

## The first record of a pre-Columbian domestic dog (*Canis lupus familiaris*) in Brazil

**Suggested Running Head:** First record of pre-Columbian domestic dog in Brazil

Rafael Guedes Milheira<sup>a</sup>, Daniel Marcelo Loponte<sup>b</sup>, César García Esponda<sup>c</sup>, Alejandro Acosta<sup>b</sup>, Priscilla Ulguim<sup>d\*</sup>

<sup>a</sup> Department of Anthropology and Archaeology, Universidade Federal de Pelotas. Laboratory of Anthropology and Archaeology (LEPAARQ/UFPEL). Pelotas. Brazil. [milheirarafeel@gmail.com](mailto:milheirarafeel@gmail.com)

<sup>b</sup> Instituto Nacional de Antropología y Pensamiento Latinoamericano (INAPL). Consejo Nacional de Investigaciones científicas y Técnicas (CONICET). Calle 3 de Febrero 1378 (CJ1426N). Buenos Aires. Argentina. [dloponte@inapl.gov.ar](mailto:dloponte@inapl.gov.ar); [acosta@retina.ar](mailto:acosta@retina.ar)

<sup>c</sup> Universidad Nacional de La Plata. Facultad de Ciencias Naturales y Museo. Paseo del Bosque s/n. 1900. La Plata. Argentina. [cesponda@fcnym.unlp.edu.ar](mailto:cesponda@fcnym.unlp.edu.ar)

<sup>d</sup> School of Science & Engineering, Teesside University, Middlesbrough, TS1 3BA, UK. ORCID 0000-0002-5563-5682. [p.ulguim@tees.ac.uk](mailto:p.ulguim@tees.ac.uk) \*

\*Corresponding Author (Tel: +44 7449949798)

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## Abstract

Archaeological excavations of the PSG-07 earthen mound at Pontal da Barra in Rio Grande do Sul, southern Brazil have revealed the earliest known evidence for the presence of domestic dog (*Canis lupus familiaris*) in Brazil. This is the first reported pre-Columbian example in the country. Analysis of morphology, morphometry, and dental enamel laminae identified a left maxillary molar 1, left maxillary molar 2 and attached fragments of the maxilla of *Canis lupus familiaris*. A direct radiocarbon date on a fragment of the maxilla provided an age range between 1701 and 1526 cal BP ( $2\sigma$ ). This is within the range of other dates for the site, which indicate intermittent occupation between 2024 and 1027 cal BP ( $2\sigma$ ). Data from carbon isotope analysis indicates a potential marine diet. However, nitrogen isotope analysis values are lower than expected for a marine diet. The sparse records of pre-Columbian *Canis lupus familiaris* in the region emphasise the importance of the present work.

## 1. Introduction

Within South America, securely identified remains of pre-Columbian *Canis lupus familiaris* (*C. l. familiaris*), the domestic dog, are mostly limited to the Andes and neighbouring regions. The paucity of remains elsewhere contrasts with the broad expansion of dogs from ca. 10000 BP throughout North and Central America, (Morey, 2006). In South America, their introduction appears to take place later, between ca. 7500 and 4500 BP (Cabrera, 1934; Gallardo, 1964-65; Mendoza and Valadez, 2006; Pozzi-Escot *et al.*, 2012; Prates *et al.*, 2010a; Schwartz, 1997; Wing, 1989; Zetti, 1973). Beyond the Andes, finds pertain to pre-Columbian *C. l. familiaris* in Argentina (Acosta and Loponte, 2010; 2011), yet there are just six undisputed published cases. Two are from north Patagonia (Prates *et al.*, 2010a) and four from the lower Paraná wetlands (Acosta and Loponte, 2010; Acosta *et al.*, 2011; 2015). In Uruguay, there is further evidence from perhaps four earthen mound sites, although several of the zooarchaeological analyses remain in unpublished literature (Bracco *et al.*, 2000; González, 1999; López Mazz and Castiñeira, 2001; Rudolph, 2014).

This report presents the first archaeological record of pre-Columbian *C. l. familiaris* from Brazil. The evidence comprises two complete maxillary molars - M1 and M2, with a small fragment of a left maxilla attached (ID: 115-04). These are from a complex of 18 earthen mounds in Pontal da Barra, southern Brazil (Figure 1) (Milheira, 2014). The mounds are archaeological deposits known as *cerritos de indios* or *aterros*. Such sites appear across the Pampa biome in the lowlands of the La Plata Basin, its southern coast including areas of modern Brazil, Uruguay and Argentina (López Mazz, 2001). Research indicates that these developed through successive occupation by complex hunter-gatherers in the wetland environments of the region over a long period, from as early as ca. 5000 BP until 200 BP (Bracco *et al.*, 2008; Gianotti, 2015; Iriarte, 2006; Schmitz, 1976). PSG-07 is a sub-circular mound with a greatest width of 36 m, aligned with three other earthen mounds on a North-South axis. The molars were recovered from Level 2 of the excavation. Lithic fragments,

potsherds, faunal and fragmented human remains were recorded across other levels (Milheira, 2014). Radiocarbon dates from the complex suggest intermittent occupation between 2024 and 1027 cal BP (2 $\sigma$ ) (Table 1). Evidence indicates hunter-gatherer use of lacustrine resources from *Lagoa dos Patos*, a post-glacial coastal lagoon.

*Figure 1. A: Location of the Pontal da Barra complex in South America, and; B: in the coastal region of southern Brazil with other records of pre-Columbian dogs as per Table 3 shown in yellow. C: Location in relation to regional mound sites. D: PSG-07 within the complex at UTM 22J 383093/6483337.*

*Table 1. Radiocarbon dates from PSG-07 at the Pontal da Barra earthen mound complex after Milheira et al., 2016b. Type 1 = date on *C. l. familiaris* taxon; 2 = date from context. \*Calibrated with OxCal 4.2 using SHCAL13 for terrestrial flora and fauna, Marine13 curve used for marine fauna (otoliths) (Bronk-Ramsey, 2009; Hogg et al., 2013; Reimer et al., 2013).*

## 2. Methods

The excavation of a 3 x 1 m unit at PSG-07 during 2013 revealed the *C. l. familiaris* remains. Members of the research team compared both molars with *C. l. familiaris* specimens at the *Museo de La Plata*, Argentina, including a pre-Columbian individual (INAPL/CL1-UE-3) from the Paraná Delta, morphologically and genetically identified as *C. l. familiaris* (Acosta et al., 2011). Furthermore, the team made comparisons with American foxes including *Chrysocyon brachyurus*, *Lycalopex gymnocercus*, *Cerdocyon thous* and *Dusicyon avus*, and to bibliographic data on *Lycalopex vetulus* (Dalponte, 2009). Molar enamel laminae patterning was examined by binocular microscope and compared with reference material, as the arrangement of dental enamel laminae (Hunter-Schreger bands) may distinguish dogs from foxes (Stefen, 1999). Standard measurements (Hillson, 1996) were completed three times by the same individual with digital callipers, and the mean value provided to the nearest 0.01 mm. Isotope values and radiocarbon ages derive from collagen samples of the maxilla fragment (Milheira et al., 2016b).

## 3. Results

The left first and second upper molars are identified as domestic dog (*C. l. familiaris*) along with fragments of the respective maxilla. Measurements are comparable to other medium-sized specimens of *C. l. familiaris* specimens of the region (Table 2). This means that individuals of similar sizes were circulating in the area during the late Holocene (González, 1999; Loponte and Acosta, 2016).

Table 2. Measurements of the PSG-07 *C. l. familiaris* dentition compared to data on the left maxillary M1 from Chenque 1 and from Cerro Lutz. The M1 from PSG-07 is similar in size to that at Cerro Lutz; the Chenque 1 M1 is smaller than the other two. Estimates of height at the shoulder were calculated from the long bones of the individuals found at Cerro Lutz (Tibia and Femur) and Chenque 1 (Humerus, Radius, Ulna and Tibia). No M2 was found at the other two sites.

Morphological features distinguish these teeth from those of South American wild canids. In *C. l. familiaris* tooth cusps are blunter and more robust than in wild species; the paracones of both molars are conspicuously larger than their respective metacones; the lingual cinguli and hypocones of both molars are reduced compared with those of wild foxes (Prates *et al.*, 2010a; Tedford *et al.*, 1995). These features are observable on the specimens from PSG-07. Moreover, other features of the molars of South American foxes differ. The molars of *C. brachyurus* are larger and proportionally narrower in their mesiodistal length; those of *L. gymnocercus* and *C. thous* are more extended transversely; those of *L. vetulus* are subquadrate, with little buccolingual extension (Figure 2).

Figure 2. The upper image is of the left maxillary molar 1; the lower is of the left maxillary molar 2 of *C. l. familiaris* recovered from PSG-07 (ID: 115-04). Labial view to the left, occlusal view to the right.

Dental enamel laminae patterning in both molars differ from South American foxes. *C. l. familiaris* molars transition from an undulating arrangement of the Hunter-Schreger bands to a zigzag arrangement. The bands of compared wild South American species undulate, an observation which agrees with previous studies (Prates *et al.*, 2010a; Stefen, 1999). The zigzag arrangement is associated with carnivorous canid species that also consume bone to some extent, such as *C. l. familiaris* (Stefen, 1999). The simpler undulating arrangement observed in all South American foxes compared here is likely linked to their omnivorous diet.

A direct date obtained from bone collagen of the maxilla yielded a conventional radiocarbon age of 1701-1526 cal BP (2 $\sigma$ ) (Beta-415598) consistent with the date range for human occupation of the site (Milheira *et al.*, 2016a; 2016b) (Table 1). Results of isotope analysis (C/N: 3.1) of the maxilla were Carbon:  $\delta^{13}\text{C}$  -11.4‰, Nitrogen:  $\delta^{15}\text{N}$  -10.6‰.

#### 4. Discussion and Conclusion

The spread of *C. l. familiaris* throughout South America occurs later than in North and Central America, and appears limited in extent beyond the Andean region until the period of European contact. The handful of sites in the south of the continent with clearly identified pre-Columbian *C. l. familiaris* remains are close to PSG-07 in distance and date. Confirmed finds come from the Pampas, at Cerro Lutz in the lower Paraná basin in Argentina, about

700km away (Acosta *et al.*, 2011), the more distant Chenque I, as well as northern Patagonia at Angostura I (Prates *et al.*, 2010a). Evidence from Uruguay reveals perhaps four sites approximately 450 km south, like PSG-07 these are earthen mounds (Bracco *et al.*, 2000; González, 1999; López Mazz and Castiñeira, 2001; Loponte and Acosta, 2016; Rudolph, 2014). The date of 1701-1526 cal BP ( $2\sigma$ ) for the Pontal da Barra remains is in the upper range associated with *C. l. familiaris* at regional sites, and within the range of those in Eastern Uruguay. Remains found further west in the Lower Uruguay River, Paraná River and North Patagonia are later in date. This may relate to the expansion of pre-Columbian *C. l. familiaris* in this region (Table 3).

*Table 3. Records of pre-Columbian dogs in south-eastern South America: Type 1 = date on taxon; 2 = date from context (after Acosta et al. 2011; 2015), (OxCal 4.2, SHCAL13). See Figure 1 for their locations in relation to the study site.*

While Andean sites with pre-Columbian *C. l. familiaris* pertain to sedentary agricultural societies (Gallardo, 1964–1965), sites across Patagonia and the Pampas of Brazil, Argentina and Uruguay relate to hunter-gatherer occupations. Many authors suggest the value of the dog in the cooperative hunting of larger-sized prey (Lupo, 2011), but although dogs supported hunting in some neotropical societies, in many they served only as pets or as a food source (Koster, 2009). Thus, it is important to understand the niche that dogs occupied in each society, both economically and symbolically. In this case and regional examples, their deposition in potential funerary contexts may point to a possible interpretation (Morey, 2006). At Chenque I a complete *C. l. familiaris* skeleton was apparently buried deliberately with a sub-adult human male (Prates *et al.*, 2010a). At Cerro Lutz Acosta *et al.* (2011) argue that the complete and articulated dog remains result from deliberate burial by humans, and there is evidence for later human burials on site. There is a strong association between *C. l. familiaris* remains and human burials in the earthen mounds noted in Uruguay at Potrerillo de Santa Teresa (López Mazz and Castiñeira, 2001), Puntas de San Luis (Bracco *et al.*, 2000) and CH2D01, San Miguel, where one of two articulated canid skeletons was recovered close to human remains (González, 1999), although Rudolph (2014) was not able to confirm the identification of these remains as *C. l. familiaris*. At PSG-07 the *C. l. familiaris* remains appeared approximately 40-60 cm above three dispersed fragments of human cranial bone and an unerupted crown of human left maxillary M1. Current research aims to contextualise these finds.

Analysis of carbon and nitrogen isotopes provides dietary information. The carbon value,  $\delta^{13}\text{C}$  -11.4‰, is typical of a marine diet, and close to others obtained from samples at archaeological sites on the seashore of the adjacent state of Santa Catarina (Colonese *et al.*, 2014; Bastos *et al.*, 2015; Loponte *et al.*, 2016). The value obtained in nitrogen,  $\delta^{15}\text{N}$  - 10.6‰, is lower than expected for diets based on marine resources. This value cannot be discarded as an outlier as the nitrogen value might be influenced by the intake of plants

within a C<sub>4</sub> photosynthetic pattern such as maize, whose cultivation is being evaluated on the basis of other lines of evidence (Mühlen, 2014; Milheira, 2014). Future isotopic analysis of human remains recovered at this site will permit improved interpretation of these results, given the similarity between human and domestic canid diets (Bartelink, 2009; Byrd *et al.*, 2013; Rick *et al.*, 2011).

In conclusion, the presence of *C. l. familiaris* at PSG-07 provides evidence for the first known pre-Columbian domestic dog in Brazil. This find expands the data set of identified remains at earthen mound sites on the Atlantic coast of South America, contributing to the discussion on the distribution and expansion of domestic canids in the region (Koster, 2009; Pozzi-Escot *et al.*, 2012; Stahl, 2013). The discovery aids our interpretations of past excavations and raises both questions and expectations in the archaeology of south-eastern South America.

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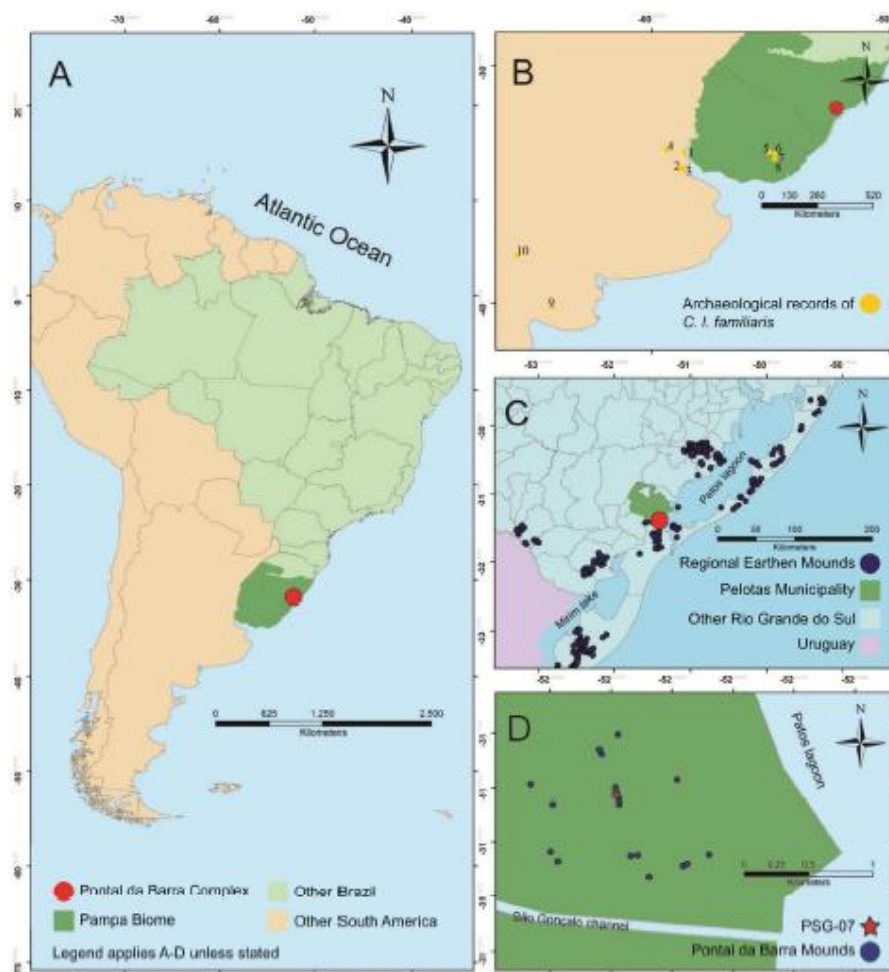


Figure 1. A: Location of the Pontal da Barra complex in South America, and; B: in the coastal region of southern Brazil with other records of pre-Columbian dogs as per Table 3 shown in yellow. C: Location in relation to regional mound sites. D: PSG-07 within the complex at UTM 22J 383093/6483337.

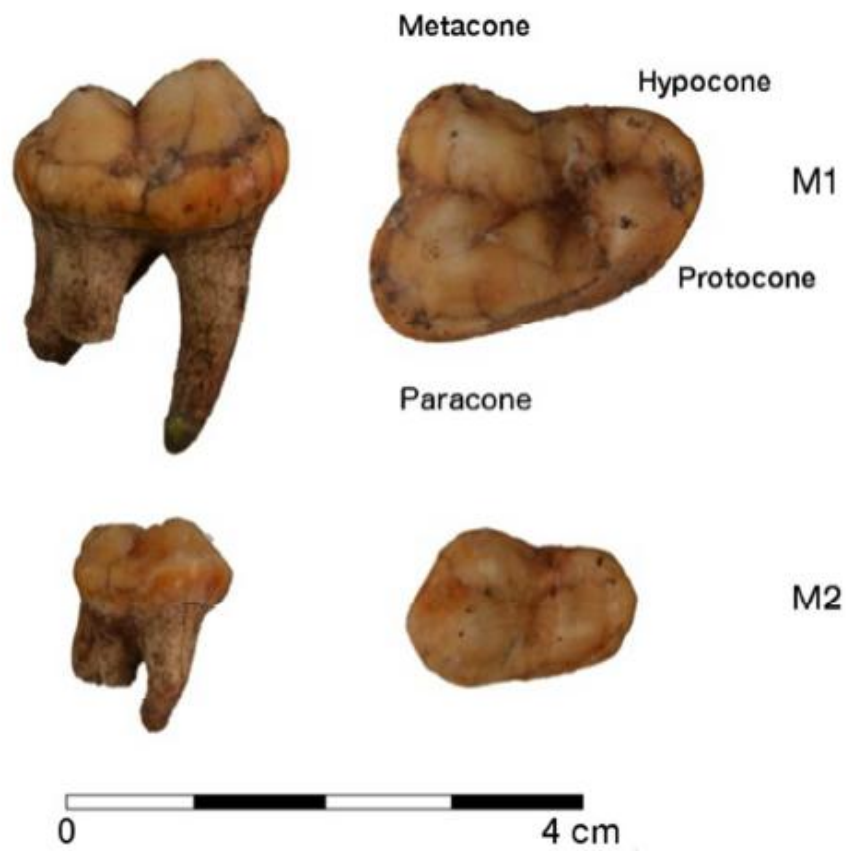


Figure 2. The upper image is of the left maxillary molar 1; the lower is of the left maxillary molar 2 of *C. I. familiaris* recovered from PSG-07 (ID: 115-04). Labial view to the left, occlusal view to the right.

PSG-07 Sample	Cal BP (2 $\sigma$ )*	<sup>14</sup> C yr BP	Type	Excavated at Depth (cm)	Lab Code
<b><i>C. l. familiaris</i> maxilla (bone)</b>	<b>1701-1526</b>	<b>1720 ± 30</b>	<b>1</b>	<b>2.5</b>	<b>Beta-415598</b>
Otolith (bone)	1686-1368	1696 ± 28	2	5.0	LACUFF-140396
Otolith (bone)	2024-1289	2340 ± 150	2	22.5	LACUFF-13052
Otolith (bone)	1654-1027	1214 ± 22	2	42.5	LACUFF-140393
Charcoal	1675-1323	1660 ± 190	2	57.5	LACUFF-140394
Otolith (bone)	1705-1408	1756 ± 28	2	57.5	LACUFF-140395
Otolith (bone)	1608-1356	1670 ± 30	2	67.5	Beta-389013
Charcoal	1545-1407	1630 ± 30	2	82.5	Beta-389014

*Table 1. Radiocarbon dates from PSG-07 at the Pontal da Barra earthen mound complex after Milheira et al., 2016b. Type 1 = date on *C. l. familiaris* taxon; 2 = date from context. \*Calibrated with OxCal 4.2 using SHCAL13 for terrestrial flora and fauna, Marine13 curve used for marine fauna (otoliths) (Bronk-Ramsey, 2009; Hogg et al., 2013; Reimer et al., 2013).*

Specimen	Element	Mesiodistal length (mm)	Labiolingual width (mm)	Est. Height at Shoulder (cm)	Reference
115-04 PSG-07, Brazil	Maxillary Left M1	12.49	14.54	n/a	This work
115-04 PSG-07, Brazil	Maxillary Left M2	6.84	9.91	n/a	This work
INAPL/CL1-UE-3 Cerro Lutz, Argentina (Table 3: ID 1)	Maxillary Left M1	12.2	16.00	47	Acosta <i>et al.</i> , 2011
ME E 41-2 Chenque 1, Argentina (Table 3: ID 10)	Maxillary Left M1	9.39	11.53	47	Prates <i>et al.</i> , 2010b

*Table 2. Measurements of the PSG-07 C. l. familiaris dentition compared to data on the left maxillary M1 from Chenque 1 and from Cerro Lutz. The M1 from PSG-07 is similar in size to that at Cerro Lutz; the Chenque 1 M1 is smaller than the other two. Estimates of height at the shoulder were calculated from the long bones of the individuals found at Cerro Lutz (Tibia and Femur) and Chenque 1 (Humerus, Radius, Ulna and Tibia). No M2 was found at the other two sites.*

ID	Sites	Cal BP (2 $\sigma$ )	<sup>14</sup> C yr BP	Type	Lab Code	Location
1	Cerro Lutz	906-689	916 ± 42	1	AA-77312	Lower Uruguay River
2	La Bellaca sitio 2	721-518	680 ± 80	2	LP-1263	Lower Paraná River
3	Anahí	1050-735	1020 ± 70	2	Beta-147108	Lower Paraná River
4	La Argentina	928-758	979 ± 44	2	AA-103642	Lower Paraná River
5	CH2D01 (Elevación B)	1160-788	1090 ± 70	2	URU 002	Eastern Uruguay
6	CH2D01 (Microrelieve)	1568-1352	1610 ± 50	2	URU 030	Eastern Uruguay
7	Potrerillo Sta. Teresa (Cerrito A)	2420-2150	2320 ± 50	2	URU 082	Eastern Uruguay
8	Puntas de San Luis (Elevación 1)	3888-3399	3430 ± 100	2	URU 0099	Eastern Uruguay
9	Angostura 1	918-730	938 ± 45	2	AA-2551	North Patagonia
10	Chenque 1	905-730	930 ± 30	1	UGA 02006	North Patagonia

*Table 3. Records of pre-Columbian dogs in south-eastern South America: Type 1 = date on taxon; 2 = date from context (after Acosta et al. 2011; 2015), (OxCal 4.2, SHCAL13). See Figure 1 for their locations in relation to the study site.*