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First records of *Echimys saturnus* Thomas, 1928 (Rodentia, Echimyidae) for the Peruvian Yungas

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Abstract

Echimys saturnus Thomas, 1928 is an echimyid rodent that has been recorded in lowland, premontane and montane forests in Ecuador and lowland forests in Peru. Here, we report five new records of this species in the Peruvian Yungas ecoregion. Our records come from Amazonas, San Martín, and Huánuco departments. The Huánuco specimen, collected at 3300 m a.s.l., constitutes the highest and the southernmost record for the species, extending its distribution range by 251 km south. Additionally, we provide some notes on the natural history and conservation status of the species.

Keywords

Amazonian region, arboreal rodents, Dark Spiny Tree-rat, Echimyinae, montane forests, range extension

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Introduction

The genus *Echimys* F. Cuvier, 1809 belongs to an endemic clade of South America spiny rats distributed within the Amazon basin (Emmons and Feer 1997). Members of this genus are moderate-sized arboreal rats characterized by having a pelage that includes stout spines; tails longer than the head and body length, covered with dense hairs, and distal portion white; and four pairs of mammae, of which three are laterals and one inguinal (Emmons 2005; Emmons et. al 2015). Three species are currently recognized: *E. chrysurus* (Zimmerman, 1708), *E. vieirai* Iack-Ximenes, de Vivo & Percequillo, 2005, and *E. saturnus* Thomas, 1928. All of them allopatric; the first two are restricted to the eastern Amazonian and Guianan regions, while the third occurs in western Amazonia (Emmons et al. 2015).

Echimys saturnus is a poorly known echimyid rodent, with only six specimens housed in museum collections (Emmons et al. 2015). *Echimys saturnus* was described by Thomas (1928) based on an adult specimen (BMNH 1934.9.10.182) collected by Mr. Sörderstöm in 1921 from

Napo River, Ecuador. Subsequent specimens were collected between 1925 and 1939 in Napo and Orellana provinces, Ecuador, and Amazonas and Loreto departments, Peru (Emmons et al. 2015). Recently, the species was recorded by camera traps in the Tiputini Biodiversity Station (Blake et al. 2010; Mosquera et al. 2016) and Sangay National Park in Ecuador (Brito and Ojala-Barbour 2016). Currently, *E. saturnus* is known from lowland, premontane, and montane forests below 1400 m a.s.l.

Based on recently available material, we present five new records of *E. saturnus* from the Yungas of northern and central Peru, update the species distribution, and include comments on the natural history and conservation status of the species.

Methods

Five field campaigns were conducted in the Yungas of eastern slopes of the Peruvian Andes, between 1992 and 2019. The first field campaign by the "Asociación Peruana para la Conservación de la Naturaleza" (APECO) in November 1992 was carried out at Los Pinchudos located near the Montecristo River in Río Abiseo National Park, Mariscal Cáceres province, San Martín department. The habitat is humid tropical montane forest; these forests are fragmented and suffer deforestation by burning, rapid expansion of cattle grazing, and pasture-maintenance (Young et al. 1994). The second record occurred inside a mini-hydroelectric plant, near La Esperanza village, in Yambrasbamba community, Bongará province, Amazonas department. Here, secondary forests and heavily intervened primary forests are predominant, and the place is crossed by an unnamed small stream (2–3 m wide) (Shanee pers. obs.). Fieldwork was carried out by an NGO, Neotropical Primate Conservation (NPC), in November 2013. The third campaign was at El Laurel village, Mariscal Cáceres province, San Martín department. The fieldwork was carried out by Antuané Zeballos in November 2014. The fourth record was at El Perol sector, located in the Alto Mayo Protected Forest, Rioja province, San Martín department, during a patrol carried out by Jhonny Ramos in 2015. The last campaign took place at Unchog Forest; located in central Peru in Huánuco province, Huánuco department. The habitat is a montane forest with dominance of *Weinmannia* sp. trees and native pastures and shrubs between the forest patches (Gonzalez et al. 2019). The fieldwork was carried out by the first author in August 2019. The specimen was captured and collected following the sampling methodology described in Pacheco et al. (2011), with the use of snap traps and live traps. These were baited in the afternoon and checked early the next morning. Baits consisted of a mixture of oats, peanut butter, vanilla concentrate, honey, birdseeds, and raisins. The captured specimen was sacrificed following the ethical guidelines for the euthanasia of animals of the American Society of Mammologists (Sikes et al. 2016) and prepared as skin, skull, and carcass. In addition, muscle tissue was obtained and preserved in 96% ethanol.

The specimen vouchers are housed in the mammal collection of the Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos, Lima, Peru (MUSM). Age criteria were determined following Patton and Rogers (1983), and for cranial nomenclature we followed Woods and Howland (1979). We also took 23 cranial measurements with dial calipers to the nearest 0.01 mm based on Leite (2003). These measurements and their definitions are as follow: greatest skull length (GSL), anterior-most projection of nasals to posterior-most projection of occipital region on midline of skull; nasal length (NL), greatest length of nasals at midline; rostral length (RL), diagonal distance from anterior edge of orbit lateral to lacrimal to anterior edge of nasals at midline; orbital length (OL), greatest length of orbits; rostral breadth (RB), breadth of rostrum at the suture between premaxilla and maxilla; interorbital constriction (IOC), least distance between bony orbits; mastoid breadth (MB), distance across cranium at mastoid processes; zygomatic breadth (ZB), maximum width across outside margins of zygomatic arches; condyloincisive length (CIL), anterior edge of upper incisors to posterior-most projection of occipital condyle; basilar length (BaL), posterior margins of upper incisors to anterior edge of foramen magnum; diastema length (D), posterior alveolar margin of upper incisors to anterior alveolar edge of PM4; maxillary toothrow length (MTRL), anterior alveolar edge of PM4 to posterior alveolar edge of M3; palatal length a (PLa), midline distance between posterior margins of upper incisors to anterior margin of mesopterygoid fossa; palatal length b (PLb), anterior edge of PM4 to anterior edge of mesopterygoid fossa; incisive foramina length (IFL), length of opening of foramina; bullar length (BuL), maximal distance from anterior to posterior edges of tympanic bulla; postpalatal length (PPL), posterior margin of inner aspect of zygomatic arch to a line perpendicular and tangent to greatest projection of occipital region; mesopterygoid fossa width (MPF), maximum width taken at the suture between palatine and pterygoid bones; first molar breath (M1B), greatest distance from lingual to buccal borders of crown; maxillary breadth (MaxB), greatest breadth of maxilla on outside of M3; occipital condyle width (OccW), width across outside margins of the occipital condyles; rostral depth (RD), depth of rostrum at the suture between premaxilla and maxilla; mandible length (MBL), from the lingual border of the incisors' alveoli to the posteriormost border of the postcondyloid process; mandible height (MH), shortest distance taken vertically from the uppermost part of the condyloid process to a plane passing from the lower edge of the symphiseal suture to the lowermost edge of the angular process; cranial depth (CD), vertical distance from ventral margin of bulla to top of cranium; cranial depth at M1 (CDM1). The measurements of the holotype were taken from Thomas (1928) and Iack-Ximenes et al. (2005). In addition, we compared our specimens with photographs from

Emmons (2005), Iack-Ximenes et al. (2005), Blake et al. (2010), Emmons et al. (2015), and Mosquera et al. (2016).

Results

With the addition of our new records presented herein, *Echimys saturnus* is known from 14 localities in Ecuador and Peru (Table 1, Fig. 1). All our new records come from elevational ranges above 1400 m a.s.l.

Family Echimyidae
Subfamily Echimyinae

***Echimys saturnus* Thomas, 1928**
Dark Spiny Tree-rat
Figure 2

New records. PERU – **Amazonas department** • Bongará province, Yambrasbamba district, La Esperanza village; −05.704, −077.911; 1830 m alt.; 20.XI.2013; Sam Shanee obs.; Tomahawk trap; 1 ♂ – **San Martín department** • Rioja province, Pardo Miguel district, Alto Mayo Protected Forest, El Perol sector, Mr. Dagoberto Pérez's abandoned cabin; −05.704, −077.911; 1830 m alt.; 15.VII.2015; Jhonny Ramos obs.; 1 individual, sex undetermined • Mariscal Cáceres province, Huicungo district, El Laurel village; −06.749, −077.639; 2600 m alt.; 07.XI.2014; Antuané Zeballos obs.; 1 individual, sex undetermined • Mariscal Cáceres province, Huicungo district, Río Abiseo National Park, Los Pinchudos; −07.967, −077.300; 2700 m alt.; 14.XI.1992; Mariella Leo leg.; individual found dead in a crevice; 1 ♂, MUSM 7888 – **Huánuco department** • Huánuco province, Chinchao district, Unchog Forest (Fig. 3); −09.714, −076.164; 3389 m alt.; 15.VIII.2019; Yangjosé Juárez-Pérez leg.; dry season, individual captured in a Tomahawk trap near to a small stream; 1 ♀, MUSM 52700.

Identification. *Echimys saturnus* is a medium-sized rodent, with a tail noticeably longer (280–383 mm) than the head and body length (240–335 mm) (Table 2). Externally, it is characterized by dark coloration throughout the dorsal part, with the presence of stiff bristles and wide, flat, rigid spines in the mid-back. The ears are small and are concealed by the hairs. The ventral coloration is white or whitish; the chin area is dark. The hind-feet are broad and robust, with strong claws on each toe. The tail is long and entirely covered by hairs and bicolored with a dark proximal part and a white tip variable in length (Emmons and Feer 1997; Blake et al. 2010; Emmons et al. 2015).

Echimys saturnus can easily be differentiated from its congeners by its size and pelage color; *E. chrysurus* and *E. vieirai* are smaller and have heads of a different color to uniform black (Emmons et al. 2015). Also, in *E. chrysurus*, a pale-colored (whitish to yellowish) blaze occurs down the center of the head, from crown to nose, either entirely covering the face between the eyes or only as a narrow stripe or small white tuft on the crown, has gray-brown underparts, and the feet are grayish brown above; and *E. vieirai* have a dark maroon medial stripe on the head from rostrum to crown, and the under parts are grayish brown. In *E. saturnus* the rostrum is larger than in *E. crysurus* and *E. vieirai*; also, *E. saturnus* has smaller bullae (Fig. 4). Besides, *E. chrysurus* and *E. vieirai* are only known from eastern Amazonia and the Guianan region, respectively (Emmons et al. 2015). On the other hand, *E. saturnus* differs from similar-sized species in the area such as melanistic squirrels, which have prominent ears and bushy tails (Emmons and Feer 1997). Similarly, *E. saturnus* differs from other genera within the Echimyidae, including *Makalata* Husson, 1978 and *Dactylomys* I. Geoffroy Saint-Hilaire, 1838, which have a short, almost naked tail (Emmons and Feer 1997; Emmons et al. 2015). *Toromys* Iack- Ximenes, de Vivo, & Percequillo, 2005 is relatively smaller and has stiff setiform and aristiform hairs that terminate in hair-like

Table 1. Summary of the locality records of *Echimys saturnus*. The locality numbers refer to the points shown in Fig. 1. The specimens reported below are deposited in the following institutional collections, listed in order of their traditional acronyms: American Museum of Natural History, New York (AMNH); The Natural History Museum, London (BMNH), Biodiversity Institute & Natural History Museum, Kansas (KU); Museum of Comparative Zoology of Harvard University, Cambridge (MCZ); Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos, Lima (MUSM).

Locality no.	Country	Locality	Latitude	Longitude	Voucher	Reference
1	Ecuador	Napo, Napo river	−01.050	−077.783	BMNH 34.9.10.182	Emmons et al. 2015
2	Ecuador	Orellana, Cotapino river	−00.800	−077.433	KU 68093	Emmons et al. 2015
3	Ecuador	Napo, Cerro Galeras	−00.833	−077.583	AMNH 71903	Emmons et al. 2015
4	Ecuador	Napo, Pucuno river	−00.800	−077.267	MCZ 41569	Emmons et al. 2015
5	Ecuador	Orellana, Tiputini Biodiversity Station	−00.617	−076.167	Only photographs	Blake et al. 2010
6	Ecuador	Orellana, Tiputini Biodiversity Station	−00.637	−076.150	Only photographs	Mosquera et al. 2016
7	Ecuador	Morona Santiago, Danu	−02.079	−078.160	Only photographs	Brito and Ojala-Barbour 2016
8	Peru	Amazonas, Santiago river	−04.427	−077.636	AMNH 98262	Emmons et al. 2015
9	Peru	Loreto, Pisqui river	−07.750	−075.017	AMNH 98261	Emmons et al. 2015
10	Peru	Amazonas, La Esperanza	−05.705	−077.911	Only photographs	This study
11	Peru	San Martín, Alto Mayo Protected Forest	−05.733	−077.688	Only photographs	This study
12	Peru	San Martín, El Laurel	−06.750	−077.639	Only photographs	This study
13	Peru	San Martín, Los Pinchudos	−07.967	−077.300	MUSM 7888	This study
14	Peru	Huánuco, Unchog Forest	−09.715	−076.164	MUSM 52700	This study

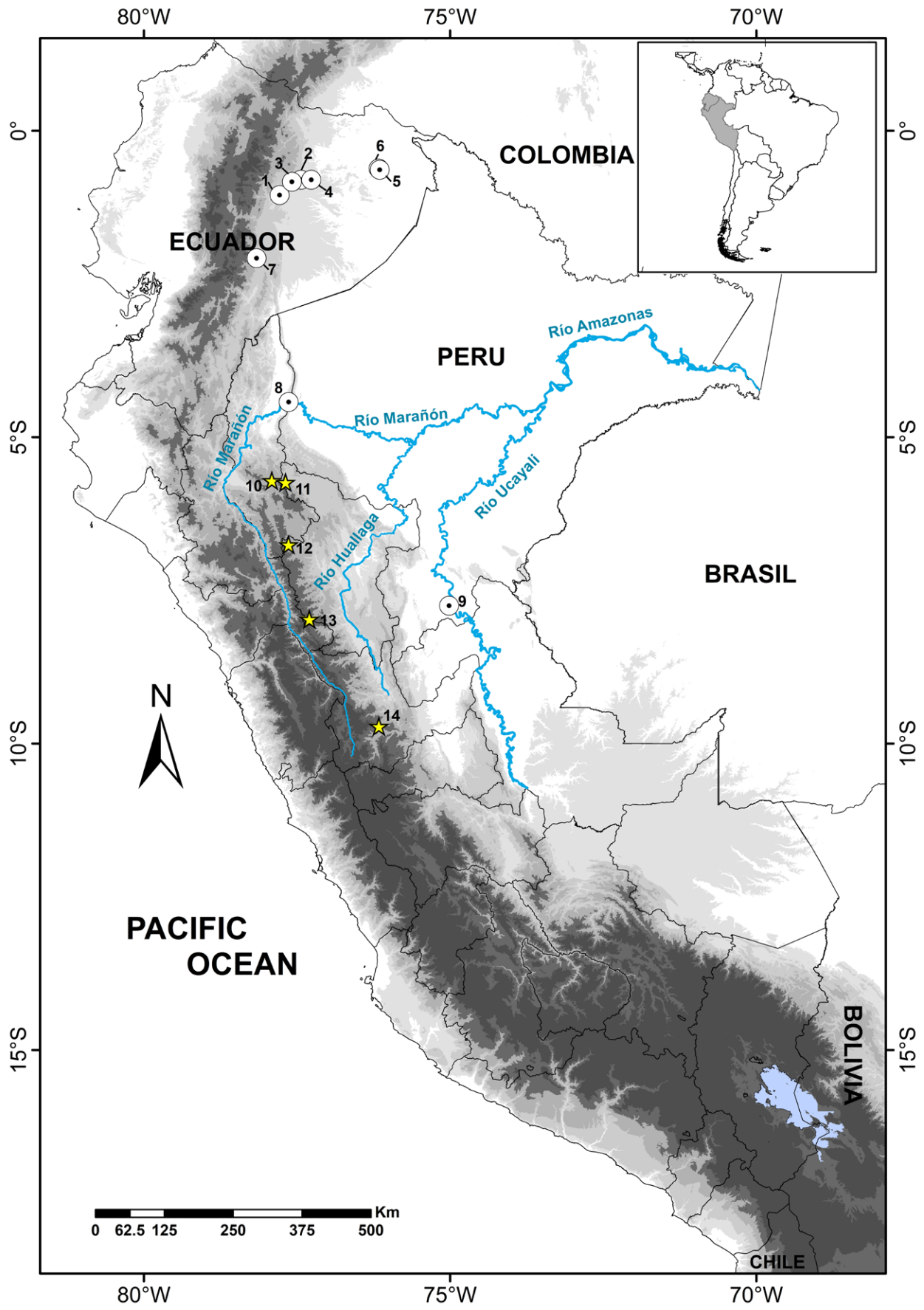

Figure 1. Map of distribution of *Echimys saturnus*. Stars show the new records in the Peruvian Yungas, in the Amazonas, San Martín, and Huánuco departments. Dots show previous records in the literature (Blake et al. 2010; Emmons et al. 2015; Mosquera et al. 2016; Brito and Ojala-Barbour 2016). For locality data see Table 1.

Figure 2. New records of Dark Spiny Tree-rat, *Echimys saturnus*, from Peru. **A.** Individual from La Esperanza, Amazonas. Photograph by Sam Shanee. **B.** Individual from Alto Mayo Protected Forest, San Martín. Photograph by Jhonny Ramos. **C.** Individual from El Laurel, San Martín. Photograph courtesy of Antuané Zeballos. **D.** Individual from Los Pinchudos, San Martín (MUSM 7888) with the collector Mariella Leo. Photograph by H. Plengue. **E.** Individual from Unchog forest, Huánuco (MUSM 52700). Photograph by Yangjosé Juárez-Pérez.

processes instead of sharp points (Emmons et al. 2015). *Leiuromys* Emmons & Fabre, 2018 are small arboreal brown rats, heavily spined dorsally with abundant wide, flat, spines on the midback from neck to rump; and the tail is naked, with short, fine, and inconspicuous hairs so that it looks bare and shiny (Emmons and Fabre 2018). *Mesomys* Wagner, 1845 has brown-yellow fur with hard spines, and the tail has rusty hairs with a tuft at the tip (Emmons et al. 2015; Lozano-Flores and Cifuentes-Acevedo 2020). Species of *Isothrix* Wagner, 1845 are smaller, have brown-yellow fur, and a long, hairy tail (Emmons et al. 2015). Species of *Proechimys* J.A. Allen, 1899 have

Figure 3. Panoramic view of the Unchog elfin forest in Huánuco, where the specimen of *Echimys saturnus* (MUSM 52700) was collected.

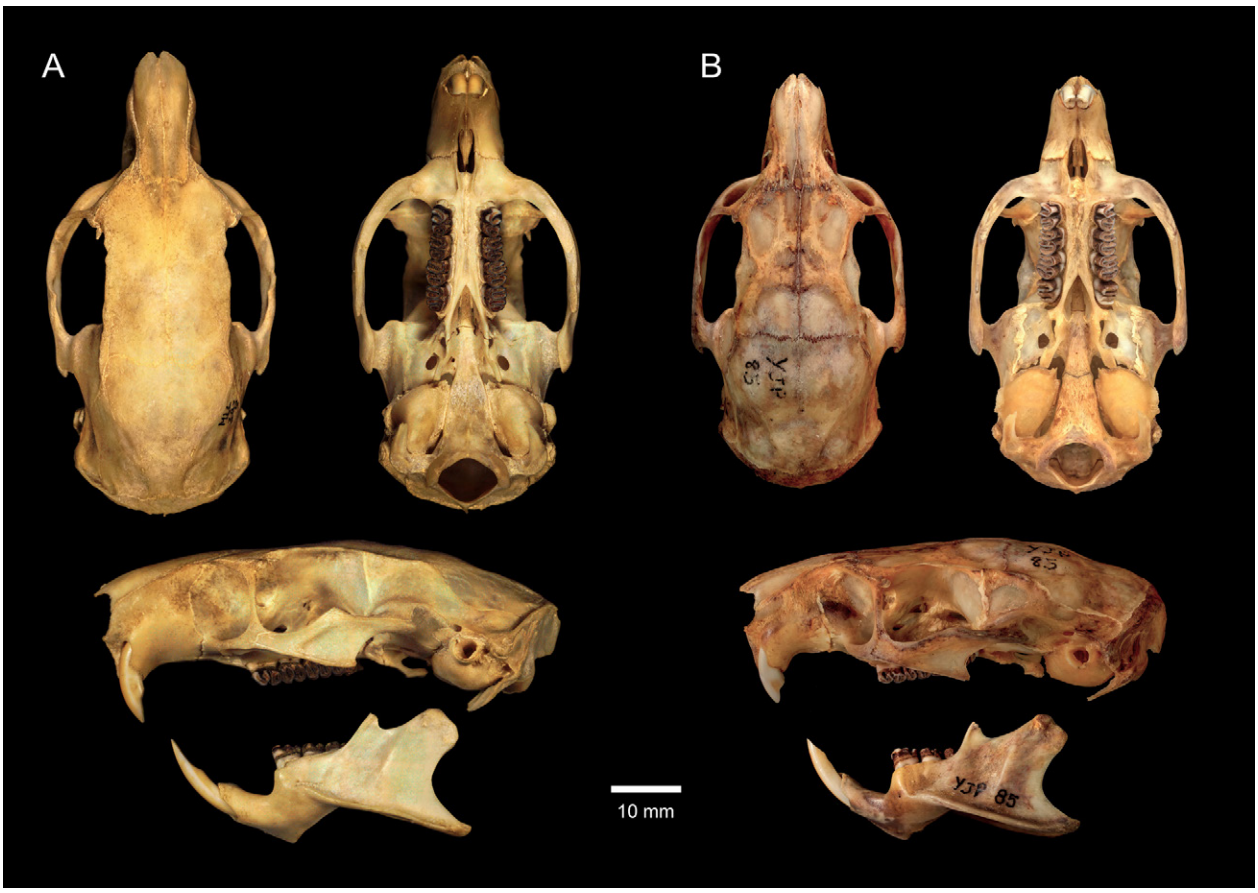

Figure 4. Dorsal, ventral, and lateral views of the skull of *Echimys saturnus*. **A.** Individual from Los Pinchudos, San Martín (MUSM 7888, an adult male). **B.** Individual from Unchog forest, Huánuco (MUSM 52700, a subadult female).

elongated heads and long rostra, with long, erect ears, and short tails without longer pelage, and are not arboreal (Emmons et al. 2015).

Discussion

Our study presents the first records of *Echimys saturnus* for the Peruvian Yungas and updates its geographic distribution. Also, our records are the first for the San Martín and Huánuco departments. We also clarify that the record from Pisqui River in Ucayali department (Emmons et al. 2015), nowadays belongs to Loreto department. Our specimen from Huánuco represents the highest and southernmost record of the species, extending the known geographic range about 251 km southwest from Pisqui River, Loreto department (Emmons et al. 2015). We note that our new records came areas near rivers or small streams and were found in places with mixed levels of disturbance, including protected areas and areas with anthropogenic impacts.

A few years ago, *E. saturnus* was considered a very rare species with a geographic distribution restricted to lowland and premontane forests (Emmons and Feer 1997; Emmons et al. 2015); however, our new records suggest its rarity in other ecoregions is more likely due to inadequate sampling. For example, similarly to other arboreal echimyid rodents, *E. saturnus* is a nocturnal species that uses the canopy and hollow trees as refugees near watercourses and conserved forests (Emmons and Feer 1997; Lozano-Flórez and Cifuentes-Acevedo 2020). For this reason, we recommend the use of traps in the canopy, although these are difficult to set in rapid inventories, especially in the Amazon region. A good alternative is to set camera traps in diverse habitats from ground level to the canopy (Blake et al. 2010; Mosquera et al. 2016; Brito and Ojala-Barbour 2016).

In Peru, we found that *E. saturnus* cohabits with *Didelphis pernigra* J.A. Allen, 1900, *Coendou bicolor* (Tschudi, 1844), *Dasyprocta fuliginosa* Wagler, 1832, *Microsciurus flaviventer* (Gray, 1867), *Potos flavus* (Schreber, 1774), and *Aotus miconax* Thomas, 1927 in Amazonas department (Pacheco et al. 2020; Shanee pers. comm.); and *Gracilinanus aceramarcae* (Tate, 1931), *Akodon kotosh* Jiménez & Pacheco, 2016, *Thomasomys* sp., and *T. ischyrus* Osgood, 1914 in Huánuco department (Pacheco et al. 2020; Juárez-Pérez pers. comm.). In Ecuador, *E. saturnus* was found cohabiting with *Chironectes minimus* (Zimmermann, 1780), *Didelphis marsupialis* Linnaeus, 1758, *D. pernigra*, *Marmosa rubra* Tate, 1931, *Hadrosciurus igniventris* (Wagner, 1842), *Microsciurus flaviventer*, *Neacomys amoenus* Thomas, 1903, *Cuniculus paca* (Linnaeus, 1766), *Dasyprocta fuliginosa*, *Myoprocta pratti* Pocock, 1913, *Dactylomys dactylinus* (Desmarest, 1817), *Coendou bicolor*, *Alouatta seniculus* (Linnaeus, 1766), *Ateles belzebuth* É. Geoffroy Saint-Hilaire, 1806, and *Choloepus didactylus*

Table 2. External and cranial measurements (in mm) of the holotype of *Echimys saturnus* (Thomas 1928; Iack-Ximenes et al. 2005) and the collected specimens from Río Abiseo National Park, San Martín (MUSM 7888) and Unchog forest, Huánuco (MUSM 52700), Peru.

Variables	BMNH 34.9.10.182	MUSM 7888	MUSM 52700
Sex	Male	Male	Female
Age	Adult	Adult	Subadult
Total length	630	548	573
TL	295	290	340
HL	51	50	54.5
Ear	17	14	16.5
Weight	—	1000	515
GSL	66.92	64.73	59.37
NL	21.63	19.53	17.02
RL	—	26.7	22.95
OL	—	16.77	16.56
RB	—	11.03	10.68
IOC	18.28	16.12	15.95
MB	—	24.64	23.5
ZB	30.59	31.78	29.33
CIL	—	57.59	54.14
BaL	—	50.15	47.23
D	—	14.87	13.48
MTRL	13.91	15.4	14.11
PLa	26.01	26.31	23.47
PLb	—	11.97	10.8
IFL	—	5.77	5.58
BuL	10.7	11.02	9.7
PPL	25.81	27.73	24.2
MPF	—	7.35	7.84
M1B	3.54	3.22	3.24
MaxB	8.77	11.11	11.12
OccW	—	11.76	11.26
RD	—	14.47	13.05
MBL	34.26	34.48	32.31
MH	15.7	17.66	17.04
CD	—	29.81	23.37
CD M1	—	18.67	17.65

(Linnaeus, 1758) (Brito and Ojala-Barbour 2016; Mosquera et al. 2016; Hurtado and Pacheco 2017; Burgin et al. 2020).

To date, the only morphological measurements that have been documented on this species are those of the type specimen (Thomas 1928; Iack-Ximenes et al. 2005). This lack of data from other individuals limits our understanding of age, sex, and population variability; therefore, our study enriches the description of *E. saturnus* by adding new measures, both external and craniodental, of two individuals of this species from montane forests populations, one of them being a subadult female. Further, integrative studies could help to determine if the populations along its distributional range in Peru all belong to a single entity or would be represented by more than one taxon.

According by the International Union for Conservation of Nature (IUCN), *E. saturnus* is classified as Data Deficient (Solari 2016) due to a lack of available information. Under Peruvian criteria, *E. saturnus* is not considered threatened (MINAGRI 2014; SERFOR 2018), but using the new information gathered here, the threat category needs updating (Sánchez-Vendizú in prep.).

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Authors' Contributions

YJP and VP designed and got the financial support for this study. YJP conducted the field sampling and data collection in Huánuco, took the photographs of the specimens, prepared the figures, map, tables, and wrote the drafts. VP provided access to the MUSM database, identified the specimens, and critically reviewed the drafts. PSV, ML, SS, and JR contributed with unpublished data, valuable comments, and revision of the final drafts. All authors approved the final version.

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