastes*, *L. huacahuasicus*, *L. huayra*, *L. inti*, *L. islugensis*, *L. jamesi*, *L. juanortizi*, *L. lenzi*, *L. melanogaster*, *L. montanus*, *L. molinai*, *L. multicolor*, *L. nigriceps*, *L. orko*, *L. ortizi*, *L. pachecoi*, *L. pantherinus*, *L. patriciaiturrae*, *L. pleopholis*, *L. poecilochromus*, *L. polystictus*, *L. pulcherrimus*, *L. puritamensis*, *L. qalaywa*, *L. robertoi*, *L. robustus*, *L. rosenmanni*, *L. ruibali*, *L. schmidti*, *L. scrocchii*, *L. signifer*, *L. tajzara*, *L. thomasi*, *L. vallecurensis*, *L. victormoralesii*, *L. vulcanus*, and *L. williamsi* by possessing isognathus jaws and tail shorter than Snout-Vent Length (SVL). Of the remaining species, *L. basadrei* **sp. nov.** are robust lizards (SVL = 88.2 mm) differing from *L. andinus*, *L. anqapuka*, *L. audituvelatus*, *L. balagueri*, *L. cazianiae*, *L. chiribaya*, *L. duellmani*, *L. eleodori*, *L. erguetae*, *L. erroneus*, *L. etheridgei*, *L. evaristoi*, *L. fabiani*, *L. famatinae*, *L. fittkaui*, *L. foxi*, *L. gracielae*, *L. griseus*, *L. hajeki*, *L. halonastes*, *L. huacahuasicus*, *L. islugensis*, *L. molinai, L. montanus*, *L. multicolor*, *L. nazca*, *L. orko*, *L. omorfi*, *L. ortizi*, *L. pantherinus*, *L. poconchilensis*, *L. poecilochromus*, *L. porosus*, *L. pulcherrimus*, *L. reichei*, *L. robertoi*, *L. rosenmanni*, *L. ruibali, L. smidthi*, *L. stolzmanni*, *L. tajzara*, *L. thomasi*, *L. torresi*, *L. vallecurensis,* and *L. williamnsi* which are smaller (SVL between 50–80 mm). The dorsal scales on the body are smooth and subimbricate in *Liolaemus basadrei* **sp. nov.**, differing

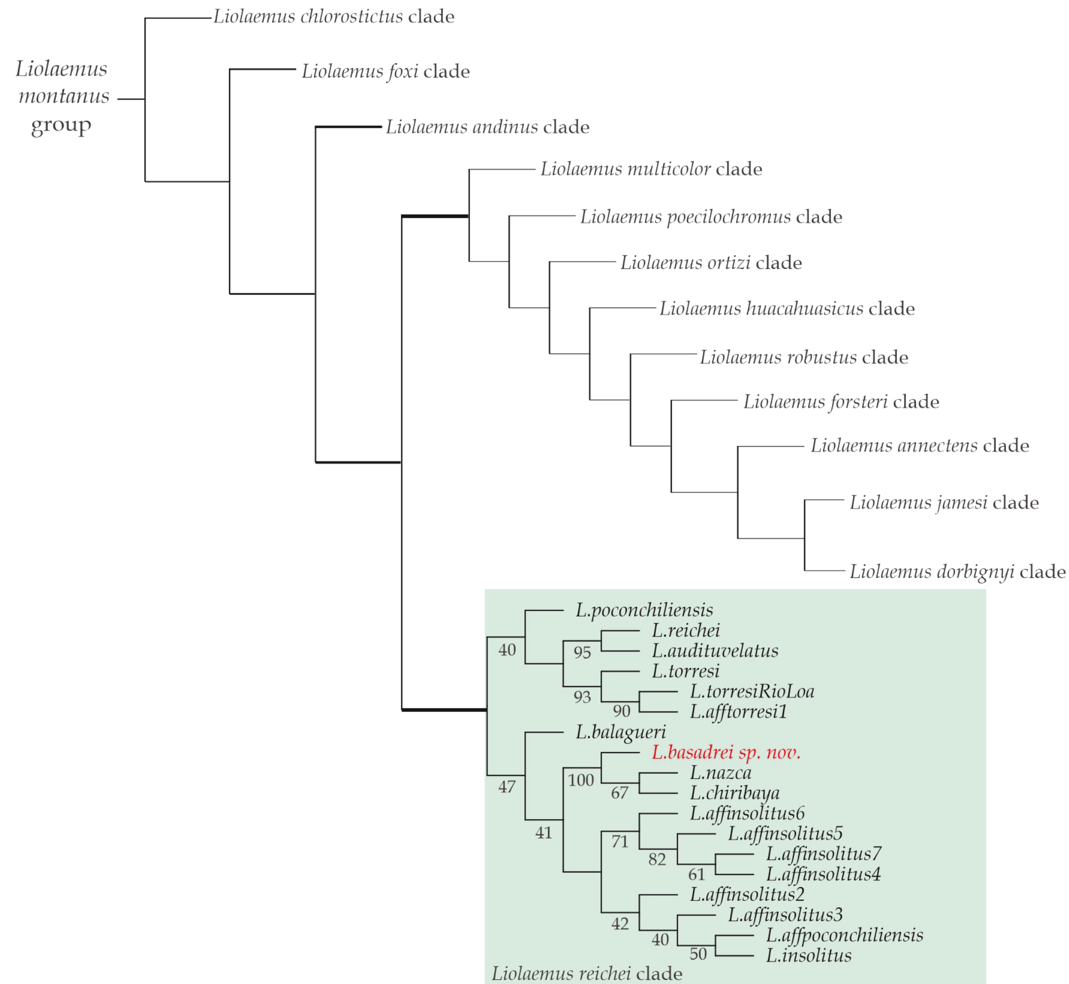

Fig 1. Phylogenetic tree obtained for the new species.

from species that have dorsal scales with an evident keel: *L. aymararum, L. etheridgei, L. famatinae, L. fittkaui, L. griseus, L. huacahuaicus, L. montanus, L. orko, L. oritizi, L. polystictus, L. pulcherrimus, L. qalaywa*, *L. signifer, L. tajzara, L. thomasi, L. victormoralesi*, and *L. williamsi. Liolaemus insolitus* is the most similar among these lizards to the new species, but it differs principally by the number of scales along the dorso-thoracic region (scales between occiput and anterior border of thigh, 63 in *L. insolitus* versus 86–89 in the new species), number of ventral scales (70–78 in *L. insolitus* versus 79–85 in the new species), and the dorsal pattern in *L. insolitus* has fewer dark red scales and more sky-blue scales.

Phylogenetic results indicate that *L. basadrei* belongs to the clade of *L. reichei* (Abdala et al. 2020). *L. basadrei* **sp. nov.** differs from *L. anqapuka*, *L. audituvelatus*, *L. balagueri, L. chiribaya*, *L. insolitus, L. nazca*, *L. poconchilensis*, *L. reichei*, *L. stolzmanni*, and *L. torresi* because the latter have a smaller size (< 70 mm SVL) and the new species is over 88 mm. *Liolaemus basadrei* **sp. nov.** also differs from *L. balagueri*, *L. chiribaya*, *L. insolitus*, *L. nazca*, *L. poconchilensis*, *L. reichei,* and *L. torresi* by having a greater number of scales around the body (74–82 vs. < 72) and a greater number of dorsal scales on the body (84–92 vs. < 80). The number of ventral scales is greater than in *L. balagueri*, *L. chiribaya*, *L. insolitus* and *L. nazca* (79–85 vs. < 79). The presence of blue scales on the body also differentiates it from species that do not have them: *L. audituvelatus*, *L. balagueri*, *L. nazca*, *L. reichei,* and *L. torresi*.

Description of the holotype. Medium-sized lizard, robust body, limbs short and robust, head triangular and short, distinct from neck, widest across temporal region, 0.89 times wider (as measured across widest part of temporal region) than long (as measured from inferior apex of external auditory meatus to anterior surface of rostral). Snout short (as measured from tip of snout to anterior corner or orbit), 0.26 times head length, orbit (as measured along its greatest horizontal length) short, 0.17 times head length. Nasal region slightly swollen, convex in profile, rostral narrow, 2.8 times wider than high, bordered by three postrostrals, semirectangular and pentagonal, external ones of greater size. Rostral scale in contact with a lorilabial and a supralabial scale on each side. Four hexagonal, irregular, and elongated internasals, external pair meeting nasals. Five medium and irregular scales between postrostral and internasal.

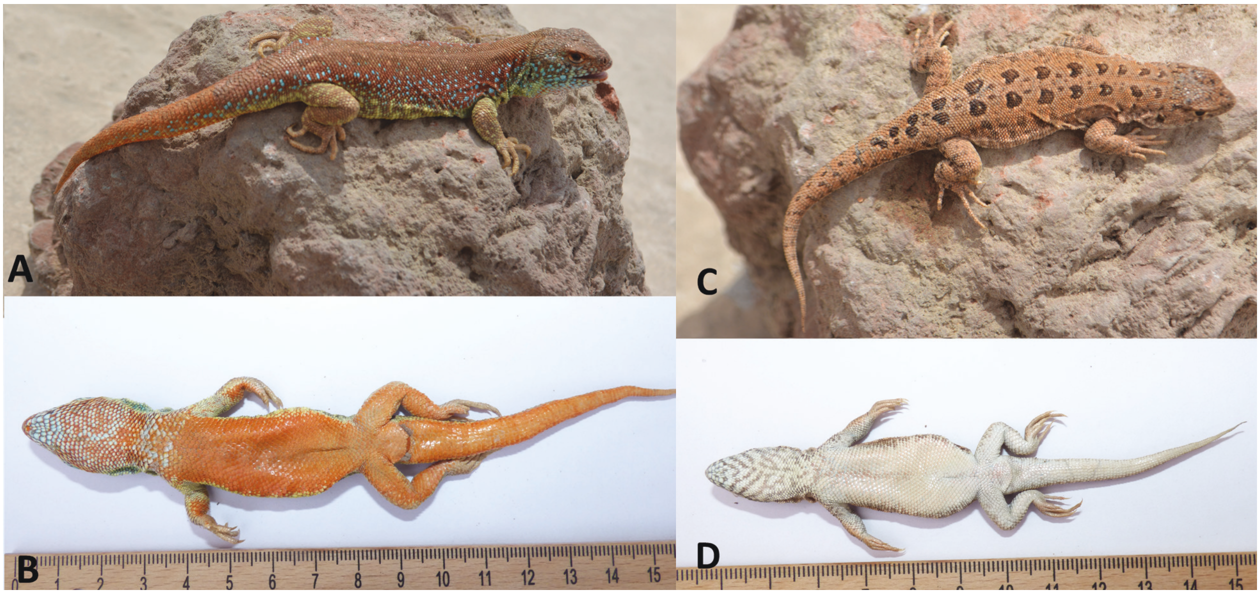

Fig. 2. Dorsal **(A)** and ventral **(B)** views of holotype specimen collected in Valle de Locumba, Jorge Basadre Province, Region Tacna, Peru. Dorsal **(C)** and ventral **(D)** views of allotype specimen collected in Valle de Locumba, Jorge Basadre Province, Region Tacna, Peru.

Nasal scales larger, in contact with one postrostral, one lorilabial, one internasal, and two irregular postnasals, and a medium scale between internasal and postrostral. Nasal is separated from rostral and anterior supralabials by anterior lorilabials. Posterior nasal rounded and its anterior part is angled. Nostril oriented postero-laterally. Dorsal head scales larger, differentiated, convex; frontonasal region convex in profile. Twenty-one irregular scales in frontonasal region, five irregular, convex and smooth prefrontals. Frontals and postfrontals fragmented and irregular. Two postfrontals meet to interparietal, which is slightly smaller than adjacent parietals, irregular, bordered by eight scales, with a distinct "eye" that corresponds to pineal organ (Fig. 3A). Elongated, convex and irregular parietals, posterior to interparietal. Supratemporal region smooth, irregular, and convex. Temporals larger, convex, juxtaposed, 11 between postocular and anterior margin of ear, 0.43 times head length. External auditory meatus large, rounded, 2 times higher than wide, bordered by irregular scales, smaller anteriorly, one largest on the upper side and not differentiated from posterior temporals, with small interstitial granules. Orbitals 0.17 times head length. Supraocular regions large, scales medium size, eight on each side, 4–5 in a horizontal line across widest part of supraocular region between superciliaries and frontals. Fifteen scales form an irregular circum-orbital semicircle. Seven superciliaries larger, not keeled, four anterior, two posterior, and one interciliar. Palpebrals small, smooth, convex and juxtaposed, 11 inner rectangular ciliaries, outer ciliaries of lower lid 12, outer ciliaries of upper lid 11, third ciliary and three posterior ciliaries triangular, but not as projecting as those of lower lid, those in middle of lid more nearly rectangular, not projecting. One preocular wider than subocular, pentagonal, preceded anteriorly by a large canthal. Subocular elongated, about 8 times longer than high and postocular elongate but shorter than preocular and subocular. Eleven lorilabials, a row of small scales between the subocular and lorilabials that start from the loreal scales. Anterior lorilabials rectangular, posteriors irregular and convex. Six irregular loreals. Ten supralabials, equal in size to lorilabials. No supralabials in contact with subocular, and one lorilabial in contact with subocular (Fig. 3B). Mental large, 1.1 times as wide as rostral, bordered by two infralabials and two postmentals, not in contact with anterior sublabials. Four postmentals on each side, infralabials six, gulars medium size, smooth, semitriangular, convex, imbricate (Fig. 3C). Ventral scales triangular, similar in size to dorsal scales, imbricate and smooth. Pectoral scales imbricate and triangular, on the sides are quadrangular. Posterior abdominal scales semirectangular. Scales of precloacal region imbricated and rounded, but wider than long. Six orange precloacal pores. Dorsal scales of neck small, smoothly overlapping, slightly concave, smooth and triangular, with interstitial granules. Dorsal scales of body larger, rounded or semicircular, smooth and subimbricate, similar to the lateral scales. Scales around midbody 79. Middorsal scales from occiput to point even with anterior margin of thigh 92. Lumbar scales wider than long, similar in size but less imbricated than dorsal scales and with interstitial granules. On the sides of the body, scales are quadrangular.

Lateral nuchal skin folds well-developed and complex. Two short folds, one originating at superior and other at inferior margin of auditory meatus, converging posteriorly to form a V-shaped fold, continuing posteriorly as longitudinal neck fold, intercepted by oblique neck fold and antehumeral fold, which reaches half of body. A fold born in the armpit, projects to the groin. Scales

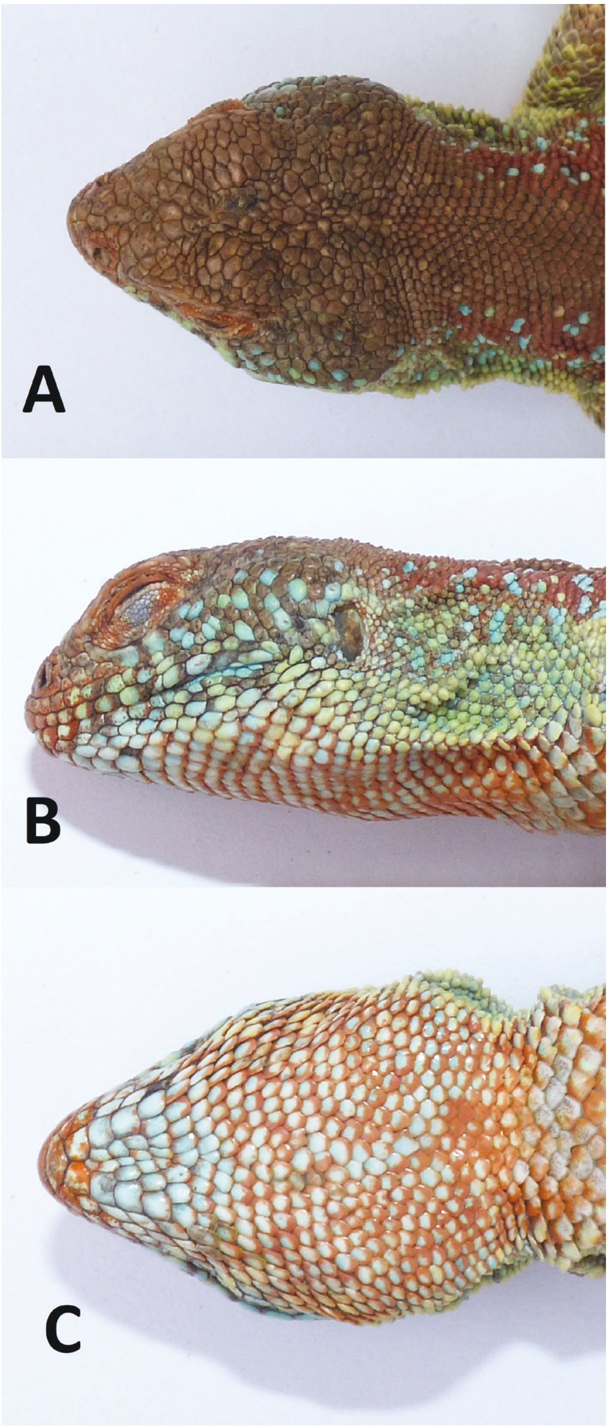

Fig. 3. Dorsal **(A)**, ventral **(B)**, and lateral **(C)** views of the head of holotype HP20CBT.

of lateral neck flat or slightly concave, nonoverlapping. Below the fold, triangular scales are slightly imbricate, similar in size to the dorsal neck. Limbs robust and short. Adpressed hindlimbs reach only middle of body. Forelimbs 0.32 times SVL and hindlimbs 0.52 times SVL. Scales of the base of the arm similar to those of the neck. Brachial scales smooth, triangular and imbricate, larger in size than dorsal body scales. Antebrachials tend to be semirectangular and smooth. Elbow scales semitriangular, and wider than long. Preantebrachials flat, smaller, rounded, and juxtaposed, with interstitial granules. Suprafemorals and postfemorals larger and triangular, smooth and imbricate. Prefemorals small, smooth, convex, juxtaposed. Supratibials and pretibials longer than wide, imbricate, with interstitial granules. Infratibials smooth, larger, triangular, and imbricated. Supratarsals large, smooth, triangular, and imbricate. Subdigital lamellae of fourth toe 25, with distal margin slightly tridentate, claws long and slender. Supracarpals large, smooth, imbricate, wide than longer. Infracarpals imbricate, somewhat projecting, mucronate, supradigitals imbricate, keeled and triangular, subdigital lamellae of fourth finger 19, with distal margin slightly tridentate, claws long and slender. Tail short and robust, slightly thickened at the base and somewhat depressed. The rest is thick and rounded distally. Tail 0.75 times body length. Dorsal and lateral caudal scales tend to be irregular, rectangular, with interstitial granules and imbricate; wider than long, rugose and slightly imbricate on middle third of tail. Ventral caudal scales triangular on middle third of tail, but then are rectangular and strongly imbricate, longer than wider. Autotomic region with 12 scales on dorsal and lateral tail, and eight ventral scales.

Coloration. The holotype has a dark red head and dorsal body color. Each side of the temporal region and body has sky blue scales that reach laterally to the tail. Ventrally there is a heavily variegated coloration, more intense on the lateral side and throat, ventral side color yellow with sandy brown spots, a pattern repeated on fore and hind limbs, and until the end of tail. Dorsal tail dark orange. Throat predominantly yellow, with sky blue scales and some red scales.

Variation in morphological measurements and scaling. Variations based on four specimens, two males and two females, collected from the same site as the holotype, are presented in Table 1. The females present a sandy brown colored head, similar to the sand on which they live. On the dorsal neck are two medium black spots which are in parallel along to the dorsal body, where they become larger and reach to the first part of the tail. Scapular area shows a short black spot subsequently followed by a white spot, a pattern which is along the dorso-thoracic region. Ventrally there is a slightly variegated pattern, more intense on the throat, ventral side color white with light gray spots, a pattern repeated on fore and hind limbs, and until the end of the tail. Female has dorsal scales well defined, not fragmented, circumorbital semicircles well-defined, large, and unfragmented subocular, parietals large, pentagonal, and well-defined. Differences are mainly in the form of interparietal, which in both females is hexagonal, while in the males it is irregular. Variation in the number and form of the scales: temporals eight between postocular and anterior margin of ear, 13 lorilabials, without a row of small scales between the subocular and lorilabials, eight supralabials, middorsal

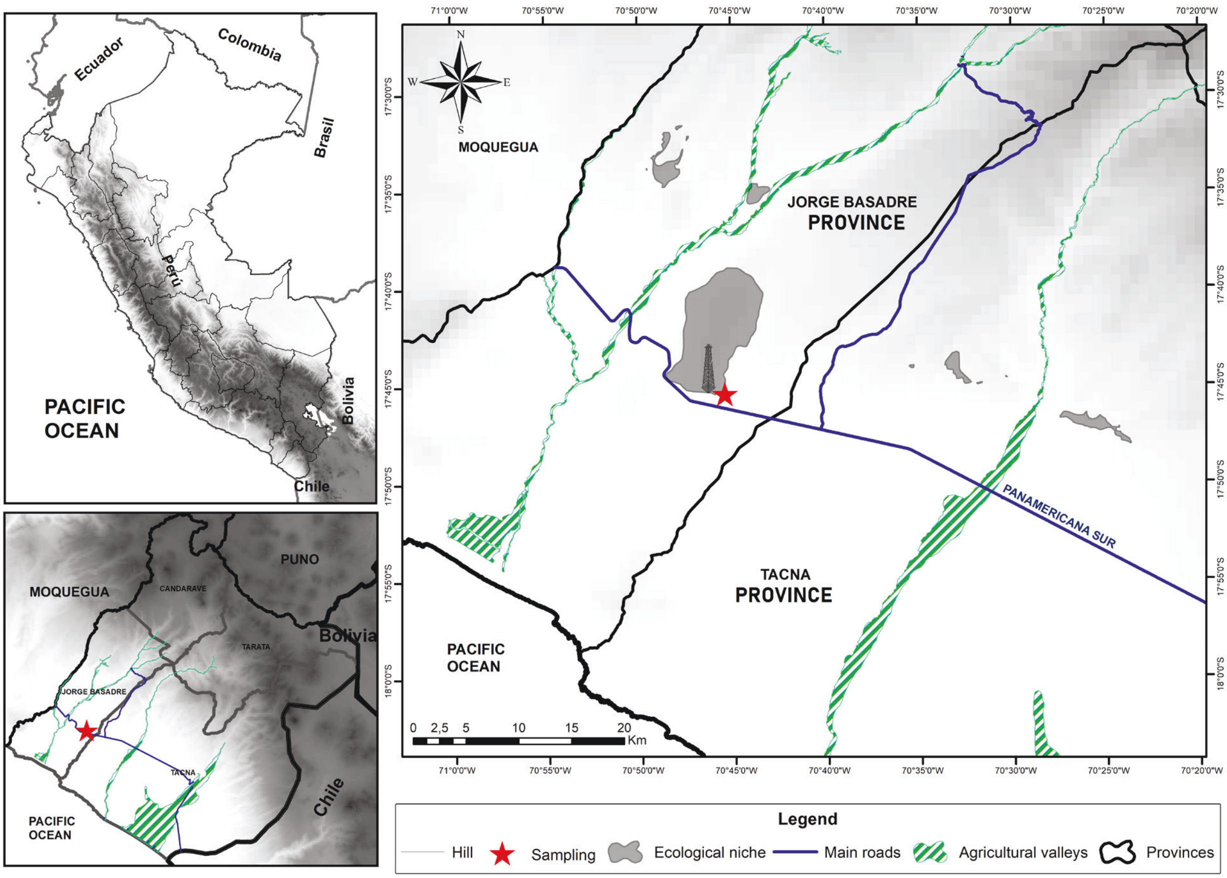

Fig. 4. Current (star) and potential (in gray) distributions of *Liolaemus basadrei* in the Jorge Basadre Province, Tacna, Peru, obtained from the MAxEnt algorithms.

scales from occiput to point even with anterior margin of thigh 88. Elbow scales semitriangular and wider than long, but lightly keeled. The tail has a spotted pattern. Forelimb with small dark spots, and hindlimbs variegated with black and dark brown spots.

The dorsal area of the female is light brown or pinkish, and the head has dark brown and gray spots with an irregular shape and order. Lateral area of the head with dark brown spots that cross the muzzle transversely. Back of neck and body of the same color as the head, with large brown spots, arranged two on each side, bordered by a row of small white scales, a pattern that is repeated throughout the entire body. Paravertebral region with small brown spots, while in the lumbar area a greater number of white scales are observed. Along the tail, the dorsal pattern is lost and dark brown spots are observed in an irregular manner and shape, both dorsally and laterally. Forelimb and hindlimb with light brown spots irregular in shape and arrangement. Lateral area of the neck and body white, accompanied by irregular dark spots. Gular area with gray bands directed towards the mid-ventral area. Chest with small and very faint gray spots, white or slightly pink belly, ventral area of the fore and hind limbs without spots. Ventral area of the tail white or slightly pink.

Ecology. The knowledge of this species is very poor. Apparently, its distribution is restricted to the *Ephedra americana* and *Poissonia* sp. desert scrub formation of the northern Tacna Region, collected in the Locumba valley, 64.5 km north of Tacna (17°45’21”S; 70°45’51”W) (Fig. 4). Their activity was noted in the morning and afternoon, and this species thermoregulates at midday by seeking shade under rocks, cacti, or bushes. Reproductive phenology, as well as diet and distribution, are unknown. The new species shares its habitat with a species of *Microlophus*, currently under description, of similar size and mass, and the two species have been observed utilizing the same cacti as refugia (Fig. 4). While there are other localities in southern Peru where *Liolaemus* and *Microlophus* can be observed in close proximity, elsewhere the *Microlophus* is of larger size and mass than the *Liolaemus*. The new species is the largest and most robust known species of the *L. reichei* clade and also the only one known to be associated with cacti. It is possible that the large size of the new species reflects its evolution in a resource-rich environment relative to the other species that are typically found in absolute desert areas with extremely sparse vegetation. The cacti likely provide food, water, refuge, and a reduced cost of thermoregulation. Examination of hawk and owl pellets from the Locumba Valley has yielded evidence that both species of lizards are important elements of the local trophic web (Valladares et al. 2021).

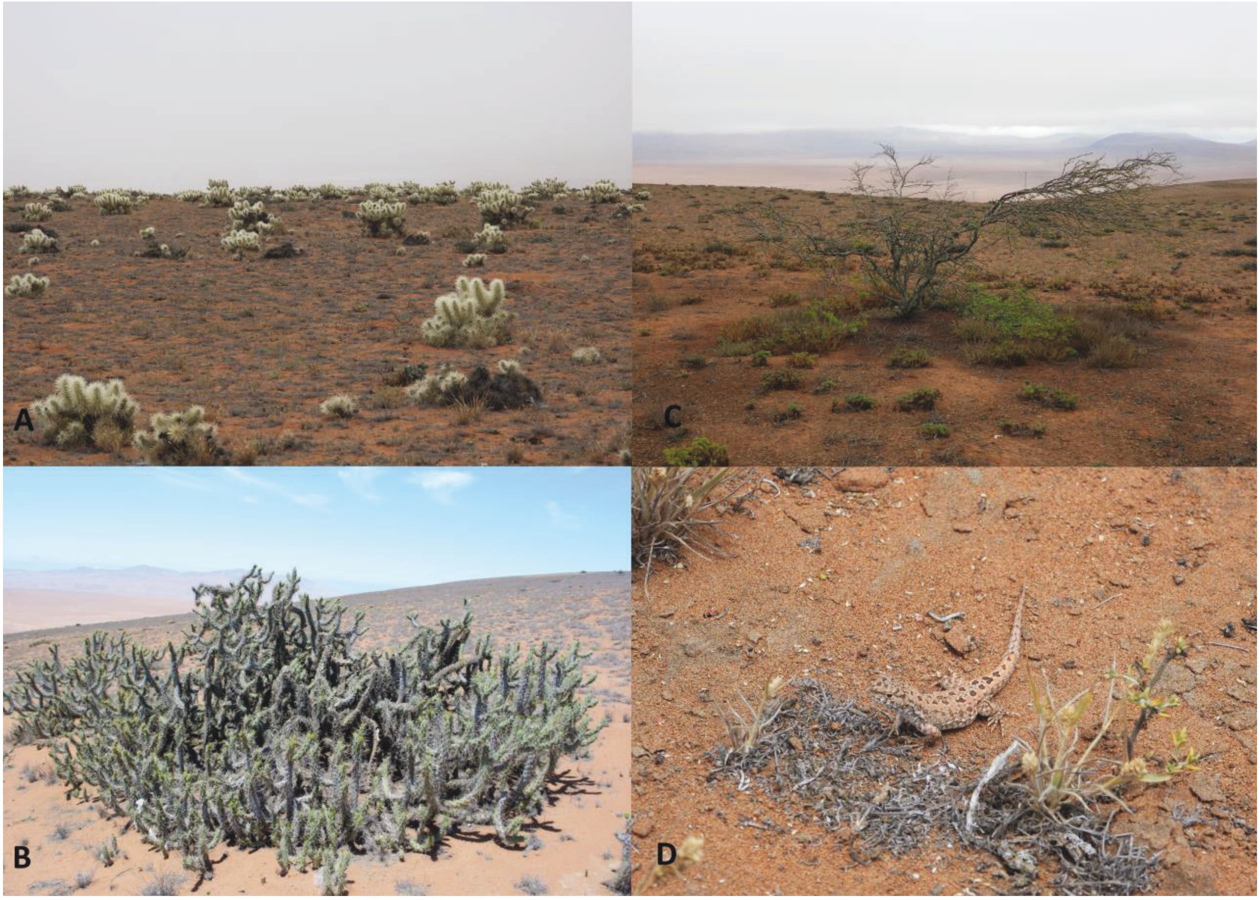

Fig. 5. *Terra typica* of *Liolaemus basadrei*. Valle de Locumba, 897 m, Jorge Basadre Province, Region Tacna, Perú.

The ecological niche modeling yielded an AUC of 0.988, indicating a high level of statistical confidence. The most informative variables for the current ecological niche of *L. basadrei* **sp. nov.** were physiography, the annual average temperature, and the type of life zone, followed by the type of climate, precipitation, and slope (Table 3). The remainder of the variables had little intervention in the model according to the Jackknife test. The area of the ecological niche of *L. basadrei* **sp. nov.** is only 79.76 km^2, with distribution exclusively in the Jorge Basadre and Tacna provinces, specifically in the districts of Locumba and Inclan, respectively, with a predicted altitudinal range of 650 to 1,125 m asl (Fig. 4).

Conservation status. According to the CPI variables considered by Cofré and Marquet (1999), *Liolaemus basadrei* **sp. nov.** is a species that inhabits only a single ecoregion (absolute desert), with an extreme specialization: known range does not exceed 100 km^2, with an abundance of 7 individuals/km^2; inhabits only southern Peru; presents a low taxonomic singularity (*Liolaemus* have around 300 species); this species is large, considering both the generic and specific level of the *L. reichei* clade (see Table 2); and it has anthropogenic pressure, because it lives near an interstate highway and agricultural areas, its habitat area includes high voltage towers, and its distribution is not within any protected wild areas. All the variables analyzed here indicate that *L. basadrei* is a species that should be considered as Endangered based on the CPI approach. Regarding the IUCN Red List criteria for evaluating whether a taxon belongs in a "threatened" category (IUCN 2012, 2019), we estimate the area of occupancy of *L. basadrei* to be less than 10 km^2 in a single location with ongoing threats to the extent and quality of its habitat, and we estimate its population size to be fewer than 250 mature individuals. Thus, we recommend the category of Critically Endangered B2ab(iii); C2a(ii). We have sampled localities broadly throughout southern Peru and northern Chile for more than 20 years, and we are confident that *L. basadrei* is restricted to an extremely small geographic area. Over the course of a year, we visited each of the areas identified as potentially suitable habitat in Fig. 4 and found the species only in the area which includes the type locality. As summarized in Table 4, all species of the *L. reichei* clade assessed to date by the IUCN are categorized as either Endangered (four species) or Vulnerable (one species), while five species of the clade remain to be assessed.

Etymology. We dedicate this species to Jorge Basadre Grohmann (1903–1980), a distinguished Peruvian historian and native of Tacna who wrote important works on the culture and history of Peru. Currently the National

Table 4. IUCN conservation status of the species of the *L. reichei* clade (Abdala et al. 2020).

Species	IUCN category	IUCN criteria	Reference
L. poconchilensis	Endangered	B1ab(iii)	Ruiz de Gamboa et al. 2017
*L. reichei**	Endangered	B1ab(iii,v)	Ruiz de Gamboa and Valladares 2017
*L. stolzmanni***	Not Evaluated	–	–
L. audituvelatus	Vulnerable	B1ab(iii); D2	Núñez et al. 2017
L. torresi	Endangered	B1ab(iii,v)	Espejo et al. 2017
L. insolitus	Endangered	B1ab(iii,iv)	Aguilar et al. 2017
L balagueri	Not Evaluated	–	–
L. nazca	Not Evaluated	–	–
L. chiribaya	Not Evaluated	–	–
L. anqapuka	Endangered***	A2cde; A3cde; A4cde; B1ab (i, iii) + 2abc(ii, iii, iv)	Huamani-Valderrama et al. 2020
L. basadrei **sp. nov.**	Endangered***	B2ab(iii); C2a(ii)	This work

*The 2017 assessment of *L. stolzmanni* is now applicable to *L. reichei*, a species which was subsequently resurrected by Valladares et al. (2018).

**The type locality of *L. stolzmanni* was restricted to the "transect between Antofagasta and Mejillones, Chile" by Troncoso-Palacios and Escobar-Gimpel (2020), who limited its known range to only as far north as Hornitos, approximately 23 NE of Mejillones.

***Recommended by the authors of the species.

University of Tacna bears his name, as does one of the regional provinces of southern Peru.

Discussion

The description of this new species of lizard indicates that the taxonomy of *Liolaemus* is still poorly known in southern Peru, and it is highly probable that additional species will continue to be discovered (Aguilar-Putriano et al. 2019; Abdala et al. 2020). Indeed, while Gutiérrez et al. (2018) indicated that there are a total of 15 species of the *Liolaemus montanus* group in Peru, Aguilar-Putriano (2016, 2019) described five new species of this group and Valladares et al. (2021) incorporate *L. pleopholis* as an element of the Peruvian fauna. Just recently, Villegas et al. (2020), Chaparro et al. (2020), and Huamani-Valderrama et al. (2020) described *L. balagueri*, *L. qalaywa*, and *L. anqapuka*, respectively, so with the addition of *L. basadrei* **sp. nov.**, the number of the *L. montanus* group species in Peru has now reached 25.

The *Liolaemus* lizards inhabiting the desert and sandy areas of the lower Pacific slope of northern Chile and southern Peru are: *L. audituvelatus*, *L. balagueri*, *L. chiribaya*, *L. etheridgei*, *L. insolitus*, *L. nazca*, *L. reichei*, *L. poconchilensis*, *L. stolzmanni,* and *L. torresi*, some of which have the "phrynosaurian" morphotypes, and they are distributed from the Atacama (Chile) to the Arequipa-Ica regions (Peru), and from sea level to over 3,500 m. Most of these species have scales of very striking colors, such as sky-blue, red, and yellow, with a strong sexual dimorphism. Although *L. basadrei* **sp. nov.** inhabits a lowland desert zone and presents characters of this morphotype, it is larger in size and more robust. In general, this group of species does not present major taxonomic controversies and their nomenclatures have remained stable, perhaps with the exception of *L. reichei* and *L. stolzmanni* (Langstroth 2011; Valladares-Faúndez et al. 2018; Troncoso-Palacios and Escobar-Gimpel 2020). However, Aguilar-Puntriano et al. (2018) found the phrynosaurian *Liolaemus* to be paraphyletic within the *L. montanus* group when analyzed using only molecular data.

Regarding the phylogenetic position of the new species, two clades were recovered within the *L. reichei* clade, one composed mainly of lizards that inhabit the Chilean desert, such as *L. poconchilensis*, *L. reichei*, *L. audituvelatus,* and *L. torresi*, and another composed of lizards living in the Peruvian desert, such as *L. balagueri*, *L. nazca*, *L. chiribaya*, *L. insolitus*, and *L. basadrei*. Recently *L. anqapuka* (Huamani-Valderrama et al. 2020) was described as a new species with molecular data. It is noteworthy that both cladograms, based on molecular or morphological data, coincide with the two subgroups of the *L. reichei* clade, with the same species composition.

From the evolutionary perspective, these species demonstrate adaptations to the extreme conditions of the desert; however, the biology and ecology of these lizards remain unstudied beyond the limited observations made at the time of collection. While we continue to improve our taxonomic knowledge, we still lack much of the important information needed for the conservation of these species, such as genetic diversity, reproductive biology, and factors that determine their distribution and abundance in spatial and temporal perspectives.

Acknowledgements.—We thank the Universidad Nacional Jorge Basadre Grohmann of Tacna, Peru, for the financing of our research with mining royalty funds. We also thank the University of Tarapacá, through the projects FFUTA1799 and UTA Mayor de Investigación Científica 4723-19. Finally, we thank SERFOR for issuing the collection permits (AUT-IFS-2019-024) for scientific research purposes.

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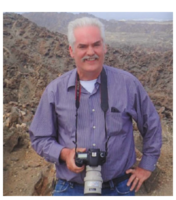

Robert Langstroth is a herpetologist, biogeographer, and environmental professional with an M.S. from the University of California, Davis (USA) and a Ph.D. from the University of Wisconsin, Madison (USA). His work focuses on the biogeography and taxonomy of South American lizards, the biogeography of the South American open formations, and the application of biodiversity mainstreaming and safeguards to enhance the sustainability of economic development. Robert is an associate researcher of the Colección Boliviana de Fauna, and currently serves as an IUCN Red List Taxonomic Authority for the Liolaemidae and as a senior biodiversity and environmental safeguards specialist at a multilateral development bank in Washington, DC, USA.

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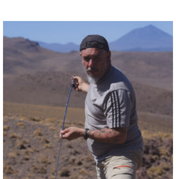
Roberto C. Gutiérrez is a biologist who graduated from the National University of San Agustín de Arequipa of Peru. Roberto is currently the Curator and Principal Researcher of the Herpetological Collection, Museo Nacional de Historial Natural, Universidad Nacional de San Agustin, Arequipa, Peru, and Vice President and Founding Member of the Herpetological Association of Peru (AHP). He is interested in the herpetofauna of the tropical Andes and the coastal desert, with a special focus on lizards of genus *Liolaemus*, and is developing studies in the systematics of amphibians and reptiles, ecology, and conservation. Roberto has conducted several biodiversity inventories, biological assessments, and biodiversity monitoring programs, and is currently working at the Natural Protected Areas Service of the Peruvian Ministry of Environment.



Cristian S. Abdala is an Argentinian biologist, a researcher at CONICET, and a professor at the Universidad Nacional de Tucumán (UNT) in Argentina. Cristian received his Ph.D. degree from UNT, and is a herpetologist with extensive experience in the taxonomy, phylogeny, and conservation of *Liolaemus* lizards. He has authored or co-authored over 90 peer-reviewed papers and books on herpetology, including the descriptions of 58 recognized lizard species, mainly in genus *Liolaemus*. One species, *Liolemus abdalai*, has been named in his honor. He has conducted several expeditions through Patagonia, the high Andes, Puna, and the salt flats of Argentina, Chile, Bolivia, and Peru. From 2016 to 2020, Cristian has been the president of the Argentine Herpetological Association.