(Table 4 cont.)

Species		Lund (1836)/Winge (1887)		Present study (2009-2011)
Name by Winge/Lund	**Actual name**	**Fossil[1]**	**Historical[2]**	**Modern [3]**
Mesomys mordax	†*Euryzygomatomys mordax*	x		
Carterodon sulcidens	*Carterodon sulcidens*	x	P, S	P
Dicolpomys fossor	†*Dicolpomys fossor*	x		
	Muridae			
Mus rattus	*Rattus rattus*		P, S	P
Mus musculus	*Mus musculus*[5]		P, S	P
TOTAL		34	23	16*

[1] Species found in the sediments of the caves.
[2] Species from fresh pellets and cave floors and collected alive.
[3] 'Superficial' and 'stratified' modern samples.
[4] According to an unpublished study, *Habrothrix clivigenis* appears to be similar to *Akodon paranaensis* (Pardiñas et al. 2015).
[5] *M. musculus* was not registered in the samples of Salitre Cave and Toca do Lixo, but was collected in the Mata Grande sample.
† Extinct species.
* Not including *Oligoryzomys mattogrossae* and *Cerradomys scotti.*

fauna. *Carterodon sulcidens*, a rodent very common and abundant in pellets in the nineteenth century (Lund 1836, p. 126), presented one mandible in 'Stratified' samples of the SC. There are hardly any recent records for this species (Bezerra et al. 2011).

Several Cricetidae—*Thaptomys nigrita*, *Bibimys labiosus*, *Kunsia tomentosus*, *Hyaleamys laticeps* and *Oxymycterus dasytrichus*—described by Lund (1839b, p.291) and Winge (1887) as living fauna, were not found in our sample, although *T. nigrita* and *O. dasytrichus* (identified as *O. roberti*) have been collected near the study area (Ávila-Pires 1960; Leal et al. 2008). The lack of recent records of *K. tomentosus* in the Lagoa Santa region may be related to the intense landscape modification by human activities (Pardiñas et al. 2008).

Several species cited by Lund and Winge as living in the Lagoa Santa region (Lund 1839b, p. 291; Winge 1887) were found in this study and in nearby regions: *Oligoryzomys* sp., *C. tener, R. mastacalis*, *N. squamipes*, and *H. brasiliensis* (Ávila-Pires 1960; Leal et al. 2008).

Winge (1887) reported that *P. simplex, C. subflavus* and *A. cursor* were common in fresh owl pellets and in fossil deposits in the caves. However, in our studies *P. simplex* was extremely rare, with only a single skull fragment found in the 'Modern' data, and *Akodon* represented just 0.21% of the modern rodents of the SC.

In 'Modern' samples, *Calomys* sp. represents 64% of the SC fauna and 80% of the sample of TL, and *N. lasiurus* was the second most abundant species, whereas in 1836, Lund reported that *N. lasiurus* was the most abundant rodent species in owl pellets, representing about 80% of individuals (**Table 5**).

In 'Modern' samples, *N. lasiurus* abundance increased in the stratified samples with depth, but the difference in the proportion was only significant in TL 'Superficial' vs. 'Stratified' ($p = 0.003$). The same pattern was observed for

Table 5

Proportion of specimens in owl pellets described by Lund (1836), collected in Salitre cave (SC, 2009) and Toca do Lixo (TL, 2011). Modern superficial: SC-A, TL-A. Modern stratified: SC-S, TL-S.

Species	Historical (Lund 1836)	SC-A 2009	TL-A 2011	SC- S	TL-S
Necromys lasiurus	80	29	13	32	29
Calomys sp.		64	82	50	56
Carterodon sulcidens	5	0	0	0.4	0
Thrichomys apereoides, *Clyomys laticeps* and *Trinomys setosus*	1	0.2	0.3	0.4	2
Other rodents (*Thalpomys lasiotis*)	1	0.8	0.1	3	0
Other rodents (*Oligoryzomys, Cerradomys, Nectomys, Rhipidomys, Akodon, Pseudoryzomys, Holochilus*)		6	5	13	12
Rattus		0.2	0.3		
Other small animals	13				
Total	100	100	100	100	100

T. lasiotis, being more abundant in the stratified samples. This species has also been collected in nearby locations such as Serra do Cipó and Serra das Sempre Vivas (Leal et al. 2008), and this species is considered Vulnerable (VU) in Brazil (MMA 2014).

Some Cricetidae found exclusively as 'Fossils' from the caves (Lund 1839, p. 291; Winge 1887)—for example *Sooretamys angouy*a, *Blarinomys breviceps* and *Delomys plebejus*—were not found in our samples. The last record for these species close to Sumidouro State Park was from Conceição do Mato Dentro, 50 km away from Lagoa Santa (Ávila-Pires 1960). The *B. breviceps* collected by Lund was fossil dated from the Pleistocene. It is probably extinct in the locality, and its existence in the region in the past could have been related to the more mesic environment (Silva et al. 2003). Meanwhile, *D. plebejus* should be considered a nomen dubium, as its equivalence to any of the living species is indeterminate (Voss 1993).

Environmental degradation

The differences in richness and abundance are important and may not be explained only by sample size or taphonomic bias. These changes in the small mammal proportions and possible local population declines can probably be related to environmental changes over the past 180 years. The fragmentation of the natural vegetation was undoubtedly the main factor contributing to the decline of medium and large mammals in the region (Trolle et al. 2007). During the last century, the Lagoa Santa region has also suffered bird population declines and the disappearance of many species recorded by Lund, Reinhardt and Burmeister. Over the years, the bird community, originally so diverse, has been replaced by a few generalist species, none of which were common in the last century (Christiansen & Pitter 1997).

Lund (1838b, p. 209, 210) already reported impacts caused by farming and exploitation of saltpeter, including possible extinctions of flora. Today, the Cerrado remnants are restricted to the dolines and rock outcrops, surrounded by pastures (Berbert-Born 2002; Travassos 2010). Studies on modern, historical and fossil rodents using owl pellets in a degraded area in North America showed variation in the richness and abundance in comparison with a preserved area, suggesting quick changes in the ecological baseline in the region. Thus, it is likely that anthropogenic processes there have led to a change in the vegetation and in the rodent

fauna (Terry 2010b), and our study found similar patterns in the Lagoa Santa region. Such landscape modifications over the last 180 years are likely to have resulted in homogenization of habitats and these changes were reflected in *T. furcata* diets, with a marked increase of *Calomys* (*C. expulsus* and *C. tener*). *Calomys* species have been described as opportunistic and dominant in the anthropogenic environments (e.g. Bellocq 1990; Mills et al. 1991; Pardiñas et al. 2000). Pardiñas et al. (2000) have observed a similar pattern, with the dispersion and increased abundance of *Calomys* (*C. laucha* and *C. musculinus*) to the detriment of other small mammals, in human-modified landscapes.

These changes in rodent abundance and geographic ranges over the past 180 years could also be explained by climate change, although little is known about how rodent communities respond to climate change through time (Hadly 1996; Grayson 2000; Blois & Hadly 2009; Blois et al. 2010). For small rodents, a warmer climate may cause a local increase in abundance of species tolerant to higher temperatures (Terry et al. 2011). Unfortunately, no analysis has been done with meteorological data for this region and period to infer any changes.

CONCLUSIONS

In this paper, a great richness of the rodents in the central karst region of Minas Gerais was revealed by owl pellets, with *Calomys tener* and *C. expulsus* prevalent in the modern samples. The 'Modern' rodent community is less rich than the 'Historical' community described by Lund and Winge. This lower diversity of rodents currently observed in the Lagoa Santa region may result from environmental degradation in the last century. Despite the increase in studies about the rodent fauna, Brazil still presents gaps in information about historical and fossil communities. Studies should also emphasize digging sequences ('Stratified' samples) to understand the changes in the small mammal communities over the centuries. Such studies would generate more complete conclusions about how anthropogenic degradation affects extinction processes, population declines and species invasion.

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APPENDIX 1

Voucher numbers

Table 1

Voucher numbers of specimens used in this study deposited in João Moojen Museum of Zoology (MZUFV).

Species	1	2	3	4	5	6	7	8
Calomys expulsus	3861	3867	3881	_	3811	3830	3845	3835
Calomys tener	3862	3868	3882	_	3812	3831	3846	3836
Calomys sp.	3863	3866	3880	3884	3810	3829	3847	3834
Necromys lasiurus	3860	3874	3883	3885	3813	3826	3838	3840
Oligoryzomys nigripes	3855	3872	3876	3888	3815	3827	3844	3833
Oligoryzomys mattogrossae	3856	3873	3875	_	3814	_	3843	_
Oligoryzomys sp.	3854	3871	3877	3887	3816	3828	3842	_
Cerradomys scotti		_	_	_	_	_	_	_
Cerradomys subflavus	3852		3879	3889	3820	3832	3841	_
Rhipidomys mastacalis	3851		_	_	3817	_	3849	_
Thalpomys lasiotis	3858	3869	3878	3886	3819	_	_	_
Akodon sp.	3853	3870	_	_	_	_	_	_
Pseudoryzomys simplex	3857	_	_	_	_	_	_	_
Nectomys squamipes	_	_	_	_	3818	_	3840	_
Holochilus brasiliensis	_	_	_	_	3821	_	3839	_
Thrichomys apereoides	3864	_	_	_	3825		_	_
Trinomys setosus	_		_	_	_	_	_	_
Carterodon sulcidens	_	_			_	_	_	_
Mus musculus	_	_	_	_	_	_	3850	_
Rattus sp.	3859	_	_	_	3822	_	3848	_

1. Salitre Cave, Cordisburgo, Minas Gerais, Brazil.
2. Salitre Cave, first layer, Cordisburgo, Minas Gerais, Brazil
3. Salitre Cave, second layer, Cordisburgo, Minas Gerais, Brazil
4. Salitre Cave, third layer, Cordisburgo, Minas Gerais, Brazil
5. Toca do Lixo Cave, Lagoa Santa, Minas Gerais, Brazil
6. Toca do Lixo Cave, first layer, Lagoa Santa, Minas Gerais, Brazil
7. Mata Grande Cave, Sete Lagoas, Minas Gerais, Brazil
8. Mariposa Cave, Lagoa Santa, Minas Gerais, Brazil

SUPPLEMENTARY ONLINE MATERIAL

Supplement 1
https://www.sarem.org.ar/wp-content/uploads/2018/06/SAREM_MastNeotrop_25-1_Boroni-sup1.docx

Fig. S1. Sumidouro State Park: A) Lagoon Sumidouro in the dry season; B) Vegetation; C) Limestone outcrop. Peter Lund Natural Monument: D) Salitre Cave, collection point indicated by the arrow.

Fig. S2. Mandibles (md) and skull in ventral view (vv) and dorsal (dv) of rodents in owl pellets in central karst region of Minas Gerais. (A) *Calomys expulsus* (dv, vv, md); (B) *C. tener* (dv, vv, md); (C) *Necromys lasiurus* (dv, vv, md); (D) *Akodon* sp. (md); (E) *Thalpomys lasiotis* (md); (F) *Oligoryzomys nigripes* (dv, vv, md); (G) *O. mattogrossae* (dv, vv, md); (H) *Cerradomys subflavus* (dv, vv, md); (I) *C. scotti* (md).

Fig. S3. Mandibles (md) and skull in ventral view (vv) and dorsal (dv) of rodents in owl pellets in central karst region of Minas Gerais. (A) *Pseudoryzomys simplex* (vv); (B) *Holochilus brasiliensis* (vv, md); (C) *Nectomys squamipes* (vv, md); (D) *Rhipidomys matacalis* (dv, vv, md); (E) *Thrichomys apereoides* (dv, vv, md); (F) *Trinomys setosus* (md); (G) *Carterodon sulcidens* (md).

Fig. S4. Rarefaction analysis graph of all 'Superficial' samples. Blue = Salitre Cave; Green = Toca do Lixo; Yellow = Mata Grande Cave; Red = Mariposas Cave. Y axis = Estimated richness. X axis = sample number (MNI). CI = 95%.

Fig. S5. Rarefaction analysis graph of the Salitre Cave samples, Peter Lund Natural Monument, Cordisburgo. Red = 'Superficial'; Blue = 'Stratified'. Y axis = Estimated richness. X axis = sample number (MNI). CI = 95%.

Fig. S6. Rarefaction analysis graph of the Toca do Lixo samples, Sumidouro State Park, Pedro Leopoldo / Lagoa Santa. Blue = 'Superficial'; Red = 'Stratified'. Y axis = Estimated richness. X axis = sample number (MNI). CI = 95%.

Table S1. Rodents collected in owl pellets in the Cerrado and Atlantic Forest biomes. (A) Motta-Junior & Talamoni (1996); (B) Motta-Junior & Alho (2000); (C) Bonvicino & Bezerra (2003); (D) Bueno & Motta-Junior (2008); (E) Magrini & Facure (2008); (F) Rocha et al. (2011); (G) Roda (2006); (H) Souza et al. (2010); (I) Lemos et al. 2015; (J) Scheibler & Christoff (2007); (K) Escarlate-Tavares & Pessoa (2005); (L) Present study.