

## CALLOVIAN NAUTILOIDS FROM THE NEUQUÉN BASIN, ARGENTINA

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**Abstract:** For the first time Callovian nautiloids from the Neuquén Basin (Argentina) are described. All the material was collected with precise stratigraphic control based on the local ammonite successions. Most specimens belong to *Cenoceras* sp. A from the Lotena Fm at Picún Leufú (Patagoniensis Z., lower Upper Callovian) and Los Molles Fm at Chacay Melehué (Proximum Z., upper Lower Callovian). Additionally, one specimen assigned to *Cenoceras* sp. B comes from the Lotena Fm at Picún Leufú (Patagoniensis Z.). Jurassic nautiloids are usually scarce all around the world with respect to ammonites, but in the Neuquén Basin they are very scarce. Our collections of cephalopods have produced some fifteen nautiloids besides more than 5.000 ammonites collected in Late Callovian to Late Tithonian sequences of the Neuquén Basin. This asymmetric pattern of abundance is surely based, at least in part, on the different reproductive strategies of ammonoids and nautiloids.

**Keywords:** Neuquén Basin ▪ Middle Jurassic ▪ Callovian ▪ Nautiloids ▪ *Cenoceras*.

**Resumen.- Nautiloideos callovianos de la Cuenca Neuquina, Argentina.** Por primera vez se describen nautiloideos callovianos de la Cuenca Neuquina (Argentina). La mayoría de los especímenes, determinados como *Cenoceras* sp. A, provienen de niveles de la Fm Lotena en Picún Leufú atribuidos a la Zona Patagoniensis (Caloviano Superior bajo) y niveles de la Fm Los Molles en Chacay Melehué atribuidos a la Zona Proximum (Caloviano Inferior alto). Adicionalmente, un espécimen determinado como *Cenoceras* sp. B proviene de niveles de la Fm Lotena atribuidos a la parte alta de la Zona Patagoniensis. Los nautiloideos jurásicos son escasos con respecto los amonites, y en la Cuenca Neuquina son muy escasos. Nuestras colecciones de cefalópodos del intervalo Caloviano Superior-Tithoniano de las secuencias de la cuenca incluyen unos quince nautiloideos frente a mas de 5000 amonites. Este patrón de abundancia tan asimétrico estaría muy probablemente originado, al menos en parte, en las estrategias reproductivas antagónicas que presentan estos grupos.

**Palabras clave:** Cuenca Neuquina ▪ Jurásico Medio ▪ Caloviano ▪ Nautiloideos ▪ *Cenoceras*.

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## INTRODUCTION

Jurassic Nautilida have much importance from an evolutionary point of view considering the great extinction in this group of cephalopods at the end of the Triassic (Kummel 1956). During Jurassic times, they slowly increased in diversity and, apparently, abundance, giving rise to the supposedly monophyletic Nautilina (the so-called post-Triassic nautiloids). In particular, *Cenoceras* Hyatt is a key genus in this scenario. However, most taxonomists agree that its systematics is complex (e.g. Dzik 1984, Tintant 1984, Rulleau 2008, King 2011), mainly due to the few morphologic variations through the lineages.

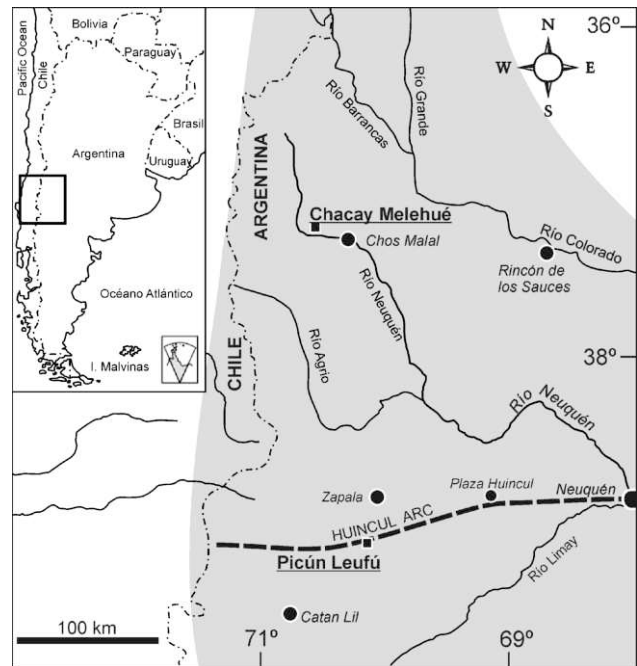
Jurassic nautiloids are known in South America almost exclusively by the Tithonian *Cymatoceras perstriatum* (Steuer, 1897), e.g. Gerth (1925), Weaver (1931), recently reviewed by Cichowolski (2003). This situation of great scarcity, especially respect to ammonites so abundant in the Neuquén Basin, seems to be a world-wide phenomenon. It was already pointed out by Kummel (1954: 320) who noted that "Nautiloids from the Jurassic formations are very uncommon fossils". This author related it with the Triassic extinction event.

In the last years, the authors have gathered an interesting collection of Callovian, Tithonian and Berriasian nautiloids from different localities of the Neuquén Basin. However, it is worth to note that among more than 5.000 ammonites collected in several localities of the basin, there were found only some fifteen nautiloids. In the present study, we describe three specimens from the Andean Upper Callovian Patagoniense Zone of Picún Leufú and two other ones from the upper Lower-Middle Callovian Proximum-"Jason" zones of Chacay Melehué. Their relatively poor preservation prevents specific identifications, but their occurrence is important considering the lack of previous records of Callovian representatives in the Neuquén Basin. The Callovian-Oxfordian chronostratigraphic zone scale of Parent & Garrido (2015) is adopted herein.

## GEOLOGICAL SETTING

The specimens come from two localities (see Fig. 1): (1) Picún Leufú, southern end of the Neuquén Basin, south of the Huincul Arc, from the upper part of the Lotena Fm (Fig. 2A), assigned to the lower Upper Callovian Patagoniense Zone (Garrido & Parent 2013), and (2) Chacay Melehué, central part (depocentre) of the Neuquén Basin, from the uppermost part of the Los Molles Fm (upper Lower-lower Middle Callovian, Proximum-"Jason" zones). The geology of this area has been dealt in variable detail by several authors (e.g. Herrero-Ducloux & Leanza 1943, Groeber 1952, Leanza 1973 and references therein). The log-section of the upper Los Molles Fm in Chacay Melehué is shown in Fig. 2B.

The outcrops of the Lotena Fm in Picún Leufú consist of a 30 to 50 m thick succession composed of mudstones and silty mudstones, with thin intercalations of limestone and fine-grained sandstone. In these thin banks occur the nautiloids described below; ammonites are moderately abundant (Fig. 2A). The age of the Lotena Fm in this area is Late Callovian, Patagoniense Zone (Parent 2006). All along the section we have collected an interesting ammonite fauna typical of this zone (see Garrido & Parent 2013), composed of *Hecticoceras* cf. *lairensis* (Waagen, 1875), *Rehmannia patagoniensis* (Weaver, 1931), *Choffatia* cf. *isabellae* Bonnot et al., 2008, *Alligaticeras?* aff. *raguini* (Gerard & Contaut, 1936), and *Binatisphinctes* sp. A. The lower occurrence of nautiloids in the silty mudstone beds consists of *Cenoceras* sp. A (Figs. 2A, 3B),



**Figure 1.** Location of the sampled localities in the Neuquén Basin (gray area) superimposed on a Recent geography.

whereas the upper occurrence in the mudstone levels consists of the single specimen described below as *Cenoceras* sp. B (Figs. 2A, 4).

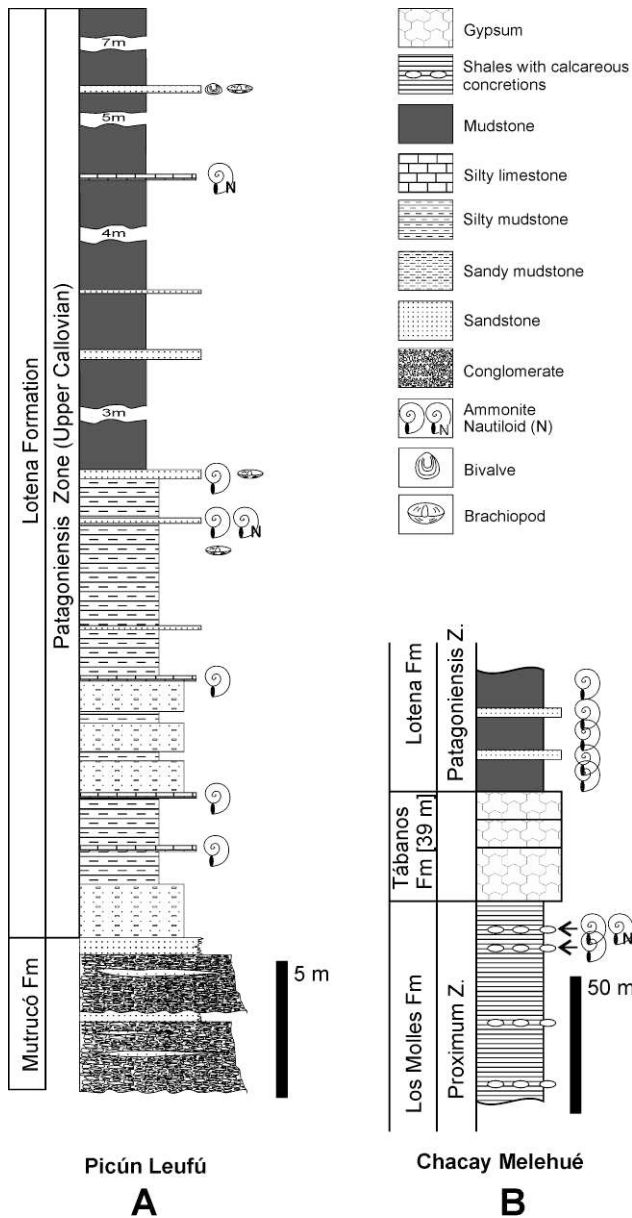
In the studied section of Chacay Melehué, the uppermost 30 m of the Los Molles Fm, where our specimen comes from, consists of black shales with levels of calcareous concretions containing abundant and well-preserved ammonites (Fig. 2B). The fauna collected from these levels is in its most part new and currently under study. Two fossiliferous levels are indicated in Fig. 2B: (1) the uppermost level, at 9.7 m below the contact of the Los Molles and Tabanos formations, yielded *Cenoceras* sp. A (Fig. 3A) and the ammonites *Araucanites?* n. sp., *Hecticoceras proximum* Elmi, *Hecticoceras* n. sp., and *Rehmannia paucicostata* (Tornquist); (2) the lower level, 14 m below the contact, yielded *Choffatia* sp. or spp. The cited ammonites indicate a stratigraphic position within the interval Proximum-lower "Jason" zones (see Riccardi & Westermann 1991, Parent & Garrido 2015: fig. 38).

## SYSTEMATIC PALAEOLOGY

The specimens are stored in the Museo Provincial de Ciencias Naturales "Prof. Dr. Juan A. Olsacher", Zapala (MOZ-PI). The dimensions of the specimens are indicated as follows: *D*: shell diameter, *U*: umbilical diameter, *W*: maximum septal width, *H<sub>1</sub>*: maximum septal height, *H<sub>2</sub>*: apertural septal height. The determinations are left in open nomenclature mainly due to the poor or incomplete preservation of the specimens.

**Class Cephalopoda Cuvier, 1797**  
**Order Nautilida Agassiz, 1847**  
**Family Nautilidae De Blainville, 1825**  
**Genus *Cenoceras* Hyatt, 1883**

Type species: *Nautilus intermedius* Sowerby, 1816; by original designation



**Figure 2.** A. Log-section of the Mutrucó and Lotena formations in Picún Leufú summarized from Garrido & Parent (2013), with indication of the occurrences of ammonites and nautiloids (lower occurrence: *Cenoceras* sp. A.; upper occurrence: *Cenoceras* sp. B). B: Log section of the topmost part of the Los Molles Fm, Tábanos Fm (total thickness 39 m), and basal part of the Lotena Fm (which is 85 m in total thickness), with indication of the occurrences of ammonites and nautiloids (*Cenoceras* sp. A). – Note the very different scales.

***Cenoceras* sp. A**  
Fig. 3

**Material.**- Two large adults with phragmocone and part of bodychamber (MOZ-PI 3556/1-2) from Chacay Melehué, Los Molles Fm, Proximum Z., upper Lower-lower Middle Callovian. A phragmocone, internal mould (MOZ-PI 7836) from Picún Leufú, Lotena Fm, Patagoniense Zone, Upper Callovian.

**Description.**- Large; maximum preserved diameter (estimated)  $D = 200$  mm, last septum at about  $D = 150$  mm. Bodychamber narrowly umbilicated, whorl section subrectangular ( $W/H_1 = 0.90$ ) with indistinct umbilical margin,

flattened flanks, and widely rounded venter. Phragmocone, at  $D = 40-70$  mm, slightly more inflate ( $W/H_1 = 1.06$ ), moderately evolute ( $H_2/H_1 = 0.60$ ), umbilicus relatively wide ( $U/D = 0.13$ ) with indistinctly rounded margin; whorl section suboval to subtrapezoidal with high, flattened flanks. Septal suture line slightly sinuous. Sculpture is not preserved.

**Remarks.**- The phragmocone in Fig. 3B could be compared with that from the upper? Callovian of Chari (India) figured by Spath (1927-1933: pl. 2: 1) as *Paracenoceras* cf. *calloviense* (Oppel). Also similar is the specimen from the lower? Callovian of Jumara figured by Waagen (1875: pl. 3: 2, later refigured by Spath 1927-1933: pl. 3: 5) as *Nautilus calloviense*. Complete adult specimens with preserved bodychamber are quite rare in the literature, furthermore most Jurassic species and genera are based on phragmocones only.

***Cenoceras* sp. B**  
Fig. 4

**Material.**- A well-preserved phragmocone and a portion of whorl of a large specimen (MOZ-PI 7265/1-2) from Picún Leufú, Lotena Fm, Patagoniense Zone, lower Upper Callovian.

**Description.**- Innermost (embryonic) whorl ( $D = 20-25$  mm) inflate, rounded subtriangular in whorl section with narrow venter. Outer whorls globose and involute; whorl section suboval with rounded umbilical margin and widely rounded venter. The sculpture is well preserved only on the innermost whorl, and consists of two elements which form a conspicuous reticulate pattern: (1) sharp, narrow rursiradiate ribs, and (2) well defined, fine, parallel spiral lirae radiating away from the apex. The siphon at  $D > 35$  mm is subdorsal, placed at about two thirds the apertural height from the venter. Septal suture line slightly sinuous.

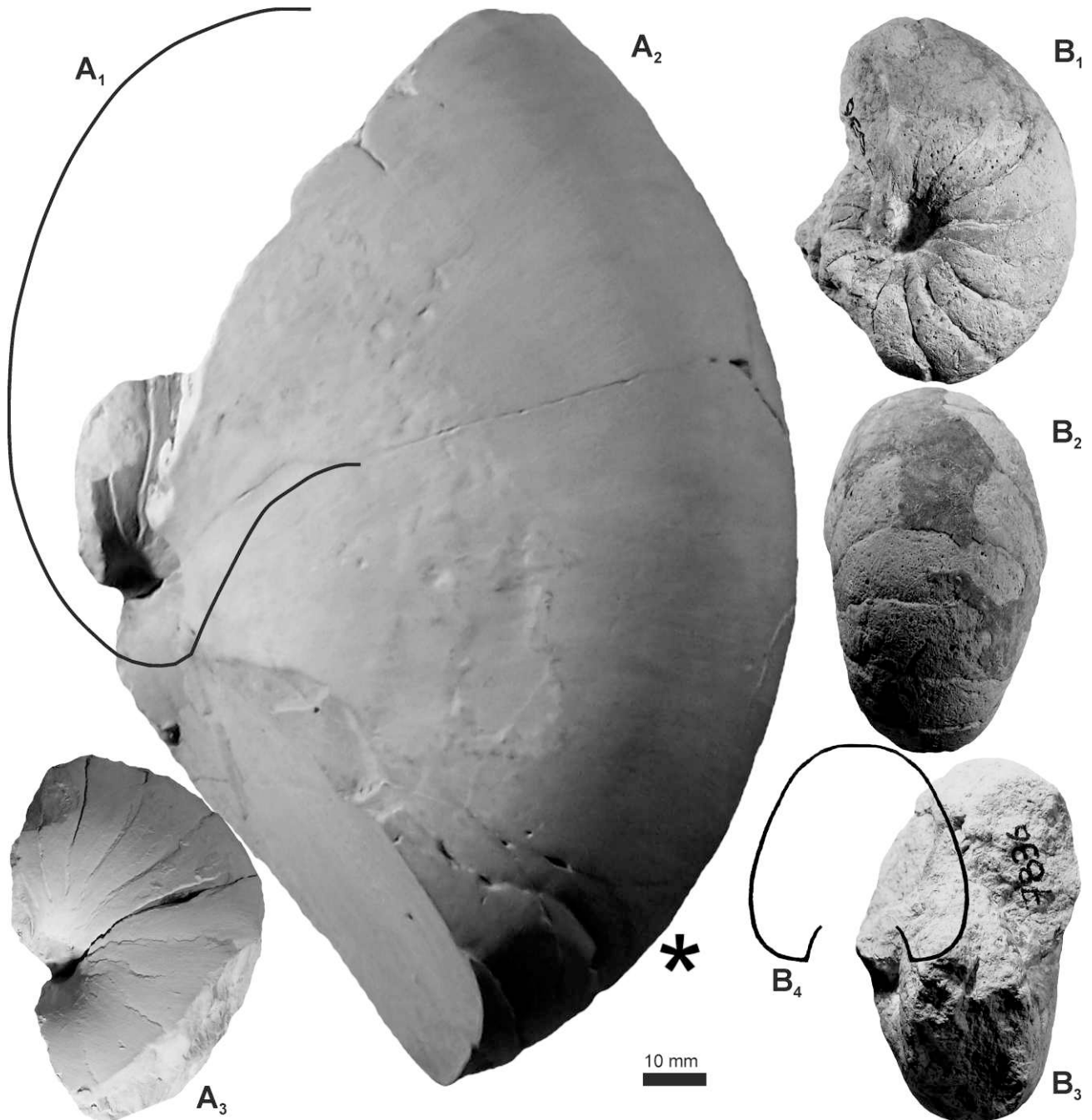
**Remarks.**- This specimen shows some resemblance with "*Eutrephoceras*" *montanense* Kummel, 1954, which seems to be Callovian in age.

**DISCUSSION**

The nautiloids from Picún Leufú were collected from two different horizons. One of the specimens, *Cenoceras* sp. B (Fig. 4), was collected in isolation in the upper part of the Lotena Fm. Two of the specimens of *Cenoceras* sp. A (Fig. 3B) come from a level where ammonites co-occur. In Chacay Melehué the studied specimens (Fig. 3A) were collected from a single horizon, associated with numerous ammonites, even relatively large fragmentary hecticeratids were found within the bodychamber of the largest specimen (not figured). Considering the absence of published records of Callovian nautiloids in western South American, it is not possible to advance a detailed discussion of the implications of the present records.

Chirat & Rioult (1998) have concluded that Jurassic nautiloids have preferred habitats in stable cratonic areas with hard substrate and low sedimentation rates in warm and well-oxygenated seawaters. The rocks of the Lotena Fm, from where the nautiloids were collected in Picún Leufú, indicate a position on the inner platform, under oxygenate conditions and low influx of terrigenous sediments (Garrido & Parent 2013).

In Europe and India the nautiloids seem to have expanded

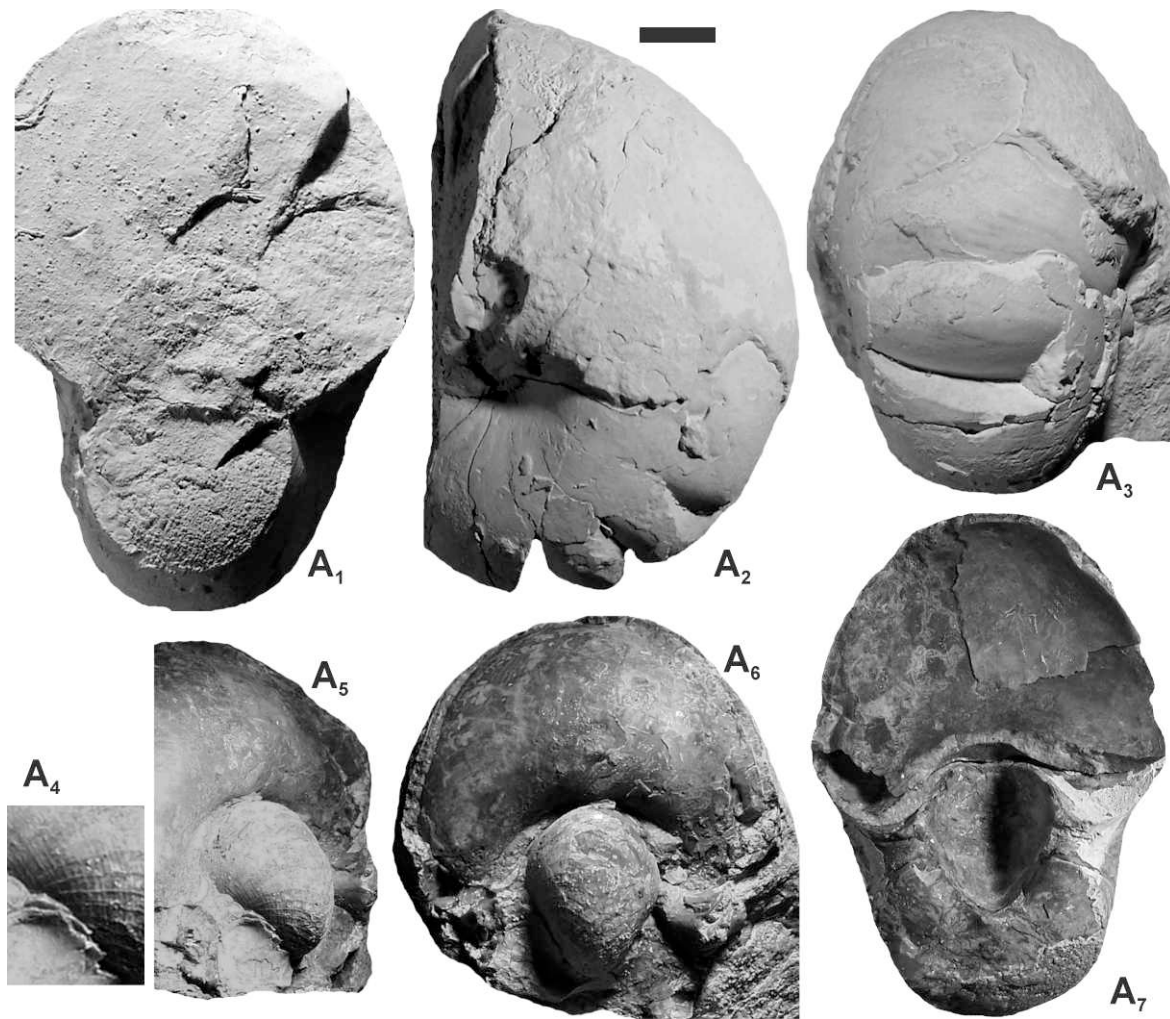


**Figure 3.** *Cenoceras* sp. A., Callovian, Neuquén Basin, Argentina. **A:** Almost complete adult specimen (MOZ-PI 3556/1) from Chacay Melehué, uppermost Los Molles Fm., Proximum-"Jason" zones, upper Lower-lower Middle Callovian; **A<sub>1</sub>**: whorl section drawn at the beginning of the body chamber (asterisk in **A<sub>2</sub>**); **A<sub>2</sub>**: lateral view of the specimen; **A<sub>3</sub>**: inner whorls removed for showing the flanks and suture. **B:** Phragmocone (MOZ-PI 7836) from Picún Leufú, Lotena Fm., Patagoniensis Z., lower Upper Callovian. Standard lateral (**B<sub>1</sub>**), ventral (**B<sub>2</sub>**) and apertural (**B<sub>3</sub>**) views; **B<sub>4</sub>**: whorl section at the apertural view. All in natural size (x1).

more widely than in other regions, being relatively abundant and diverse since the Early Jurassic (e.g. Spath 1927, Kummel 1964, Calzada 1988, Branger 2004, Rulleau 2008, King 2011). In south-western Gondwana the occurrences of these cephalopods appear to have been scarce and scattered. To our knowledge, there are no records of nautiloids from the extensive marine Lower Jurassic outcrops of the Neuquén Basin. This basin is widely known as having one of the world-wide most important outcrops, mainly Mesozoic, being a reservoir of hydrocarbons and therefore deeply studied from a geological and stratigraphical point of view (e.g. Digregorio & Uliana 1980, Uliana & Biddle 1988, Legarreta & Gulisano

1989, Uliana et al. 1989, Uliana & Legarreta 1993, Urien & Zambrano 1994, Vergani et al. 1995, Howell et al. 2005, among others). Therefore, it is worth to note the almost absence of Jurassic Nautilida in this region. Moreover, the ammonoid fauna of the Jurassic of this basin is abundant and diverse, in many aspects directly comparable to that of the Tethys, being more noticeable the almost absence of nautiloids. In the Lower Cretaceous, on the other hand, the ammonoid fauna is less diverse than that of the Tethyan region, but nautiloids, although monospecific, may locally occur in abundance (Cichowolski 2003, Cichowolski et al. 2013).

The asymmetric pattern of abundance of nautiloids versus



**Figure 4.** *Cenoceras* sp. B. (MOZ-PI 7265) from Picún Leufú, Lotena Fm., Patagoniense Zone, lower Upper Callovian. Standard apertural ( $A_1$ ), lateral ( $A_2$ ) and ventral ( $A_3$ ) views;  $A_4$ : enlarged view (x2) of the sculpture of the innermost (embryonic) whorl shown in  $A_2$ - $A_3$ , with the outer whorl ( $A_7$ ) removed. All in natural size (x1) except  $A_4$  (x2). The scale bar indicates 10 mm for all except for  $A_4$  (5 mm).

ammonoids can be attributed, among other factors, to their very different reproductive strategies (see Landman 1987, Landman et al. 1996, Stephen & Stanton 2002, Laptikhovskiy et al. 2013, Lukeneder 2015). Ammonoid reproductive strategy must have been based on thousands of small eggs per batch as undoubtedly indicated by their protoconch size range, producing large masses of mainly planktic to nektonic or demersal juvenile individuals (e.g. Westermann 1996 and references therein) which, depending the species, passed to different positions in the water column. In contrast, and as in living *Nautilus*, Jurassic nautiloids must have based their reproductive strategy in much larger eggs laid in batches of few individuals, beginning their development in benthic habitats and probably migrating through ontogeny to demersal or nektonic habitats. Interestingly these differences seem to explain not only the asymmetry of the patterns of abundance, but also the much more diversified biomes and biotas of ammonoids, which show morphologic evolutionary changes faster than nautiloids.

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