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Marsupials and rodents (Didelphimorphia and Rodentia) of upper Rio Acre, with new data on *Oxymycterus inca* Thomas, 1900 from Brazil

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Abstract: Our goal was to inventory marsupial and rodent species from two conservation units (Reserva Extrativista Chico Mendes and Estação Ecológica do Rio Acre) of the upper Rio Acre, in Brazilian Amazonia, as well as to provide new data on the morphology and geographic distribution for several species. We recorded 25 species, including seven marsupials and 18 rodents. Among these, there are poorly sampled species in Brazil, such as *Marmosa regina* and *Dactylomys boliviensis*. We document range extensions (about 450 km towards southeastern Acre state) of *Neacomys musseri*, *Dasyprocta fuliginosa,* and *Proechimys cuvieri*. We also present the first confirmed record of an undescribed species of *Monodelphis* in Acre state and the second collecting record of *Oxymycterus inca* in Brazil. We describe the morphology and morphometrics of upper Rio Acre specimens of *O. inca*. Finally, we compare our results with other inventories in the Amazon region and discuss the high efficiency of pitfall traps for capturing nonvolant small mammals.

Key words: mammal inventory; Amazon forest; distribution extensions; Acre state

INTRODUCTION

Brazil has the richest mammalian fauna in the world (Costa et al. 2005), and according to the latest compilation (Paglia et al. 2012), 701 species are known to occur in the country. The variety of vegetation physiognomies, climatic conditions, and geological history of South America are directly associated with this great diversity (Patterson and Costa 2012). The diversity of mammals in Brazil, however, is not homogenous. Among mammalian orders, Rodentia is the most diverse, consisting of 34.7% of Brazilian mammal species. This is followed by Chiroptera (24.8%), Primates (16.8%), and Didelphimorphia (7.9%) (Paglia et al. 2012). Of the Brazilian biomes, the Amazon is the most diverse and is home to 399 species of mammals, 231 of which are endemic (Paglia et al. 2012). As previously emphasized, Neotropical forests hold the richest mammal communities in the world, and among them, the western Amazon forest is outstanding in its diversity (Patton et al. 1997, 2000; Voss and Emmons 1996; Voss et al. 2001).

The Brazilian state of Acre, in the southwestern Amazon basin, harbors high diversity for many groups (e.g., palm trees, butterflies, frogs, and birds, among others). As such, it is an important area for biodiversity conservation and a region of high priority for future wildlife surveys (Souza et al. 2003; Souza 2009). Mendes-Oliveira et al. (2015) and Prado and Percequillo (2013) showed there is a large sampling gap in this region for nonvolant small mammals and oryzomyine rodents. Few comprehensive mammal studies have been conducted within the southwestern Amazon thus far; Calouro (1999) focused on medium-sized to large mammals, and Taddei et al. (1990), Nogueira et al. (1999) and Calouro et al. (2010) focused on bats. The only study published on nonvolant small mammals was by Patton et al. (2000), which recorded species along the Rio Juruá, in northwest of Acre. Moreover, recent reports of new occurrences for species in Acre (e.g., Bernarde and

Machado 2008; Marciente and Calouro 2009; Freitas et al. 2013), indicate the need for comprehensive small mammal surveys.

Systematic faunal surveys are the only way to accurately assess local species diversity (Vivo 1996). Such studies greatly contribute to the knowledge of species' distributions and provide material on which is based the understanding of morphological variation and evolutionary history. Wildlife surveys are especially important in protected areas (e.g., parks, ecological stations, extractive reserves, national forests, and biological reserves), which play an essential role in biodiversity conservation in the Amazon Biome (Peres 2005; Silva 2005). As highlighted by Peres (2005), conservation and management strategies require an understanding of ecosystem functionality, and thus, an in-depth knowledge of local species diversity, emphasizing the importance of research such as the present study.

In this context, our goal was to record marsupial and rodent species from two conservation units (Reserva Extrativista Chico Mendes and Estação Ecológica do Rio Acre) of the upper Rio Acre and to provide new data on the morphology and geographic distribution of species. Thus, we fill data gaps for species in these conservation areas, which may aid future conservation decisions, both locally and regionally.

MATERIALS AND METHODS

Study sites

Surveys were performed at the Reserva Extrativista Chico Mendes (RESEX Chico Mendes) and the Estação Ecológica do Rio Acre (ESEC do Rio Acre), along the upper Rio Acre, in southeastern Acre state, Brazil (Figure 1). The RESEX Chico Mendes (10°06′ S to 10°58′ S and 067°56′ W to 069°48′ W) was created by Decree Number 99.144, on 12 March 1990. This conservation unit has an area of 931,537 ha and is included within the municipalities of Rio Branco, Xapuri, Brasiléia, Epitaciolândia, Assis Brasil, Sena Madureira, and Capixaba. This area is occupied by traditional communities who depend on the extraction of local resources, such as Brazil nuts, copaíba oil, and rubber (MMA 2006). Two vegetation physiognomies are present in RESEX Chico Mendes: Dense Tropical Forest, covering about 27% of the total area; and Open Tropical Forest, covering about 73% of the reserve area (MMA 2006). In RESEX Chico Mendes only "terra firme" (non-flooded upland forest) habitat was sampled. The second sampling area, ESEC do Rio Acre (10°45′ S to 11°04′ S and 070°03′ W to 070°31′ W), was created by Decree Number 86.061, on 2 June 1981. It has an area of 79,093 ha within the municipality of Assis Brasil. Three main vegetation physiognomies cover the ESEC do Rio Acre area: Alluvial Open Forest, Open Forest with bamboo, and Open Forest with palm tree (MMA 2010). In ESEC do Rio Acre, both "terra firme" and "várzea" (seasonally inundated floodplain forest) habitats were sampled.

Data collection and specimen preparation

Marsupials and rodents and were sampled on a monthly basis from June 2011 to June 2012 at RESEX Chico Mendes and for 15 consecutive days, each month,

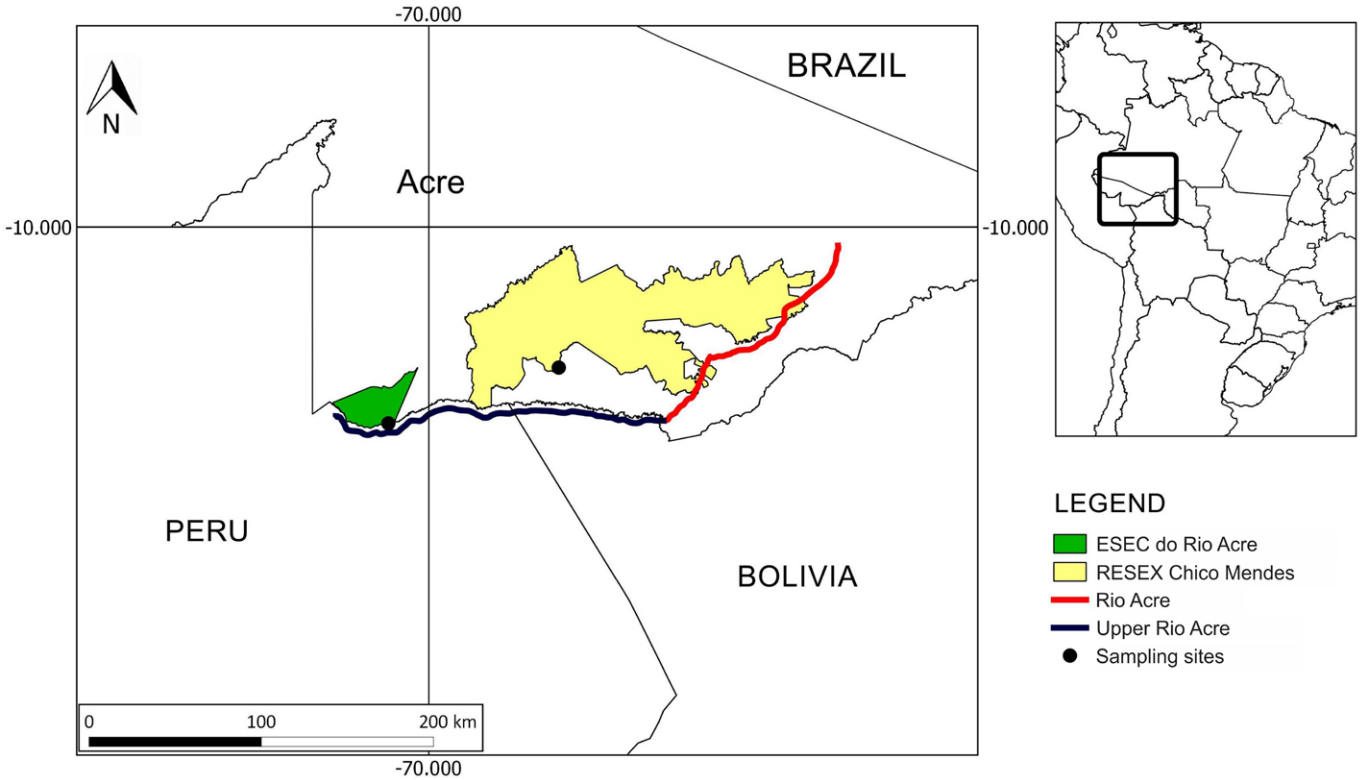

Figure 1. Geographic limits of ESEC do Rio Acre and RESEX Chico Mendes in Acre state, Brazil, and sampling sites of this study.

in April 2015 and February 2016 at ESEC do Rio Acre. Pitfall trapping surveys were implemented as the primary sampling method. In RESEX Chico Mendes, 40 100-L buckets were distributed throughout 10 sampling units, each consisting of four buckets arranged in a "Y" formation. Traps were open for five consecutive nights per month, totaling 65 sampling-nights, and 2,600 pitfall-nights. In ESEC Rio Acre, 40 60-L buckets were arranged in four sampling units (two in "várzea" forest and two in "terra firme" forest). In each unit, a line of 10 buckets, 8 m apart were set up. They were open for 10 consecutive nights per campaign, totaling 20 sampling-nights and 800 pitfall-nights.

In addition to pitfall trap surveys, active searches targeting marsupials and rodents were made along set transects. Searches were performed along 300–400 m trails for four hours every night, and along 150–200 m trails for two hours every morning. In RESEX Chico Mendes, the searches were conducted four nights per month (for 13 months), and in ESEC do Rio Acre, searches were conducted over 10 days in April 2015 and February 2016. We also recorded species that were opportunistically observed around the sampling sites and obtained carcasses and skulls of mammals from hunters within the communities surrounding RESEX Chico Mendes.

All collected specimens were fixed in 10% formaldehyde then preserved in 70% alcohol. Mammal specimens were deposited at Coleção do Laboratório de Mamíferos da Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo (LMUSP) (see Appendix 1). All specimens were captured and preserved following recommendations of the Animal Care and Use Committee of the American Society of Mammalogists (Sikes et al. 2011). Collections were made under permits issued by the Instituto Chico Mendes de Conservação da Biodiversidade (SISBIO 48448-1 and 48448-2) for herpetofauna survey; therefore, only animals that were found deceased in pitfall traps were collected.

Morphological analyses and identification

We analyzed qualitative and quantitative external and cranio-dental characters to identify species. External morphological quantitative variables included body measurements, such as head and body length, tail length, hindfoot length, ear length and weight. Qualitative characteristics included texture and coloration of pelage, presence and color of hairs on dorsal surface of manus and pes, and tail color, among other characters. We follow Leite (2003), Weksler (2006) and Voss and Jansa (2009) for external morphological qualitative characters. For cranio-dental morphology, we analyzed quantitative measurements of cranio-dental dimensions according to Abreu-Júnior (2013), as follows: greatest skull length (GSL), condylo-incisive length (CIL), condylo-zigomatic length (CZL), length of diastema (LD), length of incisive foramen (LIF), breadth of incisive foramina (BIF), length of upper molars (LM), breadth of first upper molar (BM1), incisive depth (ID), incisive width (IW), length of nasals (LN), breadth of rostrum (BR), rostral length (RL), zygomatic breadth (ZB), breadth of zygomatic plate (BZP), least interorbital breadth (LIB), orbital fossa length (OFL), palatal length (PL), length of palatal bridge (LPB), breadth of bony palate (BBP), height of braincase (HBC), breadth of braincase (BBC), interparietal breadth (IPB), interparietal length (IPL), occipital condyle breadth (OCB). Qualitative characteristics, such as presence and shape of foramina, cranial process and fossae, follow Musser et al. (1998), Leite (2003), Weksler (2006) and Voss and Jansa (2009).

In addition to upper Rio Acre specimens, we analyzed specimens housed in the Coleção do Laboratório de Mamíferos da Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo (LMUSP) and National Museum of Natural History, Smithsonian Institution (USNM) for comparative purposes. We follow the taxonomic nomenclature presented by Gardner (2007), Pavan et al. (2012; 2014) and Díaz-Nieto and Voss (2016) for marsupials, and Patton et al. (2015) for rodents.

RESULTS

Species composition

We recorded 25 species of marsupials and rodents in the upper Rio Acre (Table 1; Figures 2–4). Rodentia was the richest order, with 18 species and seven of these belonging to the family Cricetidae, four to Echimyidae, two to Dasyproctidae, and the remaining families (Sciuridae, Caviidae, Cuniculidae, Dinomyidae and Erethizontidae) represented by single species each (Figures 3 and 4). The order Didelphimorphia is represented by seven species, all from family Didelphidae (Figure 2). At RESEX Chico Mendes, we recorded 21 species (five marsupials and 16 rodents), 13 of which were exclusively found in this area; and at ESEC do Rio Acre, 14 species were recorded (four marsupials and 10 rodents), with five species only found there (Table 1).

Some of the species belong to taxonomically complex genera, having great diversity of morphologically very similar species that are difficult to identify. Among these is the didelphid genus *Marmosa*, represented in the upper Rio Acre by *M. (Micoureus) regina* (Thomas, 1898) (Figure 2B). This species can be recognized by the pure buff-colored ventral stripe that extends continuously from the chin to the genitals, and by a short portion of dorsal fur extending onto the tail. The specimen from the upper Rio Acre has the dorsal fur extending about 18 mm from the base of the tail.

Table 1. Marsupials and rodents recorded at RESEX Chico Mendes and ESEC do Rio Acre, Acre state, Brazil, with type of record on each area. The numbers in parentheses represent the number of specimens collected.

Taxa	Record type	
	RESEX Chico Mendes	ESEC do Rio Acre
DIDELPHIMORPHIA		
Didelphidae		
Didelphis marsupialis Linnaeus, 1758	Pitfall (1) /Visual	-
Marmosa (Micoureus) regina (Thomas, 1898)	-	Pitfall (1)
Marmosops (Sciophanes) bishopi (Pine, 1981)	Pitfall (4)	-
Marmosops (Marmosops) noctivagus (Tschudi, 1845)	Pitfall (1)	-
Marmosops (Marmosops) cf. *noctivagus* (Tschudi, 1845)	-	Pitfall (4)
Monodelphis emiliae (Thomas, 1912)	Pitfall (2)	-
Monodelphis glirina (Wagner, 1842)	Pitfall (1)	Pitfall
Monodelphis sp.	-	Pitfall (2)
RODENTIA		
Sciuridae		
Hadrosciurus sp.	Visual	Visual
Cricetidae		
Oxymycterus inca Thomas, 1900	Pitfall (3)	-
Euryoryzomys macconnelli (Thomas, 1910)	Pitfall (1)	-
Hylaeamys perenensis (Allen, 1901)	Pitfall (2)	Pitfall (6)
Neacomys musseri Patton, da Silva, and Malcolm, 2000	-	Pitfall (1)
Neacomys spinosus (Thomas, 1882)	Pitfall (6)	Pitfall (3)
Oecomys bicolor (Tomes, 1860)	Pitfall (3)	Pitfall (2)
Oligoryzomys microtis (Allen, 1916)	Pitfall (6)	-
Caviidae		
Hydrochoerus hydrochaeris (Linnaeus, 1766)	Visual/Skull (1)	Visual
Cuniculidae		
Cuniculus paca (Linnaeus, 1766)	Visual	Visual
Dasyproctidae		
Dasyprocta fuliginosa Wagler, 1832	Visual/Skull (1)	Visual
Myoprocta pratti Pocock, 1913	-	Visual
Dinomyidae		
Dinomys branickii Peters, 1873	Carcass	-
Erethizontidae		
Coendou bicolor (Tschudi, 1844)	Visual	-
Echimyidae		
Dactylomys boliviensis Anthony, 1920	Carcass (1)	-
Proechimys brevicauda (Günther, 1876)	Pitfall (1)	-
Proechimys cuvieri Petter, 1978	Pitfall (1)	-
Proechimys simonsi Thomas, 1900	Pitfall (1)	-
Proechimys sp.	Pitfall (5)	Pitfall (1)

The genus *Marmosops* is represented in the upper Rio Acre sample by two species from two subgenera, *M. (Sciophanes) bishopi* (Pine, 1981) and *M. (Marmosops) noctivagus* (Tschudi, 1845). *Marmosps bishopi* is one of the smallest species of the genus, and the specimens studied were dorsally pale reddish brown and ventrally entirely white (Figure 2C); all males had blade-like lateral carpal tubercles. With regards to the cranio-dental morphology (Figure 5B), two lacrimal foramens are laterally visible; they present a posterior accessory cusp on the upper canines, and the entoconid of the first lower molar is shorter than the paraconid of the adjacent second molar. All *M. bishopi* were adult individuals collected at Resex Chico Mendes.

Marmosops noctivagus is one of the largest of the genus and is predominantly orangish brown dorsally and entirely cream-white ventrally. Its cranio-dental morphology (Figure 5A) has well-developed supraorbital crests with a small postorbital process on the skull, and on the canines, the accessory cusps are absent. We identified a single individual (LMUSP 193) collected at RESEX Chico Mendes as *M. noctivagus*. This specimen presents all diagnostic features exhibited by adults of this species.

On the other hand, all *Marmosops* specimens collected in ESEC do Rio Acre were immature. Although they exhibited most of the diagnostic features of *M. noctivagus*, due to possible morphological modifications correlated with ontogenetic development, we treat them as *Marmosops* cf. *noctivagus*.

Monodelphis is another speciose genus of didelphid marsupials, but some of its species can be easily recognized by external morphology. The three species recorded in the upper Rio Acre present distinct dorsal color patterns. In *Monodelphis emiliae* (Thomas, 1912) the center of the dorsum is grizzly and the head and rump are strongly reddish (Figure 2D). In *Monodelphis glirina* (Wagner, 1842) the dorsum is grizzly on the upper portion and orange on sides (Figure 2E), and in the undescribed *Monodelphis* sp., the dorsal pelage is orange-grayish brown, with orange highlights on the head (Figure 2F).

Regarding the cricetid rodents, most species are only identified by cranial features. We recognized taxa belonging to two tribes of subfamily Sigmodontinae, namely Akodontini and Oryzomyini. From the tribe Akodontini, we recorded from the upper Rio Acre *Oxymycterus inca* Thomas, 1900 (Figure 3A), an enigmatic species previously known from Brazil by only one specimen. We obtained three specimens of *O. inca*, all from RESEX Chico Mendes, and the lack of information of this species in Brazil, prompted us to describe its external and cranial morphology and to present cranial dimensions. For comparative purposes, we also present morphometric values of a previously collected specimen of *O. inca* from Brazil (USNM 546292, from Sena Madureira, Acre) and of specimens from Bolivia and Peru (from Tomina province, department of Chuquisaca, and La Convecion province, department of Cuzco, respectively; see below).

Five genera belonging to the tribe Oryzomyini were recorded, four represented by a single species each and one represented by two species. The specimen of *Euryoryzomys macconnelli* (Thomas, 1910) (Figure 3B), differs from its congeners by presenting a very dense

Figure 2. Species of marsupials (Didelphidae) recorded at ESEC do Rio Acre and RESEX Chico Mendes: (**A**) *Didelphis marsupialis*, (**B**) *Marmosa regina*, (**C**) *Marmosops bishopi*, (**D**) *Monodelphis emiliae*, (**E**) *Monodelphis glirina*, and (**F**) *Monodelphis* sp. Photos: M.A. Freitas.

Figure 3. Species of rodents (Cricetidae) recorded at ESEC do Rio Acre and RESEX Chico Mendes: (**A**) *Oxymycterus inca*, (**B**) *Euryoryzomys macconnelli*, (**C**) *Hylaeamys perenensis*, (**D**) *Neacomys spinosus*, (**E**) *Oecomys bicolor*, and (**F**) *Oligoryzomys microtis*. Photos: M.A. Freitas.

Figure 4. Species of rodents (Cuniculidae, Dinomyidae, Dasyproctidae and Echimyidae) recorded at ESEC do Rio Acre and RESEX Chico Mendes: (**A**) *Cuniculus paca*, (**B**) *Dinomys branickii*, (**C**) *Dasyprocta fuliginosa*, and (**D**) *Dactylomys boliviensis*. Photos: M.A. Freitas.

and long pelage, a short incisive foramen (4.18 mm long), the absence of an alisphenoid strut, and the absence of capsular process on lateral face of mandibular ramus. Specimens of *Hylaeamys perenensis* (Allen, 1901) (Figure 3C), did not present the parafosset on the second upper molar, the roof of mesopterygoid fossa is completely ossified, and the cranial dimensions are large (greatest skull length ranging from 34.45 to 35.41 mm and length of upper molar toothrow ranging from 5.15 to 5.26 mm). In the genus *Neacomys,* we recognized two species: *Neacomys musseri* Patton, da Silva, and Malcolm, 2000 and *Neacomys spinosus* (Thomas, 1882). The specimen of *N. musseri* has very small corporeal and cranial dimensions (greatest skull length = 19.65 mm and length of upper molars w = 2.42 mm; Figure 6B) and presents the derived carotid and stapedial circulatory pattern (pattern 2; Voss 1988). Alternatively, specimens of *N. spinosus* (Figure 3D) showed large corporeal and cranial dimensions (greatest skull length ranging from 22.81 to 24.71 mm and length of upper molar toothrow ranging from 2.97 to 3.12 mm; Figure 6A), and they have the primitive carotid and stapedial circulatory pattern (pattern 1 *sensu* Voss 1988). Additionally, the lateral coloration is distinctly orangish in *N. spinosus*, but entirely grayish in *N. musseri*.

All specimens of *Oecomys* showed some diagnostics characteristics, such as the pure white venter, a predominantly unicolorous tail with a short apical tuft, and cranial measurements (e.g., greatest skull length ranging from 24.21 to 28.59 mm and length of upper molars ranging from 3.54 to 4.03 mm) that led us to classify them as *Oecomys bicolor* (Tomes, 1860) (Figure 3E). Interestingly, some specimens presented an unusual characteristic for the species: they had the manus orange-colored from above the wrist to the base of the digits (where it is even more strongly orange), and more subtly orange on the tip of the digits. *Oecomys bicolor* exhibits considerable phenotypic plasticity in many morphological traits, and we consider this as another example of variation within this species.

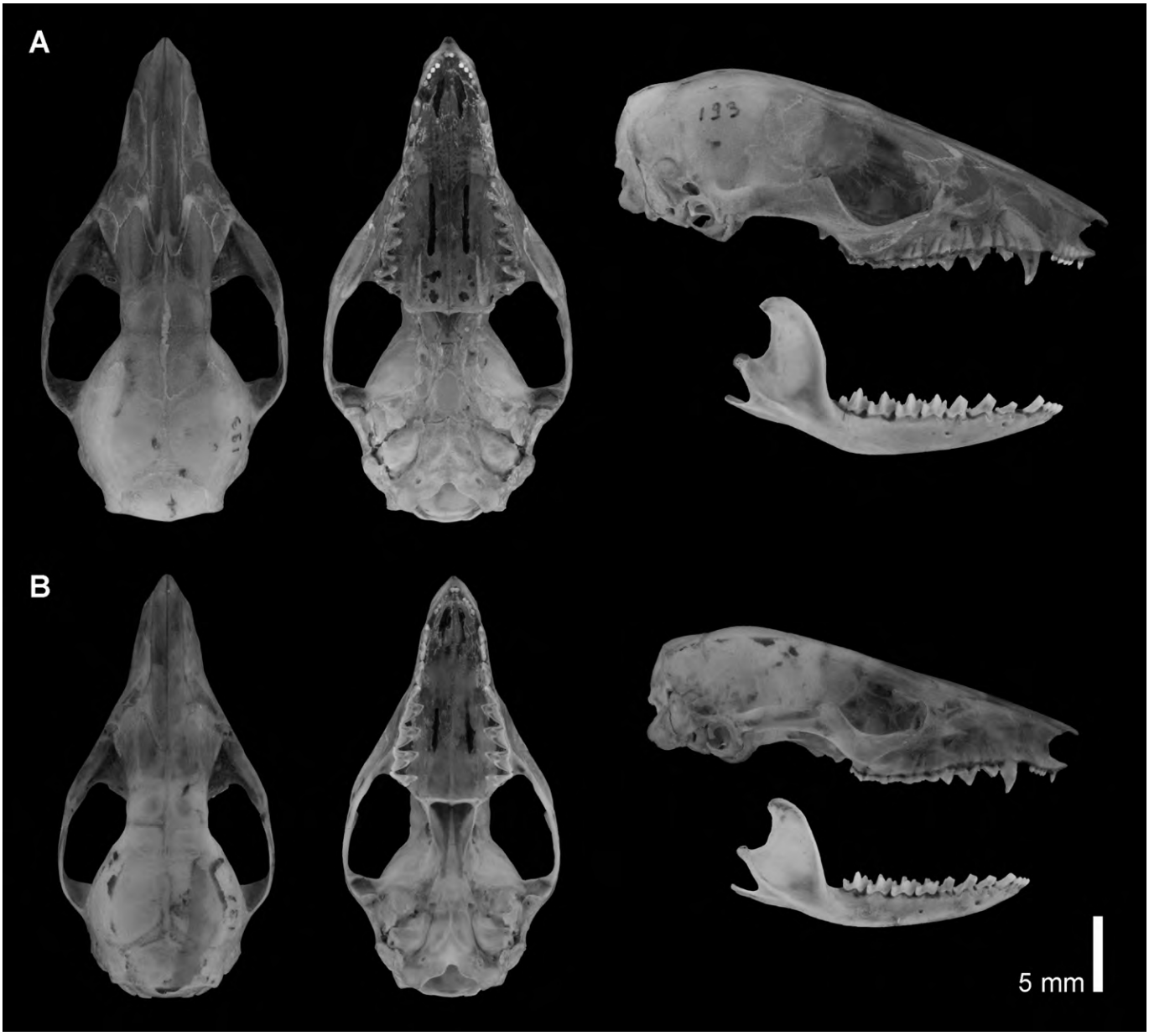

Figure 5. Skull and mandible of (**A**) *Marmosops noctivagus* (LMUSP 193; ♂; greatest skull length = 32.50 mm) and (**B**) *Marmosops bishopi* (LMUSP 191; ♂; greatest skull length = 28.53 mm). Skull on dorsal, ventral, and lateral view, and mandible on lateral view.

Regarding the genus *Oligoryzomys*, we identified *Oligoryzomys microtis* (Allen, 1916) from the upper Rio Acre specimens (Figure 3F). Specimens presented yellowish light brown dorsal coloration. Ventrally the pelage is grayish white (hairs with basal portion gray and apical portion white) with pure white patches (hairs entirely white) on the gular and inguinal regions. The tail is relatively short and no longer than the combined head and body length.

Two genera of echimyid rodents were recorded from the upper Rio Acre. The genus *Dactylomys* is represented by *Dactylomys boliviensis* Anthony, 1920. The sole specimen presented the color pattern characteristic of the species and had a black stripe on the top of the head (from crown to nape), with thighs and tail base partially tinged orangish. The other genus of echimyids, *Proechimys*, was the most diverse in our surveys, as it was represented by three species. *Proechimys brevicauda* (Günther, 1876) presents a short tail (much shorter than the combined head and body length) covered by short and sparse hairs; it is almost unicolored (dark brown on dorsal surface and brown on ventral surface). The dorsum of the pes is covered by brown hairs. The skull (Figure 7A) presents a short rostrum with relatively short rostral tube, the incisive foramen is lyrate in shape, and the mesopterygoid fossa extends to the middle of third molar. *Proechimys cuvieri* Petter, 1978 also exhibits short tail (much shorter than the combined head and body length) but it is covered by long hairs and clearly bicolored (brown on dorsal surface and white on ventral surface). The dorsum of the pes is predominantly covered by white hairs, and only on the lateral margins

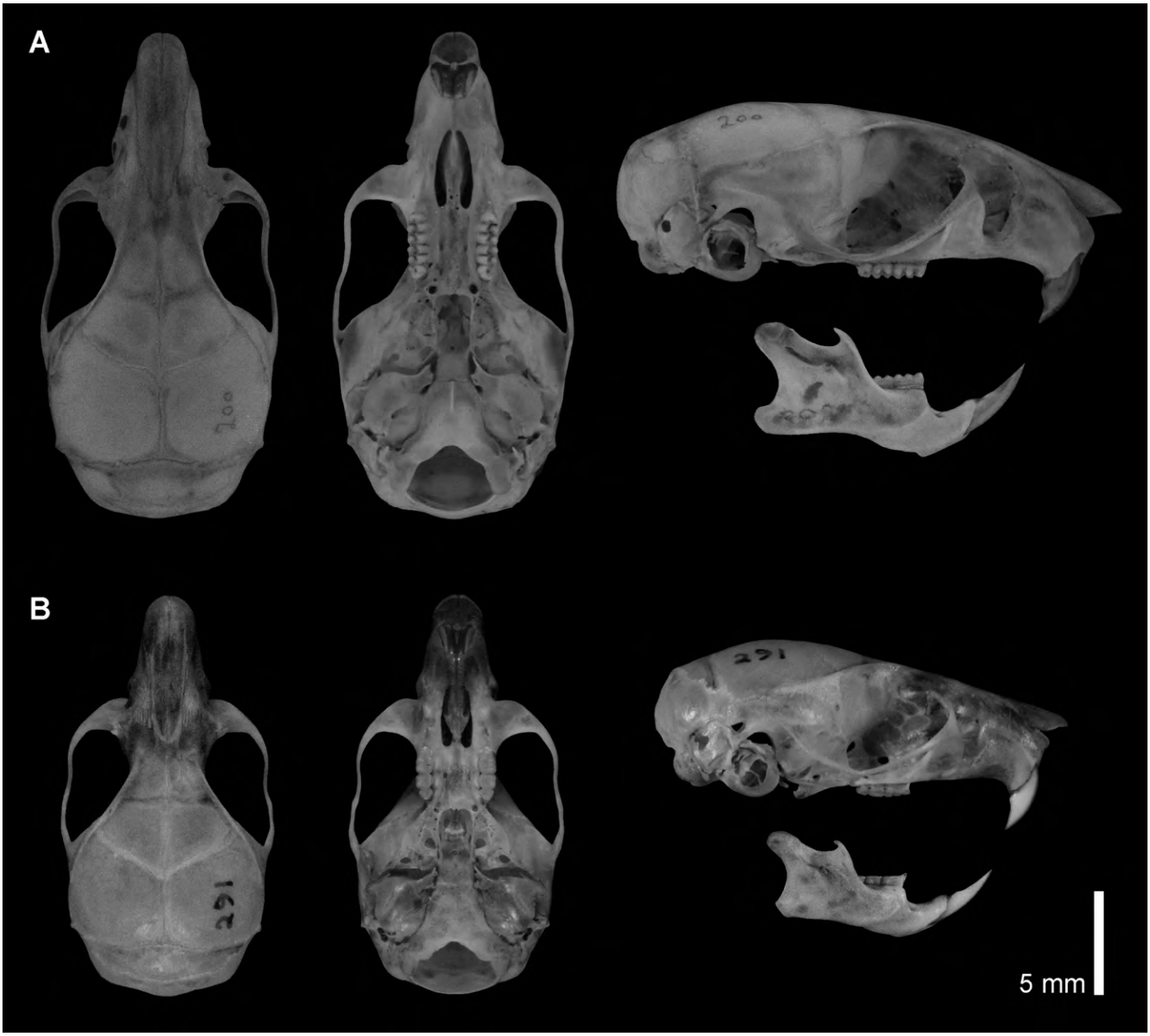

Figure 6. Skull and mandible of (**A**) *Neacomys spinosus* (LMUSP 200; ♀; greatest skull length = 23.41 mm) and (**B**) *Neacomys musseri* (LMUSP 291; ♂; greatest skull length = 19.65 mm). Skull on dorsal, ventral, and lateral view, and mandible on lateral view.

are brown hairs present. The skull (Figure 7B) presents a long rostrum with long rostral tube, the incisive foramen is mostly ovoid, and the mesopterygoid fossa surpasses the anterior margin of third molar. *Proechimys simonsi* Thomas, 1900 has the longest tail of the three species (almost same length of head and body combined) and is distinctly bicolored (dark brown on dorsal surface and white on ventral surface). The dorsum of the pes is covered by white hairs. The skull (Figure 7C) presents a long rostrum with long rostral tube, the incisive foramen is clearly ovoid and short, and the mesopterygoid fossa surpasses the anterior margin of third molar. All young specimens of this genus were treated as *Proechimys* sp. because of the plasticity of morphological features in this age class.

From the family Dasyproctidae, we recorded two genera: *Dasyprocta*, represented by *Dasyprocta fuliginosa* Wagler, 1832, and *Myoprocta*, represented by *Myoprocta pratti* Pocock, 1913. The former is one of the largest species of *Dasyprocta*. It presents a uniformly colored pelage that is predominantly blackish with some white tipped hairs mostly on the head and on the back (Figure 4C). The species of *Myoprocta* are characterized by their conspicuous, although short, tail that differs from species of *Dasyprocta*. The species of *Myoprocta* recorded here, *M. pratti*, is distinguished by the yellowish or grayish brown dorsal coloration and yellowish underparts. It does not present a distinct rump patch of long hairs, as does *M. acouchy*.

Specimens of *Oxymycterus inca* from upper Rio Acre

Here we present the morphological description of three adult specimens of *Oxymycterus inca* from RESEX

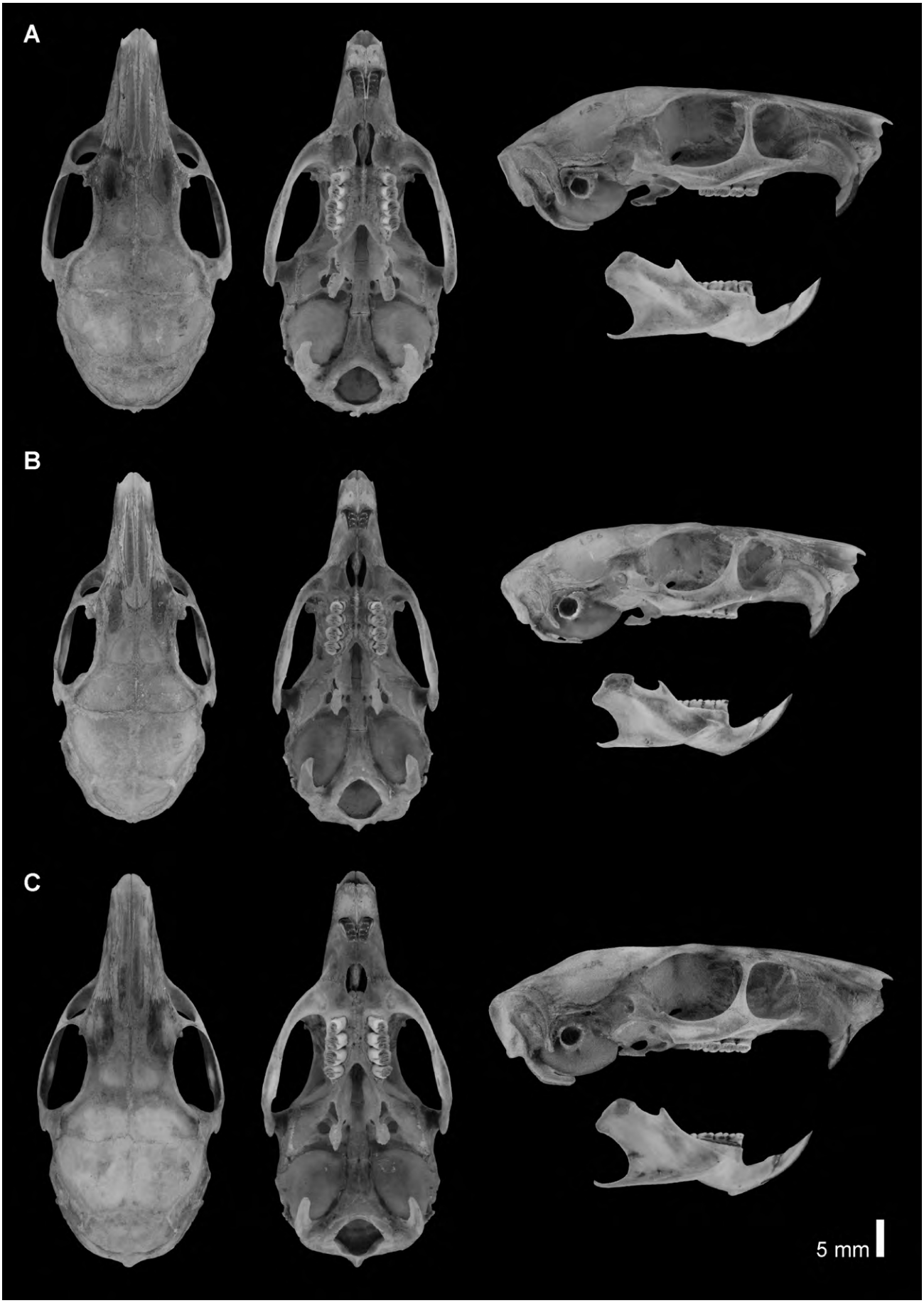

Figure 7. Skull and mandible of (**A**) *Proechimys brevicauda* (LMUSP 195; ♀; greatest skull length = 52.68 mm), (**B**) *Proechimys cuvieri* (LMUSP 196; ♂; greatest skull length = 49.15 mm) and (**C**) *Proechimys simonsi* (LMUSP 208; ♂; greatest skull length = 53.86 mm). Skull on dorsal, ventral, and lateral view, and mandible on lateral view.

Chico Mendes. Two specimens are females and one is male. They were collected in pitfall traps in "terra firme" forest. Morphometric values of two collected specimens (the third specimen was not measured) and of additional, comparative specimens from Acre, Bolivia, and Peru are presented in Table 2.

Upper Rio Acre specimens of *O. inca* exhibit dorsal pelage dense, moderately rough; pelage dark reddish brown, slightly darker mid-dorsally (Figure 3A). Lateral pelage intensely reddish brown and lighter than the dorsum. Ventral pelage dark orange and individual ventral hairs with their basal one-third gray and their apical two-thirds dark orange. Limit between lateral and ventral regions well-defined. Mystacial vibrissae short, with a few hairs reaching the base of the pinnae when laid back. Pinnae large (21 to 22 mm) and rounded, and covered internally with numerous hairs (mostly on the posterior region), and externally covered by hairs only on anterior region; pinnae hairs predominantly dark brown on both surfaces. Dorsal surface of manus covered by dark brown hairs; digits with very long claws (claw of dIII with length ranging from 5 to 5.5 mm). Pes moderately long and wide, dorsally covered by numerous hairs, dark brown colored; dIII slightly longer than dII and dIV; digits with very long claws (claw of dIII ranging from 4.5 to 5.5 mm); tufts of ungual hairs short and sparse, brown colored. Tail about 60% of head and body length, dark brown colored on both surfaces and covered by short dark brown hairs.

Table 2. Cranio-dental morphometric values (mm) for specimens of *Oxymycterus inca* from Acre state, Brazil, La Convecion province, department of Cuzco, Peru, and Tomina province, department of Chuquisaca, Bolivia.

	Brazil (Acre)			Peru (Cuzco)		Bolivia (Chuquisaca)	
	USNM 546292	LMUSP 187	LMUSP 188	USNM 582894	USNM 577997	USNM 276603	USNM 276604
Sex	♀	♀	♂	♂	♂	♀	♂
Age class	3	4	4	4	4	3	3
GSL	34.91	38.67	38.54	38.71	40.20	32.91	35.15
CIL	30.86	34.32	34.34	34.92	35.93	29.09	31.23
CZL	21.93	24.05	24.36	24.17	25.14	20.46	21.87
LD	7.88	9.28	9.09	9.88	9.65	7.50	8.23
LIF	7.63	8.84	8.37	8.43	8.33	6.88	7.21
BIF	2.54	2.66	3.01	3.32	3.00	2.12	2.73
LM	5.58	5.91	5.71	5.68	5.93	5.00	5.08
BM1	1.58	1.84	1.69	1.60	1.54	1.41	1.39
ID	1.50	1.71	1.64	1.69	1.63	1.36	1.47
IW	1.77	-	2.04	1.89	2.28	1.64	2.03
LN	13.27	15.09	15.02	14.95	15.20	12.37	13.40
BR	4.91	5.75	5.31	5.14	5.52	4.63	4.60
RL	13.84	15.20	15.51	16.21	16.34	13.38	14.76
ZB	-	17.11	17.13	17.65	18.56	14.46	15.71
BZP	2.53	3.18	2.69	3.02	2.72	2.32	2.28
LIB	6.40	6.39	6.29	6.27	6.70	6.02	5.80
OFL	10.10	11.04	11.43	11.21	11.98	9.85	10.12
PL	12.89	15.13	14.49	15.22	15.40	12.52	13.46
LPB	4.14	4.98	4.70	5.03	5.24	4.23	4.78
BBP	3.99	3.54	3.78	4.19	5.06	3.49	3.73
HBC	10.30	10.54	10.60	10.56	11.49	9.03	9.56
BBC	14.84	15.12	14.73	15.17	15.58	13.44	13.98
IPB	5.03	8.45	6.59	7.94	-	6.05	6.11
IPL	0.92	2.44	2.14	2.90	-	2.51	2.47
OCB	8.47	8.73	8.74	8.48	8.75	7.41	8.08

Skull long and narrow (Figure 8). Rostrum very long. Nasals posteriorly short, collinear to maxillary-frontal-lacrimal suture; posterior margin of nasals rounded or slightly acute. Premaxillae posteriorly very short, ending before nasals. Lachrymals with equal contact with the maxillary and frontal. Zygomatic notch deep. Interorbital region broad, hourglass shaped; supraorbital margins rounded anteriorly and squared posteriorly. Frontosquamosal suture not collinear with frontoparietal suture. Braincase narrow and elongated, without temporal crests. Parietal partial expanded to the lateral surface of braincase. Nasals and premaxillae projected anteriorly beyond incisors, forming a distinct and long rostral tube. Gnathic process very reduced. Zygomatic plate broad and sloped posteriorly with anterodorsal margin rounded and conspicuously anterior to superior maxillary root of zygoma; posterior margin of zygomatic plate situated posteriorly to the alveolus of M1. Jugal present and large, maxillary and squamosal processes of zygomatic arch not overlapping. Anterior opening of alisphenoid canal present. Alisphenoid strut present in one specimen (buccinator-masticatory foramen and accessory oval foramen not confluent) and absent in other specimen (buccinator-masticatory foramen and accessory oval foramen confluent). Squamosal-alisphenoid groove present on braincase lateral view, in the squamosal and alisphenoid bones; sphenofrontal foramen present; posterior opening of alisphenoid canal large; stapedial foramen present and large in the ectotympanic bullae, on the petrosal-ectotympanic suture (stapedial and carotid circulatory pattern 1, Voss 1988). Subsquamosal fenestra small. Postglenoid foramen small in one specimen and vestigial in other specimen. Mastoid completely ossified. Incisive foramina with parallel margins and long, posterior margin surpassing the anterior face of M1 and reaching the protocone. Palate short and wide; posterolateral palatal pits present, as one single small foramen. Mesopterygoid fossa reaching the posterior face of M3; sphenopalatine vacuities present, but reduced as small openings, predominantly anterior to basisphenoid-presphenoid suture. Parapterygoid plate with similar width to the middle portion of mesopterygoid fossae. Auditory bullae large, periotic bone mostly masked by auditory bullae in ventral view.

Mandible elongated, with low ramus (Figure 8). Sigmoid notch shallow and angular notch deep. Capsular process of lower incisor alveolus absent. Superior and inferior masseteric ridges with the anterior portion conjoined as single crest.

Upper incisors opisthodont. Maxillary toothrows

Figure 8. Skull and mandible of *Oxymycterus inca* (LMUSP 188; ♂; greatest skull length = 38.54 mm). Skull on dorsal, ventral, and lateral view, and mandible on lateral view.

slightly divergent anteriorly. First upper molar (M1) with anterocone divided into labial and lingual conules by the anteromedian flexus; anteromedian flexus more labially positioned, configuring a larger lingual anteroconule; anteroloph developed, reaching the labial margin of the molar; protostyle absent; mesoloph present, proximally fused to the paracone and free labially (mesofosset not visible; difficult to evaluate if it is a true mesoloph arising from the median mure or a paralophule); mesoloph also exhibit a small mesolophule directed to the metacone (on both M1 and M2 of specimen LMUSP 188); enterostyle absent; posteroloph not visible (probably fused to metacone). Second upper molar (M2) similar to M1; mesoloph apparently shorter. Third upper molar (M3) small, with small anteroloph (mostly fused to paracone); without noticeable hypoflexus, presenting only a small notch on the enamel surface (Figure 9A); all remaining lophs, flexus and fossets not visible. First lower molar (m1) with anteroconid divided into labial and lingual conulids by the anteromedian flexid; anteromedian flexid more labially positioned, configuring a larger lingual anteroconulid; anterolophid present, short, not reaching the margin of molar; protostylid and protolophid present, almost reaching the margin of molar; mesolophid present, not reaching the margin of molar (no entofossetid visible; difficult to evaluate if it is a true mesoloph or a entolophulid); ectostylid and ectolophid present, not reaching the margin of molar; posterolophid much shorter than other lingual lophids. Second lower molar (m2) with reduced anterolabial cingulid (protolophid), fused to protoconid; mesolophid similar to m1; ectolophid absent; posterolophid shorter than other lingual lophids. Third lower molar (m3) without anterolabial cingulid; mesolophid absent (Figure 9B).

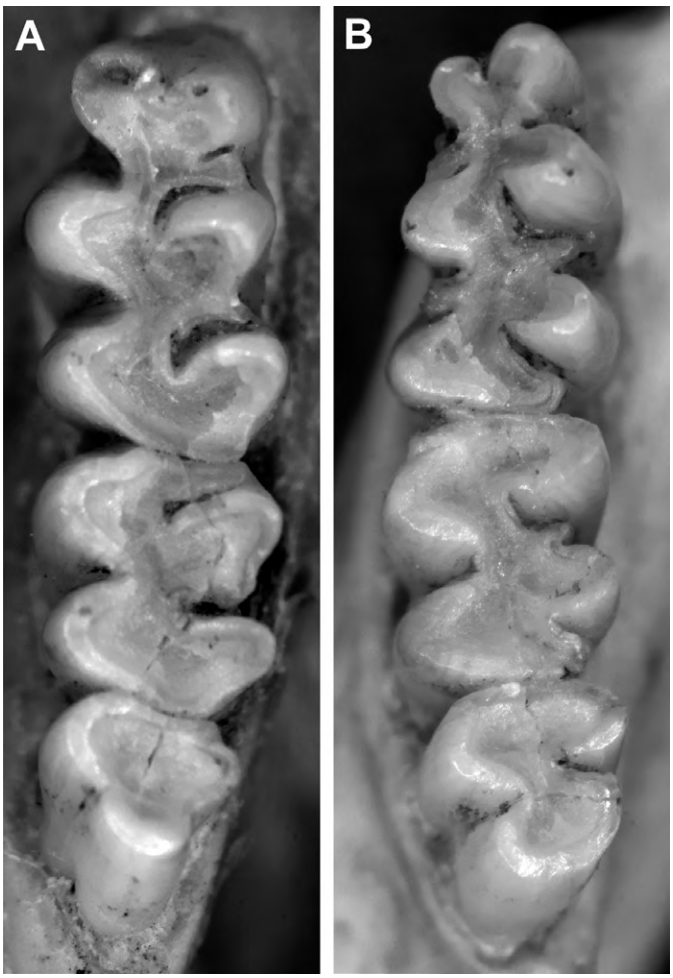

Figure 9. Upper (**A**) and lower (**B**) molar series, in occlusal view, of *Oxymycterus inca* (LMUSP 187).

DISCUSSION

Species richness on Amazon region

Of the 25 species recorded here, 18 are small mammal species, according to the classification adopted, for example, by da Silva et al. (2007), Hice and Velazco (2012), and Lopes and Mendes-Oliveira (2015), who considered as small mammals the representatives of the families Didelphidae, Cricetidae, and Echimyidae. Comparing our results with other inventories of nonvolant small mammals throughout Amazon, the richness obtained here is greater than reported for PARNA Tapajós, in Pará (12 species; George et al. 1988), and similar to the richness reported from the region of the middle Rio Madeira, in Amazonas state (19 species; da Silva et al. 2007). However, the upper Rio Acre is notably less rich in nonvolant small mammals when compared to other sites, such as the upper Rio Juruá, Acre (28 species; Patton et al. 2000), the region of Paracou, French Guiana (27 species; Voss et al. 2001); the Reserva Nacional Allpahuayo-Mishana, Loreto, Peru (28 species; Hice and Velazco 2012), and Floresta Nacional de Carajás, Pará, Brazil (31 species; Gettinger et al. 2012).

Despite the physiognomic and geographic conditions, two main factors might explain the lower richness of nonvolant small mammals obtained here. First, the duration of our survey effort was conducted over 85 days, less than in other surveys. For example, Voss et al. (2001) surveyed for 190 days and Hice and Velazco (2012) sampled more than 240 days. Second, we did not use conventional traps (e.g., Sherman, Tomahawk, and Museum special). These traps are most commonly used in nonvolant small mammals inventory work and obtain a large number of species (e.g., Patton et al. 2000).

In this last context, we compare our results with the richness of species obtained only from pitfall traps in the same studies. We observed that the number of species caught by us (17 species) was remarkably greater than in previous studies using pitfall traps: Voss et al. (2001) captured 12 species; da Silva et al. (2007), nine species; and Hice and Velasco (2012), 12 species. Therefore, the use of pitfall traps on RESEX Chico Mendes and ESEC do Rio Acre presented high efficiency on the capture of nonvolant small mammal species.

Species taxonomy and geographic distribution

Although very few studies on mammal species had been published for Acre state, most of the species recorded here were previously known from the upper Rio Acre region. In some cases (e.g., *Marmosops bishopi*, *M. noctivagus* and *Proechimys simonsi*), it is due to the documented presence of the species in the neighboring states of Amazonas and Rondônia or from Peru and Bolivia, which border the upper Rio Acre region (Gardner 2007; Patton et al. 2015; Díaz-Nieto and Voss 2016). However, three species — *Neacomys musseri*, *Dasyprocta fuliginosa* and *Proechimys cuvieri* — were not previously recorded from the upper Rio Acre, only previously known from the upper Rio Juruá region, northwestern Acre; (Patton et al. 2000). Our records represent an extension of each of these species' distribution by approximately 450 km to the east-southeast.

We recorded two species that are very poorly sampled in Brazil, *Marmosa regina* and *Dactylomys boliviensis* (Gardner 2007; Patton et al. 2015). Our record of *Monodelphis* sp. are also noteworthy. Some studies have classified this taxon as *M. kunsi* (e.g., Gettinger et al. 2011) because of morphological similarities between these species. Phylogenetic studies (see Pavan et al. 2014) and more detailed morphological comparisons (e.g., Semedo et al. 2011) have shown that the undescribed species is distinct from *M. kunsi*. Pavan et al. (2014) found that this undescribed species ("*Monodelphis* species 2" of Pavan et al. 2014) is phylogenetically closer to *M. handleyi*, *M. osgoodi* and *M. peruviana* than *M. kunsi*. This undescribed *Monodelphis* species is known from the Brazilian states of Mato Grosso, Pará and Rôndonia (Semedo et al. 2011; Pavan et al. 2014), and our specimens represent the first confirmed records from Acre state.

Our record of *Oxymycterus inca*, as already mentioned, is the second time that this the species has been found in Brazil. The first collection of *O. inca* (USNM 546292) was made in 1976 and for almost 40 years, no other specimen had been collected. Despite a massive survey effort, Patton et al. (2000) did not find it in the headwaters of the Rio Juruá; either *O. inca* is absent from this region or the methodology (non-use of pitfall traps) prevented collection of this species.

Conservation implications

Of the species we found, only *Dinomys branickii* has been categorized as threatened by the IUCN; it is considered Vulnerable (Tirira et al. 2008). In the Brazilian list of threatened species, none of the species is considered threatened (MMA 2014). For some of the poorly known species, with few records in western Amazon and Acre state, our records from RESEX Chico Mendes and ESEC do Rio Acre may be useful for future conservation plans and strategies of these species. Our results help fill a large knowledge gap of mammal distributions in Acre state. Our study highlights the importance of RESEX Chico Mendes and ESEC do Rio Acre as protected areas in the western Amazon.

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APPENDIX

Voucher specimens collected at RESEX Chico Mendes and ESEC do Rio Acre, Acre state, Brazil.

Didelphis marsupialis: RESEX Chico Mendes: ♂: LMUSP 211. ***Marmosa (Micoureus) regina:*** ESEC do Rio Acre: ♀: LMUSP 281. ***Marmosops (Sciophanes) bishopi:*** RESEX Chico Mendes: ♀: LMUSP 175; ♂: LMUSP 191, 192, 206. ***Marmosops (Marmosops) noctivagus:*** RESEX Chico Mendes: ♂: LMUSP 193. ***Marmosops (Marmosops) cf. noctivagus:*** ESEC do Rio Acre: ♀: LMUSP 283, 284, 285; ♂: LMUSP 282. ***Monodelphis emiliae:*** RESEX Chico Mendes: ♀: LMUSP 205; ♂: LMUSP 178. ***Monodelphis glirina:*** RESEX Chico Mendes: ♀: LMUSP 186. ***Monodelphis* sp.:** ESEC do Rio Acre: ♂: LMUSP 279, 280. ***Oxymycterus inca:*** RESEX Chico Mendes: ♀: LMUSP 184, 187; ♂: LMUSP 188. ***Euryoryzomys macconnelli:*** RESEX Chico Mendes: ♂: LMUSP 177. ***Hylaeamys perenensis:*** RESEX Chico Mendes: ♂: LMUSP 181, 204; ESEC do Rio Acre: ♀: LMUSP 293, 294, 296, 297; ♂: 292, 295. ***Neacomys musseri:*** ESEC do Rio Acre: ♂: LMUSP 291. ***Neacomys spinosus:*** RESEX Chico Mendes: ♀: LMUSP 200, 201; ♂: LMUSP 172, 179, 182; sex unknown: LMUSP 202; ESEC do Rio Acre: ♀: LMUSP 289; ♂: LMUSP 288, 290. ***Oecomys bicolor:*** RESEX Chico Mendes: ♀: LMUSP 173, 183, 203; ESEC do Rio Acre: ♂: LMUSP 286, 287. ***Oligoryzomys microtis:*** RESEX Chico Mendes: ♀: LMUSP 197, 299, 300; ♂: LMUSP 180, 198, 199. ***Hydrochoerus hydrochaeris:*** RESEX Chico Mendes: sex unknown: LMUSP 190. ***Dasyprocta fuliginosa:*** RESEX Chico Mendes: sex unknown: LMUSP 189. ***Dactylomys boliviensis:*** RESEX Chico Mendes: sex unknown: LMUSP 176. ***Proechimys brevicauda:*** RESEX Chico Mendes: ♀: LMUSP 195. ***Proechimys cuvieri:*** RESEX Chico Mendes: ♂: LMUSP 196. ***Proechimys simonsi:*** RESEX Chico Mendes: ♂: LMUSP 208. ***Proechimys* sp.:** RESEX Chico Mendes: ♂: LMUSP 207, 210; ♀: 174, 185, 209; ESEC do Rio Acre: ♀: LMUSP 298.