



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

Artur CHAHUD ¹

Abstract: Vale do Ribeira, in southeastern Brazil, is known for its many caves that contain osteological material, including remains that have been referred to several extinct species. The sabretooth cat *Smilodon populator* was a large predator that inhabited South America during the Quaternary. A specimen that is represented in the Abismo Ponta de Flecha Cave by small forelimb bones (metacarpals and phalanges) is commented here. The metacarpals display morphological characteristics of *S. populator*, but are smaller than those of *S. fatalis* and larger than those of *S. gracilis*. This specimen is amongst the smallest ever found specimen of *S. populator* and is comparable in size to an adult lion.

Key-words:

- Carnivora;
- Felidae;
- Machairodontinae;
- *Smilodon populator*;
- Pleistocene;
- South America

Citation: CHAHUD A. (2022).- Comments on a small sabretooth cat in the Abismo Ponta de Flecha Cave, Vale do Ribeira, southeastern Brazil.- *Carnets Geol.*, Madrid, vol. 22, no. 1, p. 1-6.

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 ces nombreuses grottes contenant des ossements appartenant plusieurs espèces éteintes. Le "chat" à dents de sabre *Smilodon populator* était un grand prédateur présent en Amérique du Sud au Pléistocène et à l'Holocène. La présente contribution traite d'un spécimen représenté dans la grotte Abismo Ponta de Flecha par de petits os (métacarpiens et phalanges) des membres antérieurs. Si les métacarpiens ont les caractéristiques morphologiques de *S. populator*, ils sont toutefois plus petits que ceux de *S. fatalis* et plus grands que ceux de *S. gracilis*. Ce spécimen de *S. populator*, qui est comparable en taille à un lion adulte, figure parmi les plus petits jamais trouvés.

Mots-clefs :

- Carnivora ;
- Felidae ;
- Machairodontine ;
- *Smilodon populator* ;
- Pléistocène ;
- Amérique du Sud

¹ Laboratory for Human Evolutionary Studies, Department of Genetics and Evolutionary Biology, Institute of Biosciences, University of São Paulo, Rua do Matão 277, São Paulo, SP 05508-090 (Brazil)
ORCID: 0000-0001-7690-3132
arturchahud@yahoo.com





1. Introduction

Located in the state of São Paulo (southeastern Brazil), Vale do Ribeira comprises carbonate rocks which have a complex system of caves. Despite the high palaeontological potential of this karst region, there has been little work involving the study of fossils from this area.

The Abismo Ponta de Flecha is a vertical cave located within an ancient centripetal drainage system formed in Proterozoic carbonate rocks (BARROS BARRETO *et al.*, 1984). This site has provided a large amount of osteological material, including the remains of both extinct and living animals (BARROS BARRETO *et al.*, 1984; CHAHUD, 2005).

The family Felidae is present in South America ever since the Great American Biotic Interchange 2 (GABI 2), which occurred at around 1.8 Ma (WOODBURNE, 2010) and saw the introduction of several species from North America.

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

Among the extinct genera reported from South America, the most common belong to the subfamily Machairodontinae and are represented by the genera *Smilodon*, *Homotherium* and *Xenosmilus*. Of all these genera, *Smilodon* is the most

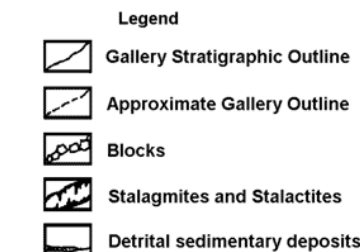
common in South America and the only one whose representatives are found in Brazil, while others locally occur in Venezuela and Uruguay (MONES & RINDERKNECHT, 2004; RINCÓN *et al.*, 2011).

For a long time, *Smilodon populator* was the only representative of the genus *Smilodon* to be known from South America, but other species have subsequently 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 from the Venezuelan Andes (RINCÓN *et al.*, 2011).

Smilodon populator was originally described by LUND (1842) on the basis of specimens from the Lagoa Santa region; subsequently further specimens were found in several caves (CHAHUD, 2020). In the Vale do Ribeira region, there is only a single record of a specimen found in the Abismo Iguatemi Cave (CASTRO & LANGER, 2008, 2011); this specimen preserved several parts of the post-cranium, revealing important information about *S. populator*.

The presence of an indeterminate Felidae in the Abismo Ponta de Flecha Cave was first noted by CHAHUD (2005) and was based on bone materials initially identified as *Xenarthra*. The present work identifies this specimen as *Smilodon populator* and makes comparisons with other occurrences of *S. populator* from the Quaternary of South America.

Abismo Ponta de Flecha Cave SP 175



Coordinates
Latitude: 24°33'38" S
Longitude: 48°41'08" W
Altitude: 490m

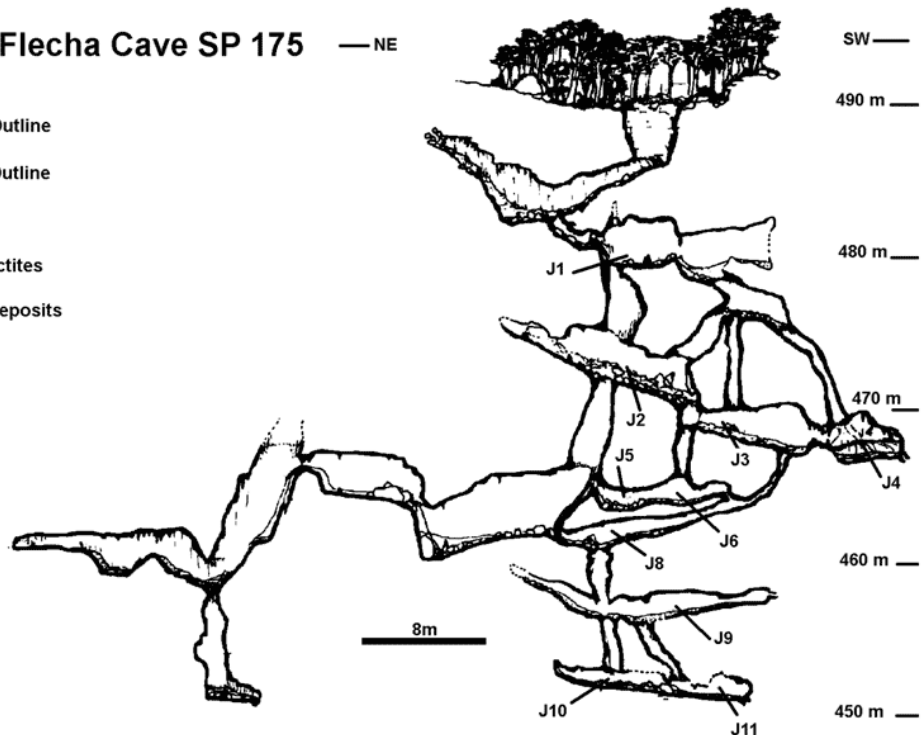


Figure 1: Schematic profile of the Abismo Ponta de Flecha Cave, SP 175. The location of the galleries (*Jazidas*, "J-") preserving osteological material (J1 to J11) is indicated. The material studied herein comes from J2. Adapted from BARROS BARRETO *et al.* (1982, 1984).



2. Material and methods

The osteological material of the Abismo Ponta de Flecha Cave consists of more than 1400 specimens, including faunal and inorganic remains (stone artifacts and pebbles), and was collected by a team of geologists and biologists between 1981-1982, as part of a large speleological study focused on the archaeological and paleontological heritage of Vale do Ribeira (Fig. 1). Much of this material, including the specimens studied herein, is preserved in the Laboratory of Systematic Paleontology of the Department of Sedimentary and Environmental Geology at the Geosciences Institute - University of Sao Paulo (USP).

Initially, the specimens were organized and listed according to location and positioning in the galleries, called Jazidas, in which each piece was found (PF-). Later the material received a second registration number (GP/2C-). The studied specimens come from Jazida 2 (J2) (Fig. 1). The osteological material was extensively reworked, with specimens of Pleistocene age associated with the remains of recent animals (CHAHUD, 2005, 2021).

3. Systematic palaeontology

Order Carnivora BOWDICH, 1821
Family Felidae GRAY, 1821
Subfamily Machairodontinae GILL, 1872
Tribe Smilodontini KURTÉN, 1963
Genus *Smilodon* LUND, 1842
***Smilodon populator* LUND, 1842**

(Fig. 2)

Type species. *Smilodon populator* LUND, 1842.

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

Taphonomy. The osteological material assigned to *Smilodon populator* is whitish and displays a carbonate crust (Fig. 2.A-C) that could not be removed without compromising the integrity of the bone. 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 therein was probably accidental.

General characteristics and comparisons. Metacarpals (mc): The metacarpals of the specimen found in the Abismo Ponta de Flecha Cave are more robust, but shorter, than the metacarpals of Pleistocene and recent species of the genus *Panthera* (CHAHUD & OKUMURA, 2021) (Fig. 3).

The studied mc II and mc III are larger and more robust than those of *S. gracilis* reported by KURTÉN and WERDELIN (1990) (Table 1). The mc II distal width is comparable to specimens of *S. fatalis*, both from North America and South America, but its length is smaller. According to KURTÉN and WERDELIN (1990) this bone proportion is expected in specimens referable to *S. populator*.

Table 1: Comparative table of metacarpal bones from the Abismo Ponta de Flecha Cave specimen and other *Smilodon* species studied by KURTÉN and WERDELIN (1990). Measurements are reported in mm.

	<i>Smilodon populator</i>	<i>Smilodon fatalis</i>	<i>Smilodon fatalis</i>	<i>Smilodon populator</i>	<i>Smilodon gracilis</i>
	Abismo Ponta de Flecha (Brazil)	Rancho La Brea (USA)	Talara (Peru)	(Brazil and Argentina, various sites)	Florida (USA)
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	17.0	17.2 ± 0.5	16.5 ± 0.3	19.4 ± 0.4	12.4 ± 0.5
Shaft depth	15.5				
Distal width	25.2	24.8 ± 0.8	24.3 ± 0.3	26.6 ± 0.2	19.2 ± 0.9
Distal depth	22.8				
Proximal width	25.3				
Proximal depth	30.3				
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 depth	12.2				
Distal width		26.5 ± 1.0	25.6 ± 0.4	28.2 ± 0.2	16.7
Proximal width	25.8				
Proximal depth	26.4				



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) Metacarpal II in dorsal (B1), left lateral (B2) and right lateral (B3) views; C) Metacarpal III in dorsal (C1), left lateral (C2) and right lateral (C3) views; D) Proximal phalanges II, III and IV in palmar view (from left to right: PF 132 - GP/2C-527b, PF 131 - GP/2C-527c, PF 133 - GP/2C-527e). Scale bar equals 20 mm.

The ratio between the width of the shaft and the length of mc II of the specimens of *Smilodon populator* described by KURTÉN and WERDELIN (1990) is identical to that observed in the Abismo Ponta de Flecha Cave (Table 2). This suggests

that the latter belongs to this species. However, compared with specimens of *S. populator* described by KURTÉN and WERDELIN (1990), the metacarpals found in Vale do Ribeira are smaller, probably indicating a small individual.

Table 2: Average ratios between the shaft width and length of *Smilodon* species as given by KURTÉN and WERDELIN (1990) compared to the mc II specimen found in Abismo Ponta de Flecha Cave.

	<i>Smilodon populator</i>	<i>Smilodon fatalis</i>	<i>Smilodon fatalis</i>	<i>Smilodon populator</i>	<i>Smilodon gracilis</i>
	Abismo Ponta de Flecha (Brazil)	Rancho La Brea (USA)	Talara (Peru)	(Brazil and Argentina, various sites)	Florida (USA)
Shaft width/length	0.22	0.19	0.19	0.22	0.17



Figure 3: Comparison between the metacarpals of *Panthera onca* and *Smilodon populator*. A) mc II and mc III of *Panthera onca*, Cuvieri Cave, Minas Gerais, Brazil (CHAHUD & OKUMURA, 2021); B) mc II and mc III of *Smilodon populator* of the Abismo Ponta de Flecha Cave. Palmar views. Scale bar equals 20 mm.

Proximal Phalanges: The recovered osteological material is represented by the left proximal phalanges II, III and IV (Fig. 2.D). The phalanges are smaller than those of a *Smilodon* specimen found in the Argentine Pampa and described by MÉNDEZ-ALZOLA (1941) (Table 3). Phalanx IV is very incomplete, and no measurements or comparisons were possible.

Table 3: Measurements of proximal phalanges II and III in specimens of *Smilodon populator* found in the Abismo Ponta de Flecha Cave and Argentine Pampa. Measurements are reported in mm.

	Abismo Ponta de Flecha		Argentine Pampa (MÉNDEZ-ALZOLA, 1941)	
	II	III	II	III
Length	46.30	44.95	52.0	55.8
Shaft width	18.5	19.9	24.9	18.0
Shaft depth	11.54	-	15.5	14.3
Distal width	15.70	17.81	20.2	20.0
Distal depth	11.23	13.40	-	-
Proximal width	23.18	23.60	27.6	28.3
Proximal depth	17.53	17.50	23.3	21.0

The specimen has fused epiphyses, which indicates an adult; however, there are no modifications related to senescence, thus suggesting a young adult.

4. Discussion and concluding remarks

The specimen recovered from the Abismo Ponta de Flecha Cave represents a smaller individual of *Smilodon populator* when compared to other specimens from South America (MÉNDEZ-ALZOLA, 1941; KURTÉN & WERDELIN, 1990). This smaller size may represent a regional difference.

Differences in proportion and morphology between the three South American species of *Smilodon*, and regional morphological differences in *S. fatalis* (Table 1) from North America and Peru are also known (KURTÉN & WERDELIN, 1990), thus the same may have occurred with *S. populator*.

In South America, size variations between individuals of the same species have been reported in the peccary *Dicotyles tajacu*, whose representatives from the Amazon region are larger compared to those from other regions (GONGORA *et al.*, 2011). The same was reported for species of the genus *Tapirus*, including *T. terrestris* (the most common species), *T. pinchaque* (from the Andean region and smaller) and *T. bairdii* (from Central America and larger) (RUIZ-GARCÍA *et al.* 2016). Among the Felidae, the greatest difference is observed in individuals of *Puma concolor* from the Amazon that are on average smaller than those from the Andean region and southern



South America (PACHECO & ZAPATA, 2017; CHIMENTO & DONDAS, 2018; CHAHUD, 2021). *Smilodon populator* is the largest species in the genus *Smilodon*, and it is even larger than the largest recent felines, but specimens that approximate *S. fatalis* and the largest recent lions (*Panthera leo*) in size have also been found (CHRISTIANSEN & HARRIS, 2005). The specimen of *S. populator* from the Abismo Ponta de Flecha Cave is comparable to *S. fatalis* and recent lions in dimensions, being among the smallest of its species.

Acknowledgements

The author thanks the reviewers of this article. The author also thanks M.A. ARAGÃO for support and Dr M. Mercedes MARTINEZ OKUMURA, responsible for LEEH (Laboratory for Human Evolutionary Studies), Department of Genetics and Evolutionary Biology, Institute of Biosciences of the University of São Paulo, who permitted the preparation of fossils in her laboratory. AC holds a CNPq Senior Post-doctoral scholarship (103934/2020-0).

Bibliographic references

- BARROS BARRETO C.N., ROBRAHN E.M., DIAS NETO C.M., DE BLASIS P.A., KARMANN I. & LINO C.F. (1982).- Abismo "Ponta de Flecha": Abismo Ponta de Flecha: um projeto arqueológico, paleontológico e geológico no médio Ribeira de Iguape, SP.- *Revista da Pré História*, São Paulo, vol. 3, p. 195-215.
- BARROS BARRETO C.N., DE BLASIS P.A., DIAS NETO C.M., KARMANN I., LINO C.F. & ROBRAHN E.M. (1984).- Abismo "Ponta de Flecha": Um projeto arqueológico, paleontológico e geológico no médio Ribeira de Iguape, SP.- *Espeleo-Tema*, São Paulo, no. 14, p. 22-35.
- CASTRO M.C. & LANGER M.C. (2008).- New postcranial remains of *Smilodon populator* LUND, 1842 from southeastern Brazil.- *Revista Brasileira de Paleontologia*, Porto Alegre, vol. 11, p. 199-206. doi: 10.4072/rbp.2008.3.06
- CASTRO M.C. & LANGER M.C. (2011).- The mammalian fauna of Abismo Iguatemi, southeastern Brazil.- *Journal of Cave and Karst Studies*, Huntsville - AL, vol. 73, no. 2, p. 83-92. doi: 10.4311/jcks2010pa0140
- CHAHUD A. (2005).- Paleomastozoologia do Abismo Ponta de Flecha, Iporanga, SP. In: II Congresso Latino-Americano de Paleontologia de Vertebrados.- Abstracts, Museu Nacional/UFRJ, Rio de Janeiro, p. 76-78.
- CHAHUD A. (2020).- Occurrence of the sabretooth cat *Smilodon populator* (Felidae, Machairodontinae) in the Cuvieri cave, eastern Brazil.- *Palaentologia Electronica*, Los Angeles - CA, vol. 23.2, article 23(2):a24, 10 p. doi: 10.26879/1056
- CHAHUD A. (2021).- Osteometria e breves comentários sobre *Puma concolor* LINNAEUS, 1771 (Carnivora, Felidae), no Estado do Maranhão, Brasil.- *Revista Biociências - Universidade de Taubaté*, vol. 27 no. 1, p. 15-28.
- CHAHUD A. & OKUMURA M. (2021).- The presence of *Panthera onca* LINNAEUS 1758 (Felidae) in the Pleistocene of the region of Lagoa Santa, State of Minas Gerais, Brazil.- *Historical Biology*, vol. 33, no. 10, p. 2496-2503.
- CHIMENTO N.R. & DONDAS A. (2018).- First record of *Puma concolor* (Mammalia, Felidae) in the Early-Middle Pleistocene of South America.- *Journal of Mammalian Evolution*, vol. 25, no. 3, p. 381-389.
- CHRISTIANSEN P. & HARRIS J.M. (2005).- Body size of *Smilodon* (Mammalia: Felidae).- *Journal of Morphology*, vol. 266, no. 3, p. 369-84.
- GONGORA J., BIONDO C., COOPER J.D., TABER A., KEUROGLIAN A., ALTRICHTER M., FERREIRA DO NASCIMENTO F., CHONG A.Y., MIYAKI C.Y., BODMER R., MAYOR P. & GONZÁLEZ S. (2011).- Revisiting the species status of *Pecari maximus* van ROOSMALEN *et al.*, 2007 (Mammalia) from the Brazilian Amazon.- *Bonn Zoological Bulletin*, vol. 60, no. 1, p. 95-101.
- KURTÉN B. & WERDELIN L. (1990).- Relationships between North and South American *Smilodon*.- *Journal of Vertebrate Paleontology*, McLean - VA, vol. 10, no. 2, p. 158-169.
- LUND P.W. (1842).- Blik paa Brasiliens Dyreverden for Sidste Jordomvaeltning. Tredie Afhandling: Forsaettelse af Pattedyrene.- *Det Kongelige Danske Videnskaberne Selskabs Naturvidenskabelige og Mathematisk Afhandlinger*, Copenhagen, vol. 9, p. 137-208.
- MANZUETTI A., PEREA D., UBILLA M. & RINDERKNECHT A. (2018).- First record of *Smilodon fatalis* LEIDY, 1868 (Felidae, Machairodontinae) in the extra-Andean region of South America (late Pleistocene, Sopas Formation), Uruguay: Taxonomic and paleobiogeographic implications.- *Quaternary Science Reviews*, vol. 180, no. 57-62.
- MÉNDEZ-ALZOLA R. (1941).- El *Smilodon bonaërensis* (MUÑIZ), Estudio osteológico y osteométrico del gran tigre fósil de La pampa comparado con otros félidos actuales y fósiles.- *Anales del Museo Argentino de Ciencias Naturales "Bernardino Rivadavia"*, Buenos Aires, vol. 40, no. 67, p. 135-252.
- MONES A. & RINDERKNECHT A. (2004).- The First South American Homotheriini (Mammalia: Carnivora: Felidae).- *Comunicaciones Paleontológicas Museo Nacional de Historia Natural y Anthropología*, Montevideo, vol. 2, no. 35, p. 201-212.
- PACHECO J.I. & ZAPATA C. (2017).- Descripción osteológica del puma andino (*Puma concolor*): I. Esqueleto Apendicular.- *Revista de Investigaciones Veterinarias del Peru*, Lima, vol. 28, no. 4, p. 1047-1054.
- RINCÓN A.D., PREVOSTI F.J. & PARRA G.E. (2011).- New saber-toothed cat records (Felidae: Machairodontinae) for the Pleistocene of Venezuela, and the Great American Biotic Interchange.- *Journal of Vertebrate Paleontology*, McLean - VA, vol. 31, no. 2, p. 468-478.



- RUIZ-GARCÍA M., CASTELLANOS A., BERNAL L.A., PINEDO-CASTRO M., KASTON F. & SHOSTELL J.M. (2016).- Mitogenomics of the mountain tapir (*Tapirus pinchaque*, Tapiridae, Perissodactyla, Mammalia) in Colombia and Ecuador: Phylogeography and insights into the origin and systematics of the South American tapirs.- *Mammalian Biology*, vol. 81, no. 2, p. 163-175.
- WOODBURNE M.O. (2010).- The great American Biotic Interchange: Dispersals, tectonics, climate, sea level and holding pens.- *Journal of Mammalian Evolution*, vol. 17, no. 4, p. 245-264.