Comments on a small sabretooth cat in the Abismo Ponta de Flecha Cave, Vale do Ribeira, southeastern Brazil

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Abstract: The Vale do Ribeira, located in southeastern Brazil, is known for many caves with osteological material, including several extinct species. The saber-tooth cat *Smilodon populator* was a large predator that inhabited the Pleistocene and Holocene of South America. A specimen found in the Abismo Ponta de Flecha Cave based on small bones (metacarpals and phalanges) is commented here. The metacarpals have morphological characteristics of *S. populator*, but are smaller than that of *S. fatalis* and *Panthera onca* and larger than that of *S. gracilis*. The specimen is among the smallest ever found and is comparable in size to an adult lion.

Keywords:

- Felidae;
- Pleistocene;
- Carnívora;
- South America;
- Machairodontinae

Résumé: Commentaires sur un petit chat à dents de sabre dans la grotte Abismo Ponta de Flecha, Vale do Ribeira, sud-est du Brésil. Vale do Ribeira, située dans le sud-est du Brésil, est connue pour de nombreuses grottes contenant du matériel ostéologique, dont plusieurs espèces éteintes. Le chat à dents de sabre *Smilodon* était un grand prédateur qui habitait le Pléistocène et l'Holocène d'Amérique du Sud. Un spécimen trouvé dans la grotte Arrowhead Abyss basé sur de petits os (métacarpiens et phalanges) est discuté ici. Les paturons ont les caractéristiques morphologiques de *S. populator*, mais sont plus petits que ceux de *S. fatalis* et *Panthera onca* et plus grands que ceux de *S. gracilis*. Le spécimen est parmi les plus petits jamais trouvés et est comparable en taille à un lion adulte.

Mots clés:

- Felidae;
- Pléistocène;
- Carnivora;
- Amérique du Sud;
- Machairodontine

1. Introduction

The Vale do Ribeira, located in southeastern Brazil, gathers carbonate rocks where a complex system of caves developed. Despite the high paleontological potential of this karst region, a few works involving the study of fossils have been developed there.

The Abismo Ponta de Flecha is a vertical cave located in ancient centripetal drainage, formed in carbonate rocks of the Proterozoic (BARROS BARRETO *et al.*, 1982). The site has a large amount of osteological material, composed of extinct and living animals (BARROS-BARRETO *et al.*, 1982; CHAHUD, 2005).

The Felidae occurs in South America since the Great American Biotic Interchange 2 (GABI 2), which occurred on the boundary between the Pliocene and Pleistocene, 1.8 Ma (WOODBURNE, 2010), with the migration of several species from North America.

Currently, the large Felidae from South America are represented by only two species, *Puma concolor* and *Panthera onca*. However, several other species are represented, all coming from the Late Pleistocene and Early Holocene.

Among the extinct genera reported in South America, the most common is the subfamily Machairodontinae, represented by the genera; *Smilodon*, *Homotherium* and *Xenosmilus*, being the first most common and the only one with representatives found in Brazil, while the others are local occurrences in Venezuela and Uruguay, respectively (MONES & RINDERKNECHT, 2004; RINCÓN *et al.*, 2011).

For a long time, *Smilodon populator* was the only representative of the genus in South America, but evidence of other species has been reported; *S. fatalis* has been found in the Andean region of Ecuador, Peru and Uruguay (KURTÉN & WERDELIN, 1990; MANZUETTI *et al.*, 2018), while *S. gracilis* has been described in the Venezuelan Andes (Rincón *et al.*, 2011).

The species *Smilodon populator* was originally described by Lund (1842) of specimens described in Lagoa Santa region, where several other specimens were found in several caves (HUBBE *et al.*, 2013; CHAHUD, 2020). In the Vale do Ribeira region, other specimens have been described, and the specimen found in the Abismo Iguatemi Cave presented the best specimen (FERREIRA & KARMANN, 2002; CASTRO & LANGER, 2008; 2011), revealing important information about the species.

The presence of an indeterminate Felidae was first noted by CHAHUD (2005), based on bone materials initially identified as Xenarthra. The present work identifies this specimen as *Smilodon populator* and makes comparisons with others described in the Quaternary of South America.

2. Material and Methods

The osteological material of the Abismo Ponta de Flecha Cave consists of more than 1400 samples, including faunal and inorganic remains, and was collected by a team of geologists and biologists between 1981-1982, as part of a large speleological study, archaeological to paleontological in Vale do Ribeira (Figure 1). Much of this material is cured, including the specimens studied here, in the Laboratory of Systematic Paleontology of the Department of Sedimentary and Environmental Geology of the Geosciences Institute – USP.

Initially, the specimens were organized and listed according to location and positioning in the gallery, called *Jazidas*, in which each piece was found (PF-), later the material received a second registration number (GP/2C-). The study specimens come from *Jazida 2* (J2), characterized by ancient sedimentation levels and collapsed blocks (Figure 1). Below these blocks, fossil bones of large animals were found (BARROS BARRETO *et al.*, 1982).

Figure 1. Schematic profile of the Abismo Ponta de Flecha, SP 175. Highlighting the galleries (*Jazidas*) with osteological material J1-J11, (Adapted from Barros-Barreto *et al.*, 1982).

3. Systematic Palaeontology

Order Carnivora Bowdich, 1821

Family Felidae Gray, 1821

Subfamily Machairodontinae Gill, 1872

Tribe Smilodontini Kurtén, 1963

Genus *Smilodon* Lund, 1842

Figure 2, Figure 3

Type species. *Smilodon populator* Lund, 1842

Material. The identified material consists of a complete left metacarpal II (PF 129– GP/2C-527d) (Figure 2A and 2B) , fragmented left metacarpal III (PF 130– GP/2C-527a) (Figure 2A and 2C), two complete proximal left phalanges (PF 131– GP/2C-527c, PF 133– GP/2C-527e) and fragmented proximal left phalanx (PF 132– GP/2C-527b) (Figure 2D).

Figure 2. *Smilodon populator* from the Abismo Ponta de Flecha Cave. A) Metacarpals III and II (PF 130– GP/2C-527a, PF 129– GP/2C-527d), dorsal view; B) Metacarpals II dorsal and lateral views. C) Metacarpal III dorsal and lateral views. D) Palmar view of the proximal phalanges II, III and IV (PF 132 – GP/2C-527b, PF 131 – GP/2C-527c, PF 133 – GP/2C-527e). Scale: 20mm.

Taphonomy. The osteological material assigned to the specimen is whitish and with carbonate incrustation (Figure 2A – C), which could not be removed without compromising the structure of the bone part. No cracks caused by bone exposure or polishing were observed, suggesting that the specimen was not transported into the cave after its death and that its presence in its interior was probably accidental. The hypothesis is that the specimen entered the cave alive and became trapped inside it.

General characteristics and comparison.

Proximal Phalanges: The recovered osteological material is represented by the left proximal phalanges II, III and IV (Figure 2D). The proximal phalanges II and III have sizes and shapes compatible with phalanges attributed to large cats that inhabited South America during the Pleistocene and compared to a proximal phalanx, but of the hind limb, of a specimen from Cuvieri cave, eastern Brazil (Figure 3), the specimen is larger,

but compared to the phalanges described by Méndez-Alzola (1941), a *Smilodon* found in the Argentine Pampa, the specimen is smaller (Table 1). Phalanx IV was very fragmented and no measurements or comparisons were possible.

Figure 3. Dorsal views of proximal phalanges of *Smilodon populator*. A) Cuvieri Cave (CVL2-14207); B) Abismo Ponta de Flecha Cave. Scale: 20mm.

Table 1. Measures of proximal phalanges II and III in specimens found in the Abismo Ponta de Flecha Cave, Cuvieri Cave and Argentine Pampa

	Abismo Ponta de Flecha		Cuvieri Cave	Argentine Pampa (Méndez-Alzola, 1941)	
	II	III	II	II	III
Length	46.3	44.95	40.2	52	55.8
Shaft width	18,5	19,9	16.08	24.9	18
Shaft deep	11.54	-	11.67	15.5	14.3
Distal width	15.7	17.81	15.8	20.2	20
Distal Deep	11.23	13.4	10.41	-	-
Proximal width	23.18	23.6	19.93	27.6	28.3
Proximal deep	17.53	17.5	17.04	23.3	21

Metacarpals: The metacarpal II of the specimen found in the Abismo Ponta de Flecha Cave is more robust but smaller than the metacarpals of Pleistocene and recent species of the genus *Panthera* (CHAHUD & OKUMURA, 2020). Compared with the *Smilodon* specimens studied by KURTÉN & WERDELIN (1990) (Table 2) it is larger and more robust than *S. gracilis*. The width is comparable to specimens of *S. fatalis*, both from North and South America, but the length is smaller than individuals of this species, according to KURTÉN & WERDELIN (1990) this characteristic is expected in specimens of *S. populator*.

Compared with specimens of *Smilodon populator* from Argentina, the specimen from Vale do Ribeira is morphologically similar to *S. populator* described by KURTÉN & WERDELIN (1990), but smaller, being probably a small individual of this species. The

relationship between shaft width and length of *Smilodon populator* specimens of KURTÉN & WERDELIN (1990) is 0.21749 while that of Abismo Ponta de Flecha Cave is 0.22154, which are similar values when compared to other *Smilodon* species (Table 3), it can be associated with the species *S. populator*.

Table 2. Measures of metacarpals bones of the Abismo Ponta de Flecha Cave specimen and other *Smilodon* species studied by KURTÉN & WERDELIN (1990).

	<i>Smilodon</i> Abismo Ponta de Flecha	<i>Smilodon</i> <i>fatalis</i> Rancho La brean	<i>Smilodon</i> <i>fatalis</i> Talara, Peru	<i>Smilodon</i> <i>populator</i> Brazil and Argentina	<i>Smilodon</i> <i>gracilis</i>
Metacarpal II	N = 1	N=7	N = 19	N= 4	N = 3
Length	76.6	90.6 ± 4.4	85.5 ± 1.1	89.2 ± 1.4	73.6 ± 1.3
Shaft width	16.97	17.2 ± 0.5	16.5 ± 0.3	19.4 ± 0.4	12.4 ± 0.5
Shaft deep	15.53				
Distal width	25.2	24.8 ± 0.8	24.3 ± 0.3	26.6 ± 0.2	19.2 ± 0.9
Distal Deep	22.82				
Proximal width	25.27				
Proximal deep	30.31				
Metacarpal III	N = 1	N=7	N = 19	N= 3	N = 1
Length		96.4 ± 4.0	97.3 ± 0.9	97.3 ± 2.7	73
Shaft width	16.2	17.3 ± 0.8	16.4 ± 0.3	19.4 ± 0.7	10.5
Shaft deep	12.23				
Distal width		26.5 ± 1.0	25.6 ± 0.4	28.2 ± 0.2	16.7
Proximal width	25.8				
Proximal deep	26.41				

TABLE 3. Relationship between the shaft width and the length of *Smilodon* species by KURTÉN & WERDELIN (1990) compared to the specimen found in Abismo Ponta de Flecha Cave.

	<i>Smilodon</i> Abismo Ponta de Flecha	<i>Smilodon</i> <i>fatalis</i> Rancho La brean, USA	<i>Smilodon</i> <i>fatalis</i> Talara, Peru	<i>Smilodon</i> <i>populator</i>	<i>Smilodon</i> <i>gracilis</i>
Shaft width/length	0.22154	0.18985	0.19298	0.21749	0.16847

4. Discussion and Final Considerations

The specimen recovered from the Abismo Ponta de Flecha Cave represents a *Smilodon* of small proportions, compared to other specimens from South America.

The genus *Smilodon* reported differences in proportion and morphology between the three species, and regional morphological differences in *S. fatalis* (Tables 2 and 3) from North America and Peru (KURTÉN & WERDELIN, 1990), and the same may have occurred with *S. populator*.

Several mammals vary in size between individuals of the same species or genus. In Africa, a variation in the proportion between the two species of elephants of the genus *Loxodonta* has been reported, with *L. cyclotis*, which inhabits forested regions, is smaller than *L. africana* (GRUBB *et al.*, 2000) found in savannas. The same was reported

for South American species of the genus *Tapirus*, among *T. terrestris* (more common), *T. pinchaque* (from the Andean region and smaller) and *T. bairdii* (from Central America and larger) (RUIZ-GARCÍA *et al.* 2016).

In South America, size variations between individuals of the same species have been reported, as observed in *Dicotyles tajacu* from the Amazon region, compared to other regions (GONGORA *et al.* 2011). However, among Felidae, the greatest difference was observed in small individuals of the species *Puma concolor* from the Amazon, compared to specimens from the Andean region and southern South America (PACHECO & ZAPATA, 2017; CHIMENTO & DONDAS, 2018; CHAHUD, 2021).

The species *Smilodon populator* is the largest of the genus and larger than the largest recent felines, but it is possible to find individuals with an approximate size of *S. fatalis*, while the largest lions (*Panthera leo*) are proportionally comparable to the smallest *S. populator* (CHRISTIANSEN & HARRIS, 2005). The specimens found in the Cuvieri Cave (CHAHUD, 2020) and in the Abismo Ponta de Flecha Cave are of comparable size to *S. fatalis* and recent lions and are probably among the smallest *S. populator*.

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