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NOTA PALEONTOLÓGICA

# FIRST RECORD OF *SMILODON* LUND (FELIDAE, MACHAIRODONTINAE) IN TIERRA DEL FUEGO ISLAND (CHILE)

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THE sabre-tooth cat *Smilodon* Lund, 1842 was a common element of the Late Pleistocene faunas of America, with a wide distribution from northern North America through southern South America (Ultima Esperanza, Chile; Canto, 1991; Mol *et al.*, 2003; Prevosti and Vizcaíno, 2006; Labarca *et al.*, 2008; Prieto *et al.*, 2010). In South America it is represented in most countries (Venezuela, Ecuador, Brazil, Bolivia, Peru, Argentina, Uruguay, Chile; Berta, 1985; Kurtén and Werdelin, 1990; Canto, 1991; Mol *et al.*, 2003; Rincón, 2006; Labarca *et al.*, 2008; Prieto *et al.*, 2010), *Smilodon fatalis* Leidy, 1868 being limited to northwestern of South America (Peru, Ecuador), and *Smilodon populator* Lund 1842 to the rest of the continent (Kurtén and Werdelin, 1990). For a long time, the southern limit of *Smilodon populator* was the Pampean Region, but Canto (1991) described a premaxillary from southern Patagonia (Cueva Lago Sofía 4, Ultima Esperanza, Chile; Fig. 1). Later findings added new records from this area, including new localities (Cueva del Medio, Cueva del Milodón; Barnett *et al.*, 2005; Mol *et al.*, 2003; Labarca *et al.*, 2008; Prieto *et al.*, 2010). Barnett *et al.* (2005) and Prieto *et al.* (2010) gave some of the few taxon dates for this taxon, that have ages of 11,265 ± 45; 11,420 ± 50; and 11,100 ± 80 $^{14}$C years BP. Other taxon dates came from Brazil: of 9260 ± 150; 14,580 ± 90; and 10,790 ± 60 $^{14}$C years BP (Hubbe *et al.*, 2013), and Argentina: 13,400 ± 200 (Scanferla *et al.*, 2013).

At the end of the Pleistocene the island of Tierra del Fuego was still part of the continent. The processes of advance and retreat of glaciers located in the western end of the present-day Strait of Magellan determined the existence of land bridges at different periods (Clapperton, 1992; McCulloch *et al.*, 2005). Most of the Late Pleistocene faunas recorded in the south of the continent occur also in Tierra del Fuego (*e.g.*, *Mylodon* sp., *Panthera onca mesembrina* Cabrera, 1933; *Hippidion* sp., and camelids according to Caviglia, 1985–1986; Mengoni-Goñalons, 1987, Martin, 2013; Massone, 1987; Prieto and Canto, 1997; Latorre, 1998; Alberdi and Prieto, 2000; Weinstock *et al.*, 2009; Orlando *et al.*, 2009). However, *Smilodon* sp. *Arctotherium* sp. and *Macrauchenia* sp. had not been recorded in the island of Tierra del Fuego (see Prevosti and Martin, 2013). The knowledge of Pleistocene faunas of Tierra del Fuego is based on one site, Tres Arroyos 1 (Fig. 1). The Tres Arroyos 1 site is located at the Cerro de los Onas, a Tertiary outcrop part of the Carmen Sylva hills, northern Tierra del Fuego. The site is known since the 1960s, but its importance was recognized only after the work of Mauricio Massone in the 1980s (Massone, 1987; Massone *et al.*, 1993; Massone, 2004). Two separate projects excavated six units identified as Layer I (upper layer) to Layer VI (base of the sequence). Layers I-IV are associated with late Holocene human occupations, while Layers V-VI are late Pleistocene. Layer V was subdivided in layer Va with human occupations and five hearths associated with Pleistocene and modern fauna; and layer Vb which presented Pleistocene fauna without human association (Massone, 2004). This stratigraphic sequence represents more than 12000 radiocarbon years, with dates ranging from 135 ± 85 $^{14}$C years BP for the upper layer to 12,540 ± 70 $^{14}$C years BP

for the lowest layer (Rapaire and Hugues, 1977; Massone, 1987; 2004, 2010; Borrero, 2003).

In this paper we describe a deciduous upper carnassial found in the lower levels of the Tres Arroyos 1 site, and discuss its systematic assignation. We conclude that it belongs to *Smilodon*, which extends the distribution of the genus to Tierra del Fuego (Fig. 1).

## MATERIAL AND METHODS

The measurements reported here were taken with digital calipers accurate to 0.01 mm (see Tab. 1), and the cusp terminology follows Kurtén and Crusafont (1977) modified in order to follow the orientation nomenclature proposed by Smith and Dodson (2003). The new record was compared with juvenile specimens of *Smilodon* and *Panthera onca mesembrina* deposited at the CEHA, MLP, MACN and MPH-P, and data of juvenile *Smilodon* published by Merriam and Stock (1932), Rusconi (1931) and Tejada Flores and Shaw (1984), and other machairodonts by Viret (1954, *Homotherium crenatidens* (Weithofer, 1889)), and Rawn-Schatzinger (1983; *Homotherium serum* Cope, 1893). For living large felids we studied specimens deposited at the División Mastozoología of the MACN. It is probable that the three juveniles of *Smilodon* found in Argentina (see Tab. 1) belong to *Smilodon populator*, because it is the only species recorded in this country (and in southern South America; see Kurtén and Werdelin, 1990), but since the diagnostic differences between *S. populator* and *S. fatalis* are not present in the DP3 (see Kurtén and Werdelin, 1990), we prefer to assign them to *Smilodon* sp. Kurtén and Crusafont (1977) assigned a juvenile specimen to *Megantereon megantereon* Croizet and Jobert, 1828 (= *Megantereon cultridens* (Cuvier, 1824)) but its preparastyle is large (a quarter larger than the parastyle) and displaced labially, two features not present in other machairodontines, and the absence of the protocone (and its root) suggest that indeed it is a Hyaenidae (L. Werdelin, pers. comm.).

***Institutional abbreviations.*** **CEHA,** Centro de Estudios del Hombre Austral, Instituto de la Patagonia, Universidad de Magallanes, Punta Arenas, Chile; **LACM**, Los Angeles County Museum, USA; **MACN**, Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Buenos Aires, Argentina; **MLP**, División Paleontología Vertebrados, Museo de La Plata, La Plata, Argentina; **MHM-P**, Museo Histórico Municipal "Alfredo E. Mulgura", General Belgrano, Argentina; **SQV**, Saint-Vallier Collection, Museum of Natural History, Lyons, France.

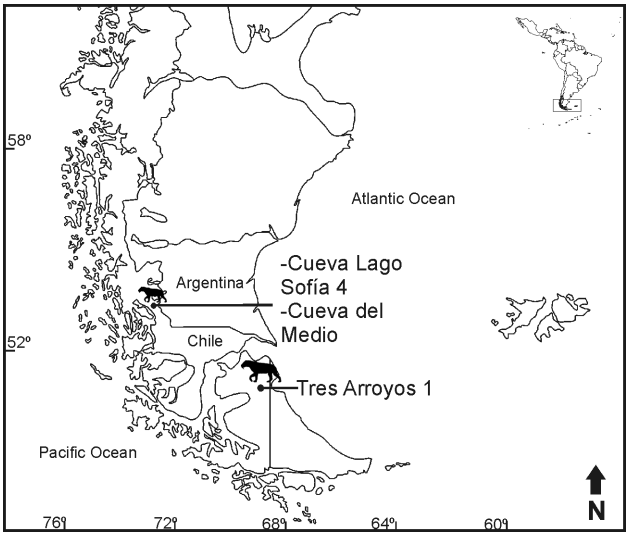


**Figure 1.** Location map showing the placement of Tres Arroyos 1 site, and other localities of Patagonia where *S. populator* was recorded.

## SYSTEMATIC PALEONTOLOGY

Order Carnivora Bowdich, 1821

Family Felidae Fischer, 1817

Subfamily Machairodontinae Gill, 1872

### ***Smilodon*** Lund, 1842

***Type species.*** *Smilodon populator* Lund, 1842; by original designation and monotypy; Quaternary; South America.

### ***Smilodon*** *sp.*

Figure 2, Table 1

***Material.*** CEHA TA1 18753, left deciduous upper carnassial (DP3).

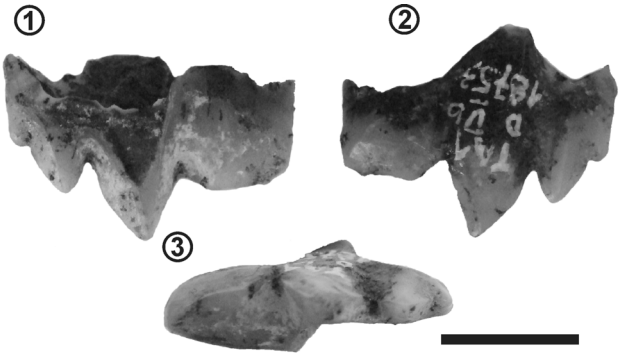


**Figure 2.** Upper deciduous carnassial of *Smilodon* sp. found in the site Tres Arroyos 1; **1,** labial view; **2,** lingual view; **3,** occlusal view. Scale bar= 1 cm.

**TABLE 1. Measuremnts (mm) of the DP3 from Tres Arroyos 1 site, compared with other felids. DP3, upper third deciduous premolar (deciduous upper carnassial); LDP3, length of the DP3; WDP3, width of the DP3 without the protocone; WN, without collection number**

| Specimen # | Taxa | LDP3 | WDP3 | Comments |
|---|---|---|---|---|
| CEHA TA1 18753 | **Smilodon** | 21.97 | 7.29 | This Paper |
| QSV 140 | **Homotherium crenatidens** | 19.5 | 7 | Viret, 1954 |
| WN | **"Megantereon megantereon"** | 23.6 | 7.4 | Kurtén and Crusafont, 1977 |
| MACN 4.196 | **Puma concolor** | 14.63 | 4.32 | Recent |
| MACN 4.398 | **Puma concolor** | 16.26 | 4.5 | Recent |
| MACN 4.311 | **Puma concolor** | 16.46 | 5.33 | Recent |
| MACN 39.403 | **Panthera leo** | 22.38 | 6.5 | Recent |
| MACN 36.939 | **Panthera leo** | 24.6 | 7.7 | Recent |
| MACN 3.46 | **Panthera leo** | 23.42 | 6.82 | Recent |
| MACN 6.20 | **Panthera onca** | 18.43 | 5.78 | Recent |
| CEHA LS4 48 | **Panthera onca mesembrina** | 24.89 | 10.12 | Cueva Lago Sofía 4, Ultima Esperanza, Chile. Lujanian. Late Pleistocene |
| MACN M 5822 | **Smilodon** | 23.73 | 8.29 | Río Reconquista, Buenos Aires, Argentina, Lujanian, Late Pleistocene |
| MLP 04-VI-1-1 | **Smilodon** | 22.79 | 7.49 | Río Quequen Grande, Buenos Aires, Argentina, Lujanian?. Late Pleistocene |
| MHM-P 55 | **Smilodon** | 22.41 | 7.71 | Río Salado, Buenos Aires, Argentina, Lujanian, Late Pleistocene |
| LACM 2003-R-6 | **Smilodon fatalis** | 24.52 | | Tejada Flores and Shaw, 1984 |
| LACM HC7002 | **Smilodon fatalis** | 24.86 | | Tejada Flores and Shaw, 1984 |
| LACM A3775 | **Smilodon fatalis** | 22.99 | | Tejada Flores and Shaw, 1984 |
| LACM 2003-R-1 | **Smilodon fatalis** | 23.64 | | Tejada Flores and Shaw, 1984 |
| LACM 2001-581 | **Smilodon fatalis** | 23.27 | | Merriam and Stock, 1932; Tejada Flores and Shaw, 1985 |
| LACM 2001-580 | **Smilodon fatalis** | 24.93 | | Merriam and Stock, 1932 |
| LACM 2001-584 | **Smilodon fatalis** | 21.48 | 5.89 | Merriam and Stock, 1932 |
| LACM 2001-577 | **Smilodon fatalis** | 21.3 | | Merriam and Stock, 1932 |
| LACM 2001-578 | **Smilodon fatalis** | 21.24 | | Merriam and Stock, 1932 |
| LACM 2001-579 | **Smilodon fatalis** | 23.04 | | Merriam and Stock, 1932 |

***Geographic occurrence.*** Tres Arroyos 1 site (53°21′S–68°48′W), Cerro de Los Onas, Tierra del Fuego, Chile (Fig. 1).

***Stratigraphic occurrence.*** It was found in the Square D, stratigraphic level Vb. This stratigraphic level is dated at 10,420 ± 100 $^{14}$C years BP, and is covered by level Va which has several dates and the older are between 10,130 ± 210 and 11,880 ± 250 $^{14}$C years BP (Borrero, 2003; Massone and Prieto, 2004; Massone, 2004, 2010). The lowest layer (VI) has a date of 12,540 ± 70 $^{14}$C years (which indicate a latest Pleistocene–earliest Holocene age for level Vb (but see below).

***Description.*** The carnassial is very long, narrow and sharp; the cusps are aligned but the preparastyle is slightly lingual to the parastyle; the preparastyle is very small and not very sharp; conversely, the parastyle is nearly 2.5 times higher and larger and very acute; the paracone is the highest cusp, it is very acute and has a subtriangular transversal section, with a flat lingual face and a very convex labial one; the metastyle constitutes a long blade that is slightly labially oriented (*i.e.*, its distal portion is placed labially in relationship to its mesial portion), and has a thin cingulum at its base along the distal half of the lingual side; the metastyle, paracone and parastyle are separated by a deep and wide depression ("V" shaped in labial or lingual views), but the depression between the parastyle and preparastyle is shallow and not so wide; the metastyle has a thin wear-facet; the protocone is not complete but apparently was scarcely developed.

## DISCUSSION

The studied specimen from Tres Arroyos 1 showed several differences with large Felinae (living *Puma concolor* (Linnaeus, 1771), *Panthera leo* (Linnaeus, 1758), *Panthera onca* (Linnaeus, 1758), and the extinct *Panthera onca mesembrina*) with a more elongated and narrow crown and more aligned cusps. The preparastyle is particularly reduced and placed in line with the parastyle, while in large felines the preparastyle is large and is labially displaced. In this Felinae Fischer, 1817, the protocone could be absent, or be a very low cusp, but its root is usually well-developed and very expanded lingually. There is one specimen of *P. concolor* (MACN 4196) that has a very reduced protocone's root, and also a low preparastyle, resembling the studied fossil, but its preparastyle is labially displaced. Specimen CEHA TA1 18753 is larger than the studied living *P. concolor* and *P. onca* specimens, smaller than *P. onca mesembrina*, similar to the smaller studied *P. leo*, and overlaps with *Smilodon* (Tab. 1). The morphology of CEHA TA1 18753 is more similar to that of Machairodontinae, but unfortunately there is little available information of the milk dentition in this group. *Homotherium crenatidens* also has a long and narrow DP3, with aligned preparastyle, parastyle, paracone and metastyle, and differs from the fossil here studied because the paracone is proportionally longer and taller in relation to the metastyle and parastyle (see Viret, 1954, fig. 3.3). Rawn-Schatzinger (1983) described the presence of only three cusps in the DP3 of *Homotherium serum*: a small parastyle, a large paracone and a blade like metastyle, and that serrations are present but quickly eroded after teeth eruption. If this description is correct and stable (*i.e.*, without intraspecific variation, see below), *H. serum* could be separated from CEHA TA1 18753 by the absence of a preparastyle in the former. The size and morphology of CEHA TA1 18753 is virtually identical to *Smilodon* spp., and differs from some specimens of *S. fatalis* from Rancho La Brea (*e.g.*, LACM 2001-577) by the presence of a preparastyle, and from some specimens of *S. fatalis* (*e.g.*, LACM 2001-579) and Argentinean *Smilodon* sp. (*e.g.*, MACN M 5822) because its paracone is more acute and the gaps between this cusp and the parastyle and metastyle are larger. But Merriam and Stock (1932) showed that the development and presence of the preparastyle is variable in their sample of *S. fatalis* from Rancho La Brea, and the presence of a more acute paracone is due to dental wear, and was observed in other specimens of *Smilodon* (*e.g.*, MHM-P 55) and S. *fatalis* (*e.g.*, LACM 2001-584).

This new fossil is the first late Pleistocene (12.5–10.1 ka BP; Massone, 1987; 2004; Borrero, 2003) occurrence in Tierra del Fuego Island. Prior to this finding, the only Pleistocene large predator recorded on the island was *Panthera onca mesembrina*, a taxon recorded in most late Pleistocene sites of Southern Patagonia (Martin, 2013). The presence of *Smilodon* in Tierra del Fuego Island during the late Pleistocene is not unexpected because it was found in other late Pleistocene sites of Southern Patagonia (Magallanes, Chile)= Cueva Lago Sofía 4 (Canto, 1991); and Cueva del Medio (Mol *et al.*, 2003; Labarca *et al.*, 2008; Prieto *et al.*, 2010). It has a wide distribution covering most of America (Berta, 1985; Kurtén and Werdelin, 1990), and introduction to Tierra del Fuego was possible through land bridges because sea level was lower and the Strait of Magellan was partially occupied by glaciers while the sea only invaded it after 10 ka (Clapperton 1992, McCul-

loch *et al.*, 2005; McCulloch and Morello, 2010). Thus, during the latest Pleistocene *Smilodon* was present in southern Patagonia and Tierra del Fuego was not an island yet. This finding also supports the interpretation by Prevosti and Martin (2013) that the absence of some carnivores in different sites of Southern Patagonia and Tierra del Fuego Island is related to sampling and/ or taphonomic biases.

The new record of *Smilodon* sp. came from a stratigraphic level (Vb) that does not carry evidence of human activities, but the level immediately above has a good record of human activities dated between 10,855–10,130 $^{14}$C years BP (Massone *et al.*, 1998; Massone and Prieto, 2004; Massone, 2010). At least the deposition of a *Panthera onca mesembrina* metapodial is older than the recorded cultural evidence, since it was dated at 11,085 ± 70 $^{14}$C years BP (Massone, 2004). It must be noted that the chronology of level Va is coincident with the only date known for level Vb (10,420 ± 100 $^{14}$C years BP; Massone *et al.*, 1993), thus there is no chronological distinction between them. There is also evidence that other bones collected in the V level are the result of vertical migration (Borrero, 2003). This evidence indicates that the finding of a *Smilodon* DP3 in Layer Vb could not be related to human deposits, and that its age, based on the taxon dates of extinct taxa and other dates obtained for the lower levels (V and VI), could be constrained to 12,540–10,130 $^{14}$C years BP.

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