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# ON THE TYPE OF *SCHISMOTHERIUM FRACTUM* AMEGHINO, 1887 (XENARTHRA, FOLIVORA, MEGATHERIOIDEA) FROM THE EARLY MIOCENE SANTA CRUZ FORMATION (SANTA CRUZ PROVINCE, ARGENTINA)

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**Palabras clave.** *Schismotherium.* Perezosos. Neotipo. Taxonomía. Santacrucense. Patagonia.

FLORENTINO Ameghino (1887) was the first to describe several sloths species from the Santa Cruz Formation (SCF; early Miocene, Santacrucian Age) of Argentine Patagonia. In subsequent publications, Ameghino (*e.g.*, 1891, 1894) expanded the roster of sloths, to which Mercerat (1891), Lydekker (1894), and Scott (1903, 1904) also contributed. As noted by Brandoni (2013), Racco *et al.* (2013) and De Iuliis *et al.* (2014), among others, the taxonomy of these Santacrucian sloths still remains unsettled. Expeditions by the Museo de La Plata (MLP, La Plata, Argentina) in collaboration with Duke University (Durham, North Carolina, USA) have recovered numerous new remains, belonging to the Museo Regional Provincial Padre M. J. Molina (MPM, Río Gallegos, Santa Cruz Province, Argentina) that hold promise of solving many of the vexing systematic problems that have persisted since these sloths were first described.

However, the resolution of such taxonomic problems first requires a clear understanding of the classically named taxa and the basis on which they were erected and recognized. Several factors contribute to the confusion regarding Santacrucian sloths, including the typological mindset of Ameghino (and most of his contemporaries) in recognizing species (Ameghino, 1915), Ameghino's use and recognition of type material, and the problems with Ameghino's collection (see Fernicola 2011a, b). These factors have been considered in several recent publications, such as Fernicola (2011a, b), Racco *et al.* (2013), Vizcaíno *et al.* (2013) and De Iuliis *et al.* (2014).

A species requiring such clarification is *Schismotherium fractum* Ameghino (1887, p. 21), ironically the very first fossil sloth erected by Ameghino from the Santa Cruz Formation beds. Gaudin (1995, 2004) considered *S. fractum* as a basal megatherioid. Its original type is not figured and is presumably lost (Mones, 1986, p. 250). The aim of the current contribution is to 1) track the sequence of events leading ultimately to the development of the concept of this species, 2) identify the specimens on which this concept is based, 3) trace the work of Ameghino (1887, 1889, 1894, 1898) and Scott (1904) in arriving at this concept, 4) confirm, to the extent possible, that the original type is lost, and

if so, 5) designate an appropriate neotype for the species, according to the International Code of Zoological Nomenclature (ICZN, 1999, Art. 75), in order that further systematic work may be undertaken.

## AMEGHINO'S (1887, 1889) ORIGINAL CONCEPT OF *SCHISMOTHERIUM*

Ameghino (1887) reported an incomplete dentary of *Schismotherium fractum*, indicating that the teeth were arranged in a series without (a measurable) diastema, the mesial tooth was molariform (Ameghino was careful to note this both in stating that it was not caniniform and by referring to it as one of the "muelas", *i.e.*, cheek teeth), and the teeth were oblongorectangular (a term used by Ameghino to mean rectangular with rounded corners or somewhat elliptical) with a central depression that did not open widely lingually and vestibularly (as occurs, in contrast, in nothrotheriid and megatheriine sloth molariforms). The potential existence among Santacrucian sloths of a caniniform first tooth separated by a diastema from the remaining teeth was clearly recognized by Ameghino (1887, 1889) as a prominent feature of the next two genera that he described: *Eucholoeops* Ameghino, 1887 and *Hapalops* Ameghino, 1887.

Ameghino (1889) expanded his description based on the 1887 specimen (a partial left dentary), noting that it was the only known material of the species and preserved the last two teeth and the incomplete alveoli of the first two teeth. The generic description essentially repeated information provided in 1887. Under the specific characterization, Ameghino (1889) stated that the first tooth, based on its incompletely preserved alveolus, was the smallest. The second tooth, also based on its alveolus, was described as similar to but slightly larger than the third, oblongorectangular tooth. He also noted that the last tooth was smaller than the third and had a slightly convex mesial surface and a flattened distal surface.

We may surmise several aspects of Ameghino's (1887, 1889) concept of *Schismotherium fractum*: 1) the teeth, all somewhat oblongorectangular, were arranged in a continuous series, essentially without a diastema; 2) given the degree of incompleteness of the alveoli of the first two teeth, he could not have known with a reasonable degree of confidence the precise shape of the first tooth; 3) the second tooth was probably the largest and similar in shape to the third tooth; and 4) the last tooth, smaller than the two that preceded it, had a convex mesial border.

With regard to the first lower tooth, it is unclear why Ameghino considered it molariform, given that he could not have known its shape. We suspect that he inferred the presence of a molariform based on the size and non-circular or -oval shape of its incomplete alveolus, the absence (or near absence) of a diastema, and the form of the dentition of sloths then commonly known. For example, a pronounced diastema is often preceded by a prominent caniniform (*e.g.*, in the extant *Choloepus*, and the Santacrucian *Eucholoeops* and *Hapalops*) or incisiform (*e.g.*, in the extinct *Megalonyx*) tooth, whereas the absence of a diastema is often accompanied by a more nearly molariform first lower tooth (*e.g.*, in the extant *Bradypus* and fossil Megatheriinae).

According to historical records and given that Ameghino worked at MLP until 1888 (Fernicola, 2011a, b), the holotype should have been deposited in this institution. However, many of the specimens that had been collected by that time for the MLP were appropriated by Ameghino and incorporated into his personal collection, most of which has been part of the Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" (MACN, Buenos Aires, Argentina) collections since 1935 (Fernicola, 2011a). Unfortunately, recent attempts by the authors and staff of the collections to locate this specimen at the MLP and MACN have been fruitless. Many specimens from Ameghino's collection and the old collections of the MLP were exchanged or sold, especially to institutions in Europe and the USA (see Vizcaíno and Bargo, 2013; Vizcaíno *et al.*, 2013). Searches by some of the authors in several US museums (*e.g.*, National Museum of Natural History, Smithsonian Institution, Washington, USA; Field Museum of Natural History, Chicago, USA; Yale Peabody Museum, New Haven, USA) and inquiries to several European museums and other US institution (see Acknowledgements) also proved negative with respect to the type of *S. fractum*.

Mercerat (1891) described but did not figure the MLP specimen that he considered the type of *S. fractum*, remarking that it had a noticeable diastema between the first two teeth. This author also noted several other teeth that may have belonged to a different specimen, and suggested that all this material was very similar to *Hapalops*, another well-known Santacrucian sloth. Ameghino (1891) dismissed

Mercerat's (1891) claims and suggested that he had mistaken this material for the type; Mercerat never addressed (at least in print) Ameghino's rebuke.

Indeed, Mercerat's (1891) description does not agree with the type specimen as described by Ameghino (1887, 1889); and this instance is not the sole example of confused identity. There is a photograph of a dentary labeled as the type of *S. fractum* in an album (Fig. 1) kept in the Department of Paleontology of the Kansas University Natural History Museum (KUNHM; Lawrence, Kansas, USA; Vizcaíno *et al.*, 2016). This album includes photographs of many of the specimens that were part of Ameghino's collection and others that were (and most still are) in the collections of MLP and MACN. This is almost certainly the album assembled by W. B. Scott during his visit to the MLP, MACN, and Ameghino's home in 1901 (Vizcaíno *et al.* 2017). Although the photograph of this dentary is labeled as the type, it does not match Ameghino's (1887, 1889) descriptions and is not identified by a catalogue number. The specimen is a fragment of a probable left dentary. It preserves only the alveoli of the three distal teeth and, possibly, a small portion of the vestibular wall of the alveolus of the mesial tooth, but lacks its ventral margin. Ameghino (1887, 1889) noted that the two distal teeth were preserved in the type and reported a depth for the dentary, which would have required preservation of its ventral margin. Further, the shape of the nearly complete alveolus in the image is quadrangular, rather than oblongorectangular. It is not known how this material came to be considered the type specimen. As noted above, this specimen does not agree well with Ameghino's (1887, 1889) descriptions. Whether it be the same specimen, but in a poorer state of preservation than when Ameghino had first described it (nearly 15 years before Scott saw it), or a different specimen cannot be ascertained. The futile search for the type, noted above, took into account the specimen as Ameghino described it and of the appearance of the specimen in the KUNHM album.

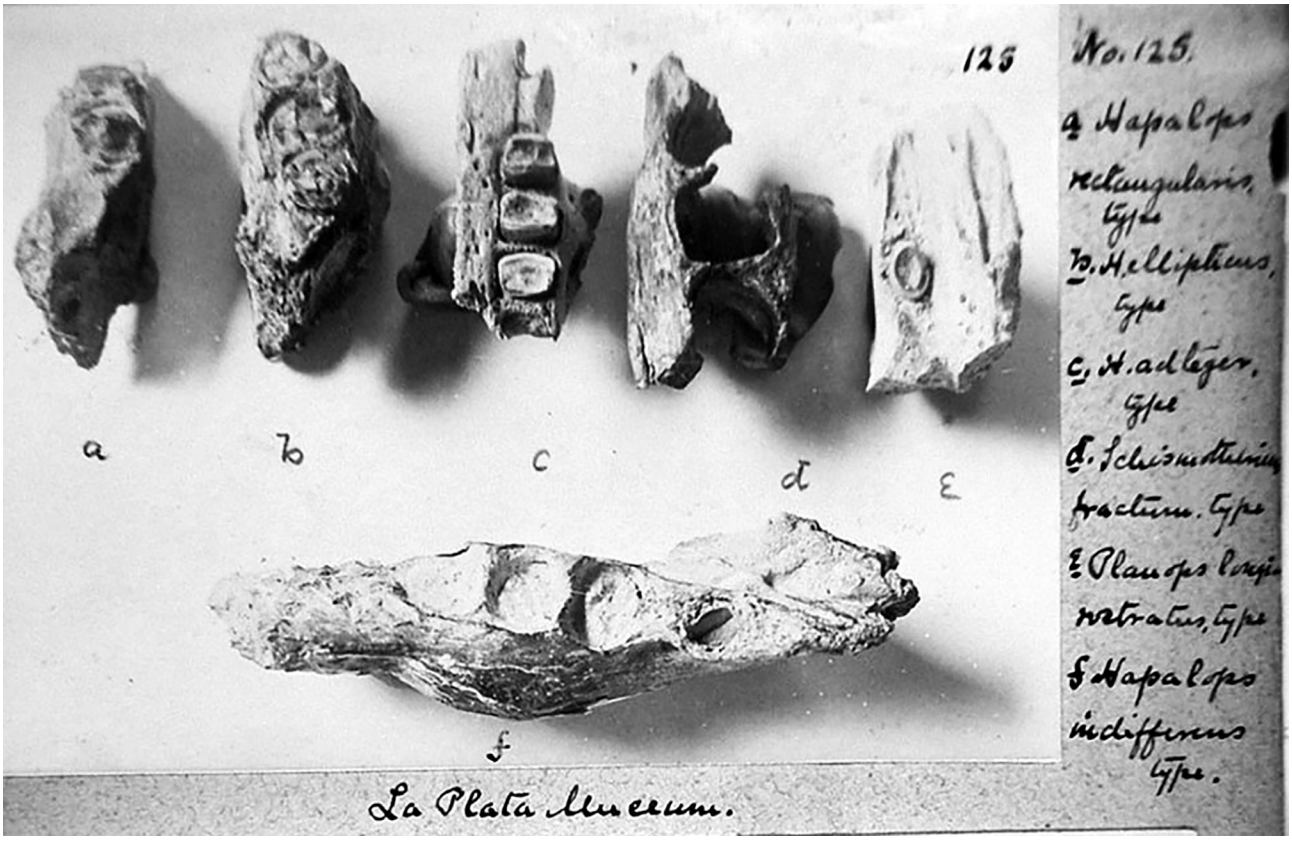


**Figure 1.** Plate 125 of the **KUNHM** album. The photograph legend indicates that the specimen labeled 'd' was in MLP and was the type of *Schismotherium fractum*.

## AMEGHINO'S (1894, 1898) "NEW" MATERIAL OF *SCHISMOTHERIUM FRACTUM*

Ameghino (1894, 1898) refined the description of *Schismotherium fractum* based on additional and more complete material that included the skull, mandible, and several postcranial elements of a single individual. In the generic description, Ameghino (1894) reported the lower teeth and, for the first time, the upper teeth and skull. He rectified the description of the first lower tooth, stating that it was nearly as large as the second tooth, but triangular in section, with three nearly equal sides meeting at rounded angles. The following two lower teeth were rectangular, as Ameghino had previously stated, and the last was cylindrical. The first upper tooth was described as elliptical and strongly compressed vestibulolingually, with a nearly flat lingual surface, a slightly convex vestibular surface, and a distally facing occlusal wear facet. A short diastema separated it from the second tooth, which was subcylindrical and slightly narrower mesially than distally.

Among the differences between Ameghino's earlier and later characterizations is the form of the first lower tooth, described as molariform (Ameghino, 1887, 1889) and triangular (Ameghino, 1894, 1898). Given that he could not have known the shape of the tooth from the type (see above), it is evident that Ameghino did not so much change his description of the tooth but finally established its form on more complete remains. Another difference concerns the last lower tooth, described first as oblongorectangular (Ameghino, 1887), then as having convex mesial and flattened distal margins (thus not oblongorectangular; Ameghino, 1889), and finally as cylindrical (Ameghino, 1894, 1898). A more or less cylindrical or circular section of this tooth is common in non-mylodontid Santacrucian and later fossil sloths. As in other teeth and morphological structures, both intraspecific and within individual variation exists, and thus some teeth approach a more circular section than others (see De Iuliis *et al.*, 2014, for a discussion of such variation in the Santacrucian sloth *Eucholoeops ingens* Ameghino, 1887). It is plausible that the form of the tooth in Ameghino's (1887, 1889) specimen may have been less regularly circular than in Ameghino's (1894, 1898) specimen.

Ameghino (1894, 1898) did not explicitly identify his specimen, but it was clearly not the type specimen. It becomes evident through Ameghino's (1894, 1898) and Scott's (1904) descriptions and illustrations (Fig. 2) that the specimen in question is MACN-A 6445–6470. This specimen is catalogued as *Schismotherium fractum* and includes the associated remains of a single individual.

Ameghino (1898) amplified the characterization of *S. fractum*, noting that: the skull was wide, short, and truncated anterior to the level of the mesial tooth; the teeth were large, arranged in a continuous series, with the lower

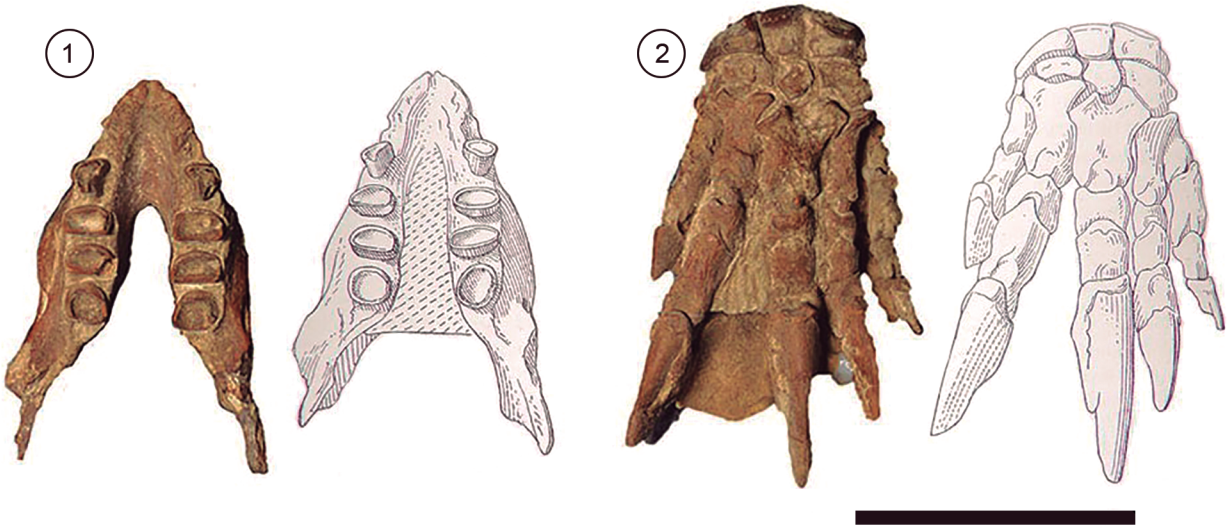


**Figure 2.1.** Mandible (**MACN-A** 6446 neotype) of *Schismotherium fractum* next to Scott's (1904) representation. Dorsal view; **2,** Left manus (**MACN-A** 6454 neotype) of *S. fractum* and its corresponding representation by Scott (1904). Dorsal view. Scale bar= 5 cm.

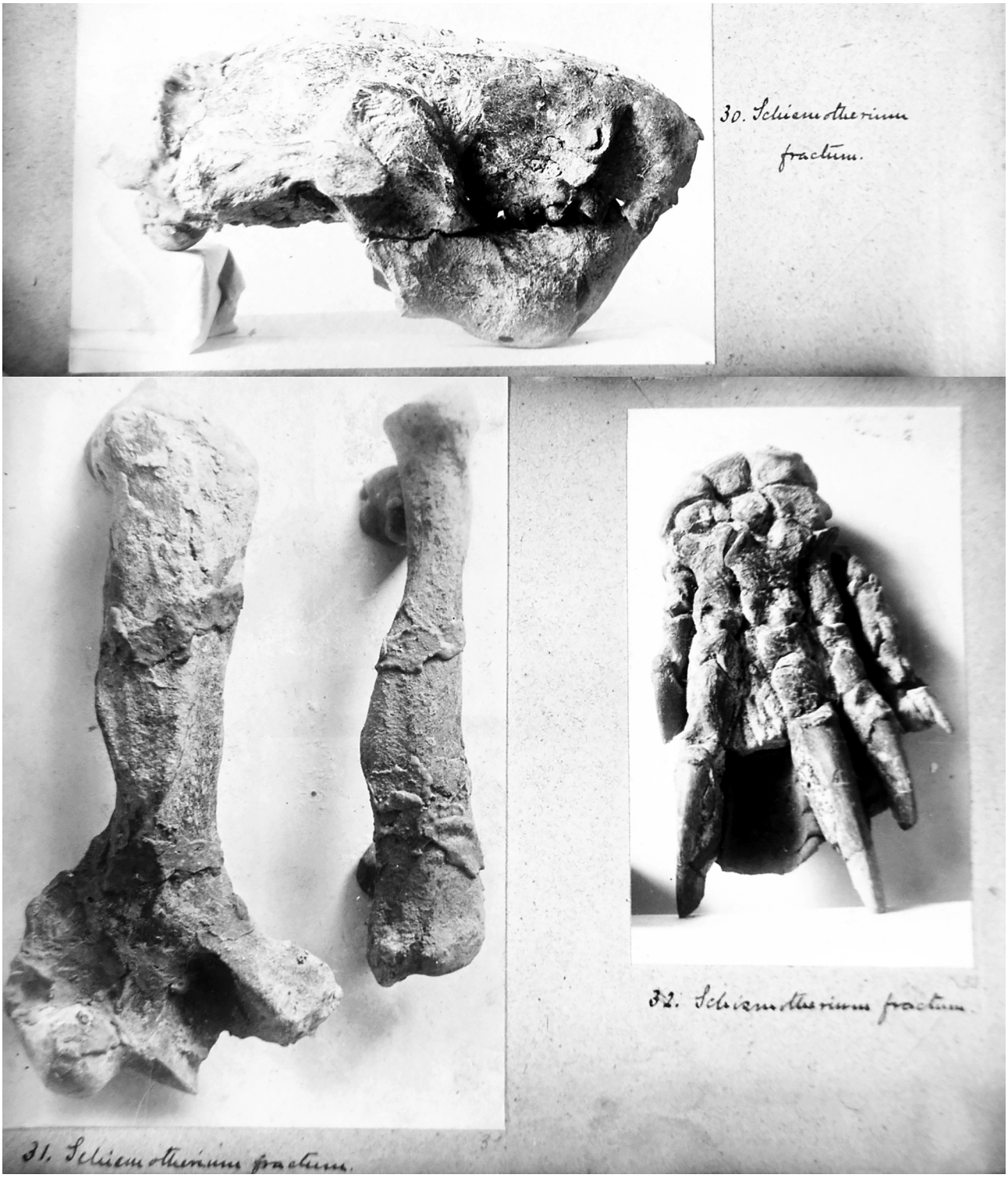


**Figure 3.** Plates from the **KUNHM** album of the skull and mandible (Plate 30; **MACN-A** 6445–6446), right humerus and left radius in anterior view (left and right side images, respectively, of plate 31; **MACN-A** 6447 and **MACN-A** 6450), and left manus (Plate 32; **MACN-A** 6454) in dorsal view of the specimen designated here as the neotype of *Schismotherium fractum* Ameghino, 1887.

mesial tooth thick, triangular, and obliquely truncated (*i.e.*, worn); the symphysis was short; and the posterolateral opening of the mandibular canal was situated anterior to the base of the ascending process. The humerus and manus were illustrated but not described (Ameghino, 1898: fig. 69). It is through these illustrations, as well as Scott's (1904:


**Figure 4**. ***Schismotherium fractum*** Ameghino, 1887 neotype. **1,** Skull and mandible (**MACN-A** 6445–6446) in right lateral view; **2,** Axis (**MACN-A** 6456) in lateral view; **3,** Atlas (**MACN-A** 6455) in anterior view; **4,** Right humerus (**MACN-A** 6447) in anterior view; **5,** Left radius (**MACN-A** 6450) in posterior view; **6,** Right radius with carpals (**MACN-A** 6451) in anterior view; **7,** Right ulna (**MACN-A** 6449) in medial view and left ulna (**MACN-A** 6448) in lateral view; **8,** Right femur (**MACN-A** 6452) in anterior view; **9,** Right tibia (**MACN-A** 6453) in anterior view. Scale bar= 5 cm.

figs. 35–36) illustrations of the mandible and manus, that the identity of the material Ameghino (1894, 1898) described can be ascertained (Fig. 2) because it is against these images (and measurements) that MACN-A 6445–6470 may be compared and matched. Images of the skull, dentary, humerus, radius, and manus of this individual are also present in the KUNHM album and labelled as *Schismotherium fractum* (Fig. 3).

As demonstrated, Ameghino (1887, 1889, 1894, and 1898) arrived at a revised concept of *S. fractum* over the course of several years by incorporating better-preserved remains in his analyses (Fig. 4). In achieving this and in accordance with Article 24.2.1 of the International Code of Zoological Nomenclature (ICZN, 1999), Ameghino may be regarded as his own first reviser. Scott (1904, p. 296) agreed with Ameghino's recognition of the specimen as *S. fractum*, noting that it was a "fine skull, with mandible and forelimb nearly complete…" However, MACN-A 6445–6470 is more complete than may be inferred from the literature. It includes a nearly complete skull and mandible, atlas, axis and several other vertebrae, numerous rib fragments, right humerus, both ulnae and radii (of which the right includes some carpal elements such as the scaphoid, lunar, and probably trapezoid and magnum), left manus, and right femur and tibia (Fig. 4).

## DISCUSSION

A better understanding of the species assigned to *Schismotherium* requires consideration of intraspecific and interspecific variation, and comparison with the morphologically similar *Pelecyodon*. A review of all relevant specimens, housed in several international institutions, must be considered, including the remains recently recovered by the MLP-Duke University expeditions.

Such systematic work on *Schismotherium* is currently being undertaken by the authors. Until this in-progress analysis is completed, presentation of a formal diagnosis for *Schismotherium* would be premature. In accordance with Article 75 of the ICZN, a neotype is required for clarifying the taxonomic and systematic status of *Schismotherium fractum* and its concept. Given that Ameghino (1894, 1898) and Scott (1904) developed this concept on MACN-A 6445–6470, we formally designate this specimen as neotype of *S. fractum*, as was suggested by Racco *et al.* (2015).

The original type specimen was collected in 1887 from one of the localities along the Río Santa Cruz, including, from east to west, Barrancas Blancas, Segundas Barrancas Blancas and Yaten Huageno (Fernicola *et al.*, 2014). In 1887 C. Ameghino also explored a more western locality in the vicinity of a tributary river named Río Bote. We may dispense with the possibility that the type specimen belonged to the Río Bote locality given that Ameghino (1902, 1906) considered *S. fractum* an exclusively Santracrucian species, whereas he considered all the Río Bote species of Notohippidian Age (Fernicola *et al.*, 2014).

According to the Ameghino catalog (archived in the MACN) and letters between the brothers Carlos and Florentino (Vizcaíno, 2011), MACN-A 6445–6470 was collected between 1892–93 from a coastal locality (see below) known as La Cueva (SCF). The exact location is uncertain but it was probably situated near the coastline between Monte León and Yegua Quemada (Ameghino, 1906; Feruglio, 1949; Marshall, 1976). Marshall (1976) also indicated another La Cueva locality along the Río Santa Cruz. This information can no longer be verified, but during the years specified in the letters between the Ameghino brothers, Carlos worked localities along the coast, rather than along the Río Santa Cruz. Although the type specimen and the proposed neotype are from different localities, both were collected from and belong to the SCF in Santa Cruz Province in Patagonia.

## CONCLUSIONS

The specimen on which *Schismotherium fractum* Ameghino, 1887 was erected and that must be regarded as its type was never figured by Ameghino and can no longer be located. Ameghino (1887, 1889, 1894, 1898) arrived at a definitive concept of *S. fractum* over several years, revising it as better material became available. Beginning with a fragmentary dentary bearing two teeth, Ameghino was able to provide only an interpretation of the form of the first two teeth based on incomplete alveoli. A definitive understanding of the dentition was achieved years later through more complete material. Designation of a neotype is required to permit further systematic analyses. MACN-A 6445–6470 was illustrated and recognized by Ameghino (1894, 1898) and by Scott (1904) and has long been housed in the MACN, an internationally recognized institution.

Given its established taxonomic usage and in consideration of Article 75 of the ICZN, MACN-A 6445–6470 is designated as the neotype for the species *Schismotherium fractum*.

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