



## A new species of the rare batomorph genus *Hypolophodon* (?latest Cretaceous to earliest Paleocene, Argentina)

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With 5 figures

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**Abstract:** Isolated teeth of a new species of the rare batomorph genus *Hypolophodon* were found in Paleocene beds of the Lefipán Formation (Maastrichtian-Paleocene) of southern Argentina. The new species *H. patagoniensis* differs from the type species *H. sylvestris* in the absence of an occlusal transverse crest on the crown of unworn teeth and of a broad and rounded central uvula on the lingual face of the crown; and in the presence of a lower boundary of the enameloid smooth on all crown faces, many expanded basoapically striae on all sides of the root, and a deep root. It differs from the Eocene species *H. dockery* in the larger size, the less widely separated root branches, the presence of root foraminae or striae, the absence of uvula, and the deeper crown. The new species material, the two teeth from Jaguel Formation, and an indeterminate tooth of *Hypolophodon* from the Lower Cenozoic of Chile represent the sole records of the genus in the Southern Hemisphere. The shark fauna helped to date the bearing beds.

**Key words:** Batomorphii, *Hypolophodon*, Argentina, South America, Paleocene, Cenozoic.

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### 1. Introduction

During the Late Cretaceous and Early Paleogene different batomorph clades suffered extinctions and diversifications (KRIWET & BENTON 2004). *Hypolophodon* has been considered to be one of the batomorphs that replaced the taxa that became extinct during the Cretaceous-Paleogene event. In South America, there are few relatively recent descriptions of Maastrichtian to Danian elasmobranchs (i.e. REBOUÇAS & SANTOS 1956; SCHAEFFER 1963; CAPPETTA 1975, 1991; ARRATIA & CIONE 1996; GONZÁLEZ RIGA 1999; GAYET et al. 2001; BOGAN & AGNOLIN 2010; BOGAN & GALLINA 2011). Additionally, there here are very few records of the batomorph genus *Hypolophodon* CAPPETTA, 1980 around the world, especially from the Southern

Hemisphere (see BOURDON 1999a). In this contribution, a new species of *Hypolophodon* is described from the latest Cretaceous and the earliest Paleogene of southern Argentina.

### 2. Geological setting

Most of the material here described comes from a section of the Lefipán Formation (LESTA & FERELLO 1972) located in the Estancia “26 de Mayo,” owned by the Grenier family (42°46' S and 69°51' W), about 20 km to the west of Paso del Sapo, near the Río Chubut, northwestern Provincia del Chubut, Argentina (Fig. 1).

The Lefipán Formation is maximal 370 m thick, marine to proximal marine siliciclastic unit, which crops out discontinuously in northwestern Chubut

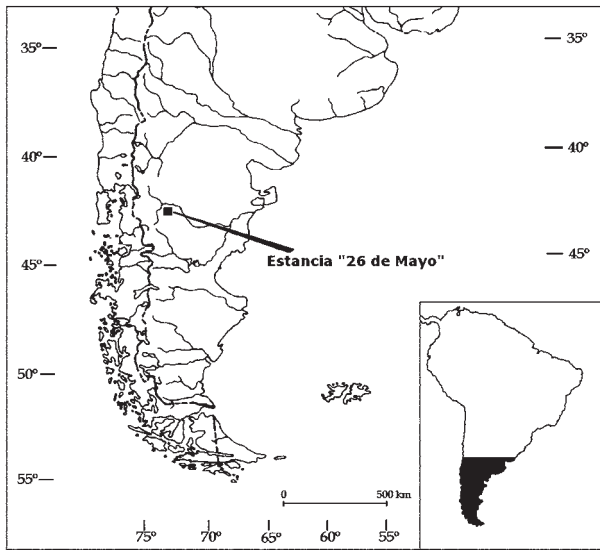


Fig. 1. Location map.

Province of southern Argentina (OLIVERO et al. 1990; OLIVERO & MEDINA 1993; SCASSO et al. 2012). Along the Río Chubut, it is recognized from Piedra Parada to Estancia T. Ibarra (formerly Estancia Lefipán; PETERS-EN 1946; FERUGLIO 1949; MEDINA et al. 1990; OLIVERO et al. 1990).

The Lefipán Formation is mainly composed of massive and heterolithic mudstones with several intercalations of sandstone lenses and coquinas with well preserved molluscan faunas of Maastrichtian and Paleocene age (SCASSO et al. 2012). Sandstones are massive, or display parallel or cross-bedding. Occasionally they show well preserved bioturbation of the *Skolithos-Cruziana*-like ichnofacies and contain phosphatic concretions (PEREIRA & SCASSO 2002). The complete unit was deposited in a shallow epeiric sea and the sandstones were interpreted as bars and shoals accumulated in a shoreface environment (SPALLETTI 1996). The Lefipán Formation overlies the Late Cretaceous Paso del Sapo Formation (Campanian-Maastrichtian; PAPÚ et al. 1988) and underlies the Eocene strata of the Laguna del Hunco Series.

The unit can be divided into three sections (MEDINA et al. 1990). These sections can be recognized in the Estancia "26 de Mayo" profile, where 65 m of exposures represent the Cretaceous-Paleocene transi-

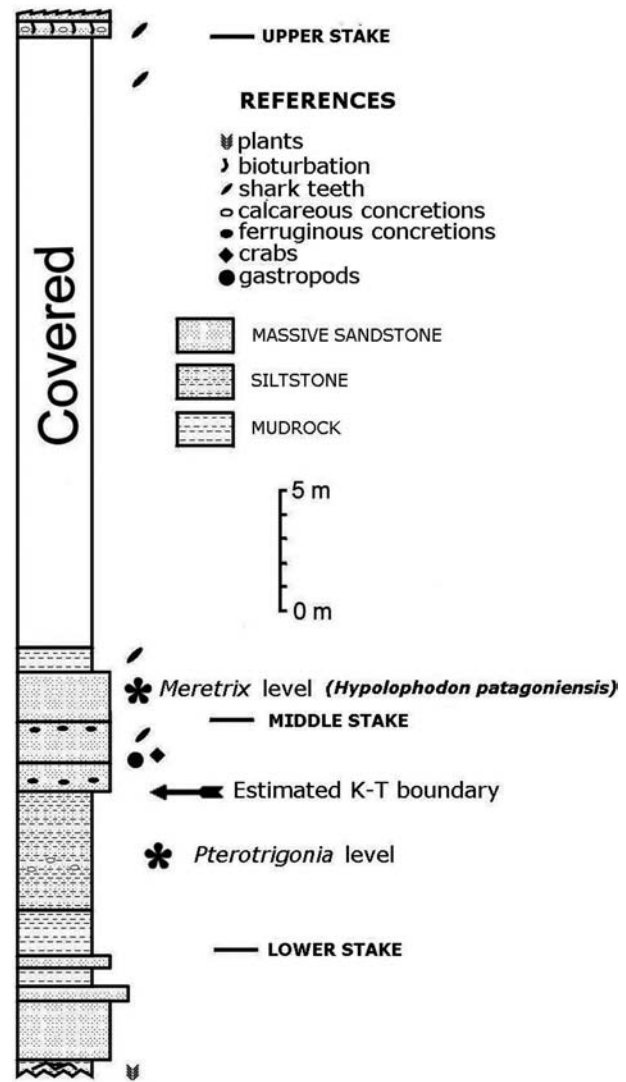


Fig. 2. Profile at Estancia "26 de mayo."

tion. The lower 12 m are characterized by brown mudstones with concretions and rare heterolithic bedding, and rusty-brown massive sandstones. It is conformably overlaid by a 5 m thick packet of massive sandstones of the middle section, with large carbonatic concretions, bivalves, gastropods, callianassid crabs, and shark and ray teeth. The upper section is mainly composed of unconsolidated to slightly consolidated mudstones and exposure is poor. The uppermost bed is a strongly bioturbated, fossiliferous sandstone with abundant

*Ophiomorpha* and *Thalassinoides*. In the farm Estancia “Don Félix”, owned by Mr. CRETTON, a few kilometers west of Estancia “26 de Mayo,” one *Hypolophodon* tooth was found. The Lefipán Formation here conformably underlies possible early Paleocene continental strata composed mainly by gray sandstones and mudstones, including abundant leaf impressions and volcanoclastic agglomerates (Fig. 2; PETERSEN 1946; ARAGÓN & MAZZONI 1997). The middle section of Lefipán Formation is also exposed at Estancia “Don Félix”, and the fossil fish material is well represented, as in the Grenier farm.

Apparently, a continuous Cretaceous–Cenozoic transition is represented in the Grenier section, without any apparent unconformity. The lower section of the Lefipán Formation was assigned to the Maastrichtian because of some of the invertebrate fossils (*Ostrea* cf. *rionegrensis*, *Pterotrigonia* (*Rinetrigonia*) *windhausenia*, *Pacitrigonia patagonica*, *Tagelus gratus*, *Pugnelus* sp., *Struthioptera pastorei*; see MEDINA et al. 1990; OLIVERO et al. 1990).

The middle and upper sections were assigned to the Paleocene (MEDINA et al. 1990). They include the bivalve *Meretrix chalcedonica*, among others, which also occur in the Danian Salamanca Formation. In the upper section, *Pycnodonte miradonensis* predominates, which also is known from the Salamanca Formation (MEDINA et al. 1990). There are additional invertebrates that support a Paleocene age.

The fish material described here comes from the middle section. The ichthyofauna includes isolated teeth of teleosts and neoselachians and it is in agreement with a Cenozoic age because A) there are neither specimens of families or genera that became extinct before the Cretaceous–Paleocene boundary (e.g. Hybodontidae, Acrodontidae, Anacoracidae, Polyacrodontidae, Sclerorhynchidae, Ptychodontidae, Rhombodontidae, *Scapanorhynchus*, *Igdabatis*), nor of those families that are relatively abundant in the Cretaceous (Palaeospinacidae, Orthacodontidae, Cretoxyrhinidae) in an ichthyofauna with predominance of *Carcharias*, and (B) several teeth of a new species of the batoid genus *Hypolophodon* have been recorded. Until recently, *Hypolophodon* was only known from the Paleocene–middle Eocene (but see below). Crab and foraminifera remains do not include any definite Cretaceous taxa. Besides, there are no records of Cretaceous marine tetrapods such as plesiosaurs or mosasaurs. The same level that the new species of *Hypolophodon* yielded the oldest Cenozoic mammal of South American was reported (GOIN et al. 2006).

### 3. Systematic palaeontology

Subclass Elasmobranchii BONAPARTE, 1838

Order Myliobatiformes COMPAGNO, 1973

Family indet.

Genus *Hypolophodon* CAPPETTA, 1980

*Hypolophodon patagoniensis* nov. sp.

Figs. 3–4

2010 cf. *Pseudohypolophus mcultyi* BOGAN & AGNOLIN, p. 184

2011 *Hypolophodon sylvestris* BOGAN & GALLINA, p. 59

**Etymology:** The species name is derived from the South American region called Patagonia.

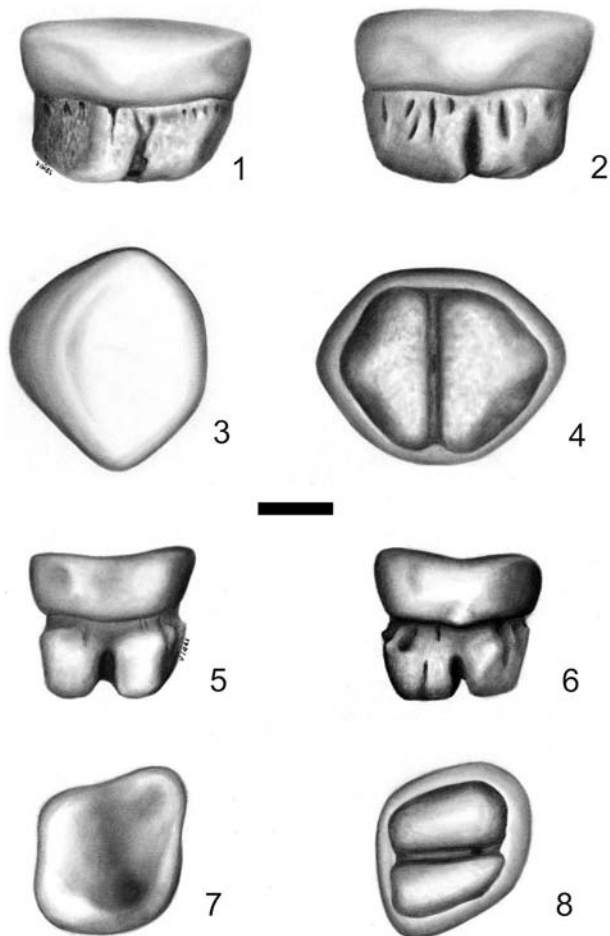
**Holotype:** LIEB-PV 1600. Anterior tooth. Crown width: 6.4, crown length: 4.6, ratio of crown width/length: 1.4, total height: 4.4. Estancia “26 de Mayo” (measurements in mm).

**Repository:** Laboratorio de Investigaciones en Evolución y Biodiversidad, Facultad de Ciencias Naturales, Sede Esquel, Universidad Nacional de la Patagonia “San Juan Bosco,” Sarmiento 849, 9200 Esquel, Chubut, Argentina (LIEB).

**Referred material:** LIEB-PV 1601. Fragmentary tooth. Estancia “26 de Mayo.” LIEB-PV 1602. Lateral tooth. Crown width: 2.2, crown length: 2.0, rate crown width/length: 1.1, total height: 2.0. Estancia “26 de Mayo.” LIEB-PV 1603. Anterior tooth. Crown width: 4.8, crown length: 4.0, rate crown width/length: 1.2, total height: 3.4. Estancia “Don Félix.” LIEB-PV 1604. Anterior tooth. This tooth was sectioned (Fig. 4). Crown width: 5.2, total height: 3.3. Estancia “26 de Mayo.” LIEB-PV 1605. Fragmentary lateral tooth. Crown width: 2.1, crown length: 2.0, rate crown width/length: 1.05. Estancia “26 de Mayo.”

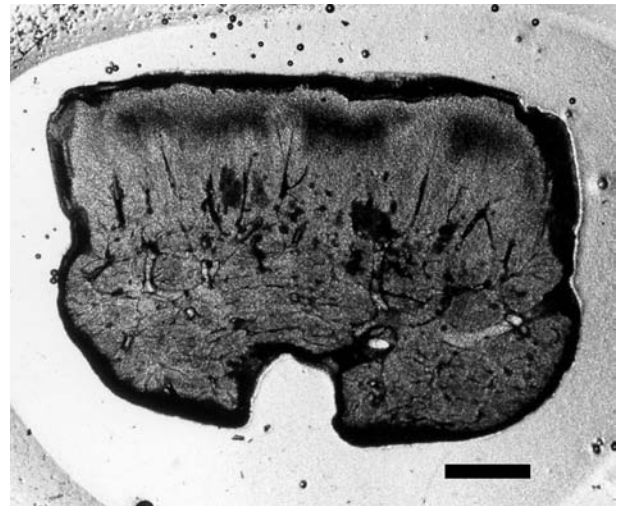
**Type locality and horizon:** Estancia “26 de Mayo” (LIEB-PV 1600, 1601, 1602, 1604, 1605), and Estancia “Don Félix” (LIEB-PV 1603), northwestern Chubut Province, central Patagonia, Argentina (Fig. 1). Middle section of Lefipán Formation. Early Paleocene. Collectors: FRANCISCO GOIN and MARCELO TEJEDOR. Two other teeth, reported as *Hypolophodon sylvestris* by BOGAN & GALLINA (2011) come from Maastrichtian beds of the Jagüel Formation at Cerro Dientes, provincia de Río Negro Argentina.

**Diagnosis:** Species of *Hypolophodon* that differs from the type species (*H. sylvestris*) in the absence of an occlusal transverse crest on the crown of unworn teeth and of a broad and rounded central uvula on the lingual face of the crown; and in the presence of the lower boundary of the enameloid which is smooth on all crown faces, many expanded basoapically striae on all sides of the root (not only the lingual one as in *H. sylvestris*), and a deep root. *H. patagoniensis* differs from another putative species (*H. dockeryi*) in the larger size, the less widely separated root branches, the presence of root foraminae or striae, the absence of uvula, and the deeper crown.



**Fig. 3.** *Hypolophodon patagoniensis* sp. nov. Anterior teeth. LIEB-PV 1600: 1 – lingual view; 2 – labial view; 3 – lateral view; 4 – occlusal view; 5 – basal view. Young individual, LIEB-PV 1603: 6 – lingual view; 7 – labial view; 8 – occlusal view; 9 – basal view. Scale bar equals 2 mm.

**Description:** The teeth have a strongly grinding morphology. The crown is deep. The crown oral face is smooth and usually almost flat, without any transverse crest. In the holotype the oral face is slightly convex. The crown width/length ratio ranges from 1.4 to 1.05. The smaller ratio of 1.4 probably corresponds to anterolateral teeth and those near equant probably represent laterals (see CAPPETTA 1987). LIEB-PV 1600 presents a clear hexagonal contour, but the other well preserved teeth are rounded or even quadrangular in shape. The lower boundary of the enameloid is always smooth on all crown sides. The crown is broader at the level of the occlusal face than at the level of the collar and slightly overhangs the root (Fig. 3). There is no central uvula on the lingual face of the crown. There is a constriction all around the teeth in the collar.



**Fig. 4.** *Hypolophodon patagoniensis* sp. nov. LIEB-PV 1604: Ground section of an anterior tooth showing trabecular dentine in the crown. Scale bar equals 1 mm.

The root is deep, bilobate, with a well defined, narrow labiolingual groove. There is one foramen in the bottom of the labiolingual groove. Most specimens display numerous expanded basoapical foramina on all root faces (LIEB-PV 1600, 1602, 1603; see also BOGAN & GALLINA 2011, fig. 2).

One tooth was sectioned lengthwise (LIEB-PV 1604; see also BOGAN & GALLINA 2011). The root show large vascular spaces. The crown is mostly made up of trabecular dentine in the crown (Fig. 4). There is no pulp cavity. The upper part of the crown shows the distinct pattern of radiating dentine that defines the boundary between the clusters of orthodentine. We have not seen any structures in the enameloid.

#### 4. Discussion

The combination of a smooth and almost flat crown, smooth crown faces, the reduced width, the ratio between root and crown height, the single basal groove in root, the basoapical elongated foramina in the root separates the present material from other batomorphs such as fossil and extant Torpediniformes, Pristiformes, Rhiniformes, Rhynchobatiformes, Rajiformes, and Myliobatiformes and the extinct Sclerorhynchoidei, Platyrrhinidae, Distobatidae, Archaeonobatidae, Hypsobatidae, *Aegyptobatus*, *Myledaphus*, *Parapaleobates*, *Protoplatyrhina*, *Segmetia*, *Renpetia*, *Squatirhina*, and *Ptychotrygon* (extant taxa according to McEACHRAN et al. 1996; fossils according to CAPPETTA 1987, 1992; WERNER 1989; DELSATE & CANDONI 2001).

The material resembles species of the Cretaceous *Pseudohypolophus* and the Cretaceous-Eocene *Hypolophodon* genera. *Pseudohypolophus* includes the species *P. mcultyi* (CAPPETTA & CASE, 1975) and *P. ellipsis* CASE et al., 2001. The genus ranges in age from the Barremian to Maastrichtian of North America, Europe, and South America (BOURDON 1999b) and was considered to be *Rhinobatoidei incertae sedis* by CAPPETTA (1987). However, there are other opinions (see BOURDON 1999b). Reports from Europe include the Barremian of Teruel, Spain (KRIWET 1999). Reports from the United States include the Aptian to Cenomanian of North Carolina (CAPPETTA & CASE 1975) and Texas, United States (WELTON & FARISH 1993), the Turonian of Nebraska and Kansas, United States (KIRKLAND 1989; EVERHART et al. 2003; STEWART & MARTIN 1993), the Santonian-Campanian of Mississippi (MANNING & DOCKERY 1992), Santonian of Alabama (MEYER 1974), Campanian of New Jersey (LAUGINGER 1986), Georgia (SCHWIMMER 1986), and North Carolina (ROBB 1989, as *Rhombodus levis*), and the Maastrichtian of Maryland (HARTSTEIN et al. 1999).

*Hypolophodon* is assigned here to an indeterminate family of Myliobatiformes. Several putative species of *Hypolophodon* were recognized. The species *Hypolophodon sylvestris* (WHITE 1931) was reported from the Danian of New Jersey (THE PALEOBIOLOGY DATABASE 2008) and Belgium (HERMAN 1975), Thanetian of northwestern United States (CVANCARA & HOGANSON 1993), the Thanetian and lower Eocene of England, Belgium, and France (KEMP et al. 1990; BAUT & GENAULT 1995; DUTHEIL et al. 2002), the lower Eocene of the Chesapeake region, United States (KEMP et al. 1990; BOURDON 1999a, b), the middle Eocene of Virginia, United States, and Uzbekistan (WILLIAMS 1999; CASE et al. 1996). *Hypolophodon dockery* (CASE, 1994), was formerly assigned to genus *Platyrhina* and it is only known from the early Eocene Bashi Formation of Mississippi (CASE 1994). Another species referred to *Hypolophodon*, *H. malembensis*, from the Eocene and Miocene of Africa, does not appear to belong to the genus (see MURRAY et al. 2010).

The Patagonian material resembles the Cretaceous genus *Pseudohypolophus* on the smooth occlusal crown surface, absence of uvula on the lingual face of the crown, and the lower boundary of the enameloid usually not irregular on any crown face. However, it clearly differs in the crown being broader at the level of the oral surface than at the level of the collar and not overhanging strongly the root, in having numerous apicobasally elongated foramina on all the crown

faces, and because there is no pulp cavity.

The Patagonian material resembles the genus *Hypolophodon* in its size, the crown being broader at the level of the oral face than at the level of the collar and not overhanging strongly the root, and especially, by its histology. CAPPETTA (1987) and JOHNSON & LUCAS (2002) indicated that histology is a fundamental character for distinguishing *Pseudohypolophus* from *Hypolophodon*.

*Hypolophodon patagoniensis* differs from the Paleocene and Eocene species *H. sylvestris* in several features: the absence of an occlusal transverse crest on the crown of unworn teeth and of a broad and rounded central uvula on the lingual face of the crown; in the presence of the lower boundary of the enameloid smooth on all faces (see for example, teeth of *H. sylvestris* with blunt and broad vertical folds in the base of enamel in CAPPETTA (1987, fig. 140C) and KEMP et al. (1990, pl. 10, fig. 11), the numerous basoapically elongated striae on all faces of the root (not only on the lingual one as in *H. sylvestris*), and the deeper root. It also differs from the putative Eocene species *H. dockery* in the larger size, the less widely separated root branches, the presence of root foraminae or striae, the absence of uvula, the deeper crown (see CASE 1994).

In northern Patagonia, from Maastrichtian beds of the Jagüel Formation, BOGAN & AGNOLIN (2010) identified a tooth as cf. *Pseudohypolophus mcultyi*. The following year, BOGAN & GALLINA (2011) reported this specimen plus a new one to *Hypolophodon sylvestris*. We assign both teeth to *Hypolophodon patagoniensis* on the basis of their morphology. In Chile, MUÑOZ et al. (2007) had figured a specimen under the name of Dasyatidae indet. (mentioning the similarity to *Hypolophodon* teeth) from putative upper beds of the Quiriquina Formation (Late Cretaceous). The material clearly belongs in *Hypolophodon*. CARLOS MUÑOZ (2008, pers. comm.) presently believes that these beds are Cenozoic in age.

*Pseudohypolophus* had been reported from Barremian to Maastrichtian strata and *Hypolophodon* from latest Maastrichtian to Eocene strata. Both genera present a grinding-type dentition as adaptation to hard-shelled prey (KRIWET & BENTON 2004). *Pseudohypolophus* became extinct along numerous other taxa with grinding dentitions (*Hypsobatis*, *Pucabatis*, *Rhombodus*, and *Youssoubatis*) at the end of the Cretaceous and was replaced by other taxa with the similar adaptations (e.g., *Hypolophodon*, *Hypolophites*, *Myliobatis*) (CAPPETTA 1992; KRIWET & BENTON 2004). Remarkably, the report of *Hypolophodon* from the Jagüel



**Fig. 5.** Geographic distribution of *Pseudohypolophus mcnulty* (black circles), *Hypolophodon sylvestris* (star), *Hypolophodon dockery* (square), *Hypolophodon* sp. of Chile (triangle), and *Hypolophodon patagoniensis* sp.nov. of Chubut and Río Negro (arrows).

Formation (BOGAN & GALLINA 2011) is the sole record of the genus from Cretaceous beds. The occurrence of the genus before the great extinction of the K-P boundary is curious.

Species of *Pseudohypolophus* and *Hypolophodon* inhabited shallow waters. However, we do not know if also occupied deeper waters. Other than one doubtful report from relatively low latitude areas (CAPPETTA 1987), *Hypolophodon* appears to have been restricted to middle palaeolatitudes (Fig. 5). It has not been reported from neither equatorial nor polar areas. The Patagonian and Chilean material are the sole records of *Hypolophodon* from the Southern Hemisphere. The southern South American specimens might indicate that the genus would have a bipolar distribution, with one or two northern species and one southern species.

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