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The earliest ammonite faunas from the Andean Tithonian of the Neuquén-Mendoza Basin, Argentina – Chile

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With 7 figures

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Abstract: A succession of two ammonite faunas is reported from basal beds of the Upper Jurassic Vaca Muerta Formation of the Neuquén-Mendoza Basin in Argentina. The bulk of them consists of perisphinctids which are morphologically similar to forms described from Mexico and Europe. Especially the lower fauna ('Fauna A') occurs at various localities of the basin in Argentina and Chile, but a correlation with areas outside the Andean Realm is very difficult due to endemism. The strata containing the ammonite faunas are supposed to be early Tithonian in age.

Zusammenfassung: Eine Abfolge zweier Ammonitenfaunen wird aus den basalen Schichten der Vaca Muerta-Formation im Neuquén-Mendoza-Becken von Argentinien beschrieben. Die Faunen enthalten vorwiegend Perisphinctiden, die morphologisch Arten aus Mexiko und Europa nahe stehen. Insbesondere die tiefere Fauna ("Fauna A") findet sich an verschiedenen Lokalitäten des Beckens in Argentinien und Chile wieder, aber eine Korrelation mit Regionen außerhalb der Anden-Provinz bereitet aufgrund von Endemismus erhebliche Schwierigkeiten. Die Schichten mit den Ammonitenfaunen werden dennoch vorläufig als unter-tithonisch angesehen.

1. Introduction

It has long been held that the Neuquén-Mendoza Basin was flooded suddenly during the Early Tithonian after a relatively long period of continental regime (GROEBER 1952). The basin was unconnected from the Pacific Ocean during most of the Kimmeridgian. The rocks related to the flooding event are placed biostratigraphically into the *Mendozanus* Biozone of the Andean

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Lower Tithonian. This biostratigraphic unit was originally described by BURCKHARDT (1900) based on successions in the western Mendoza Province (see LEANZA 1980, 1981). Later GROEBER (1946, 1952) proposed an alternative biozonation which was only used in few papers (e.g. LEANZA 1973). Time-correlation of the *Mendozanus* Biozone with the Darwini Zone of the Tethyan Standard Scale (GEYSSANT 1997) was explicitly proposed by ZEISS (1968) and followed by LEANZA (1980, 1981). OLÓRIZ & TAVERA (1989: fig. 2) suggested a correlation with the late Hybonotum – early Darwini zones. In Casa Pincheira, Mendoza (Fig. 1A), the base of the *Mendozanus* Biozone was dated recently as Hybonotum Zone (PARENT & CAPELLO 1999) on the basis of the occurrence of an ammonite closely resembling "*Lithacoceras*" *malarguense* (SPATH, 1931). This species looks closest to submediterranean *Lithacoceras*, especially to *Lithacoceras eigeltingense* OHMERT & ZEISS, 1980 (subjective synonym: *Lithacoceras acricostatum* OHMERT & ZEISS, 1980 – both taxa were originally placed in different subgenera, but they apparently exhibit the ribbing style typical of *Lithacoceras* s. str., see SCHWEIGERT & ZEISS 1999) and related forms from the earliest Tithonian of Europe. Very similar ammonites occur in Mexico named as "*Lithacoceras*" *mexicanus* (BURCKHARDT, 1906); for more details see CALLOMON (1992), VILLASEÑOR et al. (2000), and PARENT (2003).

New material collected during the last years has shown the occurrence of the same ammonite morphologically very close to "*L.*" *malarguense* (SPATH) in the basal beds of the Vaca Muerta Formation, just overlying the continental rocks of the Tordillo Formation. This can be observed not only in Casa Pincheira but in several other localities of the Neuquén-Mendoza Basin: Picun Leufú, La Amarga, Portada Covunco, and Pampa Tril (Fig. 1A-B). In the present communication we give a brief account of this early Tithonian fauna which was first described with material from Casa Pincheira (PARENT 2003).

The figured specimens are deposited in the Museo Olsacher of Zapala, Neuquén (MOZP) and the Laboratorio de Paleontologia, Universidad Nacional de Rosario (LBP).

2. Stratigraphic framework

The Andean Kimmeridgian is mainly represented by the Tordillo Formation (Fig. 1B), consisting of continental to fluvial sandstones and conglomerates

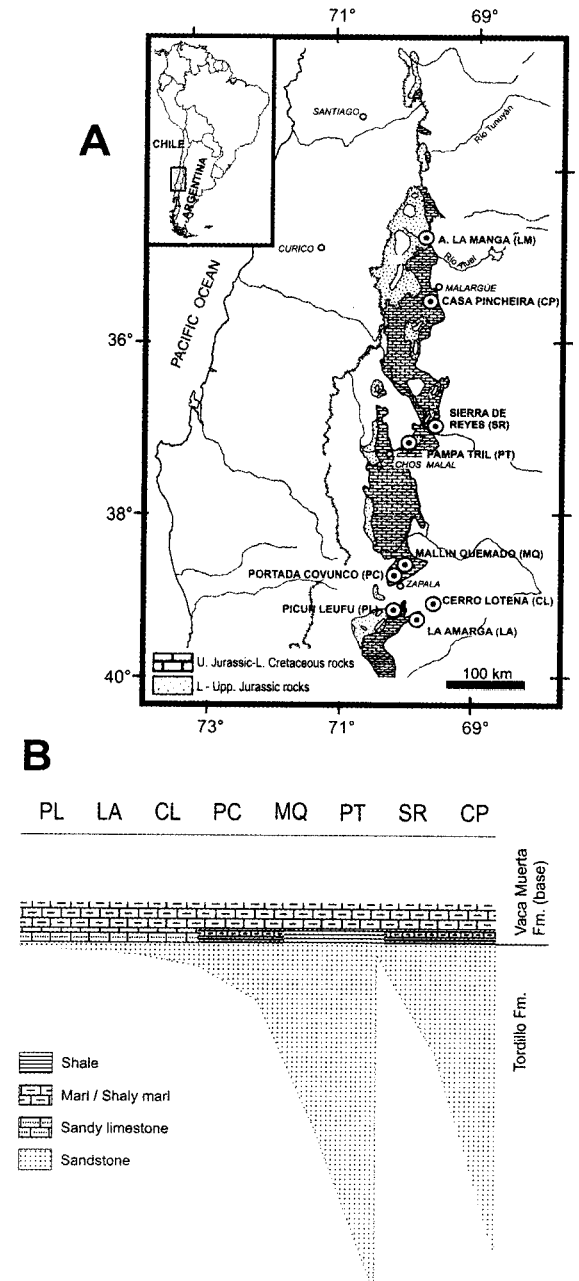

Fig. 1. A: Geographic location of the localities cited in text. **B**: Main lithology of the lower Tithonian throughout the Neuquén-Mendoza Basin, indicating broader facial changes (approximated scale). Names of localities as abbreviated in the map (A).

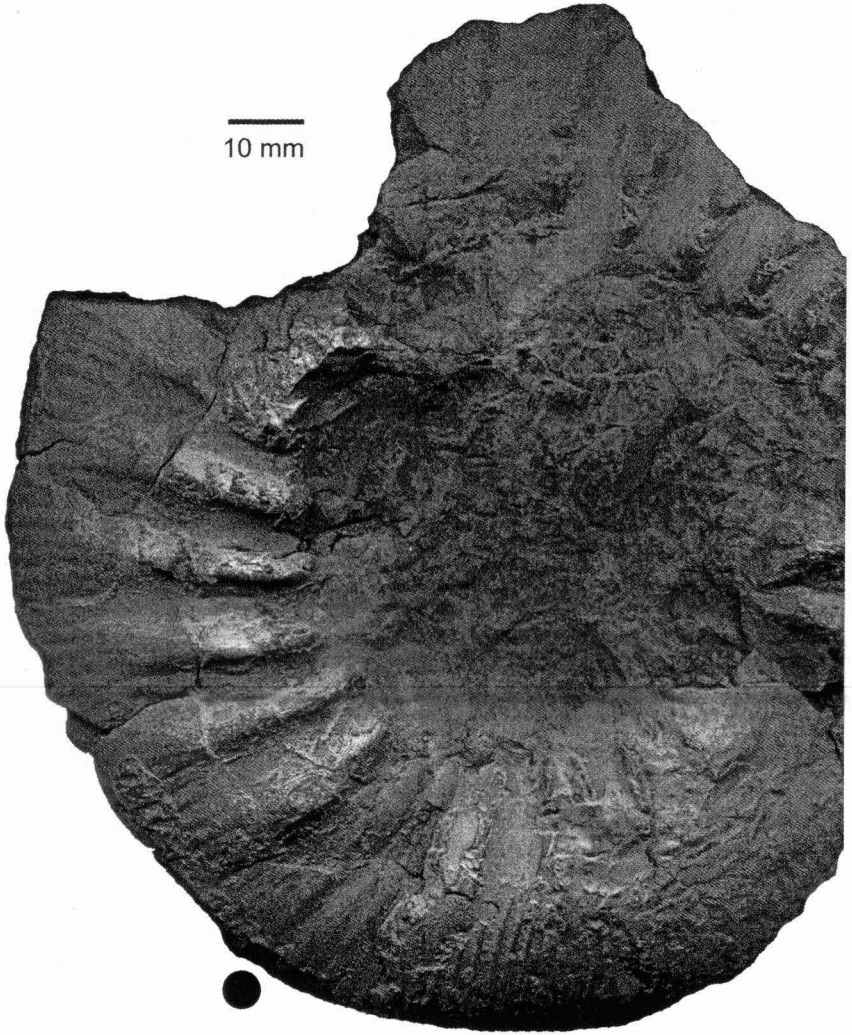

Fig. 2. "*Lithacoceras*" n. sp. aff. *malarguense* (SPATH, 1931); adult macroconch with incomplete bodychamber (MOZP 6390); Picún Leufú, Lower Tithonian, *Mendozanus* Biozone, Fauna A. Natural size (× 1), point marks last septum.

throughout the entire basin. Above this lithostratigraphic unit follows concordantly the Vaca Muerta Formation consisting of shales, marls and limestones (see MARCHESE 1971, LEANZA 1981). The Andean early Tithonian rocks belong to the base of the Vaca Muerta Formation, and are included in the *Mendozanus* Biozone all throughout the Neuquén-Mendoza Basin. The lowermost beds attributed to this biozone contain a characteristic ammonite assemblage (Fauna A). These beds consist of about one meter of sandy limestones at Picun Leufú and Casa Pincheira, few centimeters of sandstones at La Amarga and Cerro Lotena, and less than one meter of shales and marls at Portada Covunco and Pampa Tril. The ammonites (Fauna A) recorded from sandstone lenses in La Amarga and Cerro Lotena are poorly preserved, but they are well preserved and abundant in the other localities, where they have been previously overlooked by most authors. Above these beds the lithology becomes more homogeneous, consisting of dark grey to black marls and limestones. In the lower 3-5 meters of the Vaca Muerta Formation in some localities occurs another ammonite assemblage (Fauna B).

2.1. Fauna A

"*Lithacoceras*" n. sp. aff. *malarguense* (SPATH, 1931) [M & m] (Figs. 2, 3A-B): This ammonite resembles a lithacoceratid, typically evolute, with subovaI to subrectangular whorl section. The ribbing follows, in the macroconch, the typical ontogenetic sequence of the genus: bipartite primaries on inner whorls passing to facipartite – virgatotome units on the last whorl of the adult phragmocone, with thickened primaries and palmate secondaries on the middle or upper third of flanks of the adult bodychamber. Adult macroconchs have a rather uniform diameter of about 150-200 mm in all studied sections. The microconch is smaller and lacking the terminal facipartite – virgatotome ribbing stage of the macroconchs, and it bears lateral lappets.

This species was recently described as "*Euvirgalithacoceras malarguense*" by PARENT (2003) but the abundant newly collected material has shown us that it actually does not belong to *Subplanites malarguensis* SPATH, 1931, but to a new species which is widely and abundantly recorded through the entire Neuquén-Mendoza Basin. SPATH (1931) introduced *S. malarguensis* for an ammonite originally described and figured as *Perisphinctes* aff. *pseudolictor* CHOFFAT by BURCKHARDT (1903, pl. 4, figs. 1-6) and BURCKHARDT (1900, pl. 24, fig. 4). These forms could either belong to *Lithacoceras* or to a new, homoeomorphic genus although its microconch (Fig. 3B) could be well assigned to *Silicisphinctes* SCHWEIGERT & ZEISS, 1999, which represents the antidimorph of *Lithacoceras* HYATT, 1900. In contrast, it clearly differs from *Subplanites* SPATH, 1925, by a denser ribbing style, showing more blunt ribs, and a much smaller size.

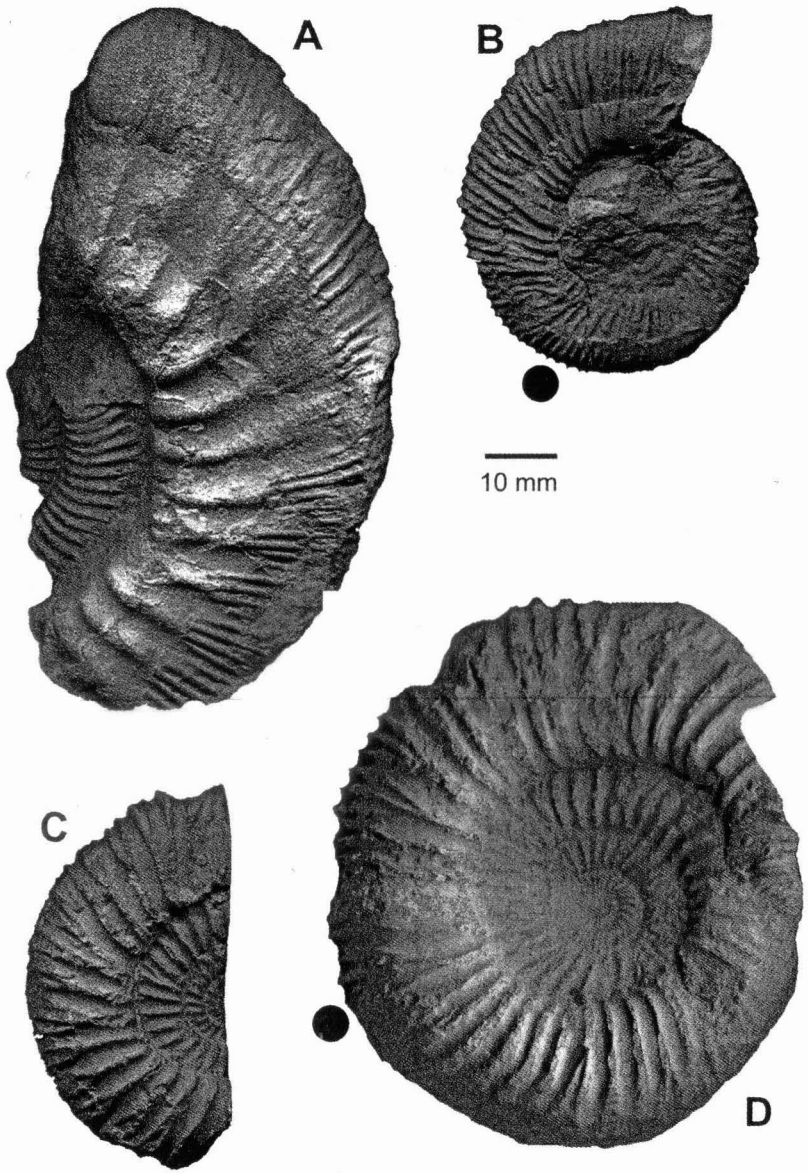

Fig. 3. A-B: "*Lithacoceras*" n. sp. aff. *malarguense* (SPATH, 1931), **A**: adult macroconch with portion of bodychamber (MOZP 7338), **B**: complete microconch with lappets (MOZP 7305). **C-D**: "*Torquatisphinctes*" cf. *mendozanus* (BURCKHARDT, 1911), **C**: juvenil phragmocone (MOZP 7404), **D**: adult macroconch with almost complete bodychamber (LPB 623/1). All specimens from Picún Leufú, Lower Tithonian, *Mendozanus* Biozone, Fauna A. Natural size (× 1), point marks last septum.

"*Torquatisphinctes*" cf. *mendozanus* (BURCKHARDT, 1911) [M & ?m] (Fig. 3C-D): This form is a serpenticone perisphinctid, very evolute, with a subrectangular to subcircular whorl section. The ribbing is rather simple, strong and not very dense. Strong primaries are slightly prosocline, arising from the umbilical seam and bifurcating on the upper half to the upper third of flanks. Triplicates and dischizotomous secondaries occur, sometimes preceding more or less wide and deep constrictions. The aperture of the macroconchs is not preserved in any of the studied specimens. A single specimen, smaller (D = 58 mm), with the same ribbing and bearing lappets, is most likely the corresponding microconch. The largest adult macroconch with slightly uncoiled and coarsely ribbed bodychamber reaches a diameter of about 100 mm.

Choicensisphinctes cf. *windhauseni* (WEAVER, 1931: 425, pl. 48, figs. 324-325 [as *Virgatosphinctes windhauseni* WEAVER n. sp.] ; non *Aulacosphinctes windhauseni* WEAVER n. sp., p. 412, pl. 44, fig. 300) [M & ?m] (Fig. 5A-B): It is a compressed discoidal ammonite, moderately involute, with a subrectangular to subtrapezoidal whorl section. Its ribbing style is fascipartite. In the phragmocone the ribbing is fine and dense, prosocline, polyfurcating, with the division point situated about the mid-flank. On the adult body-

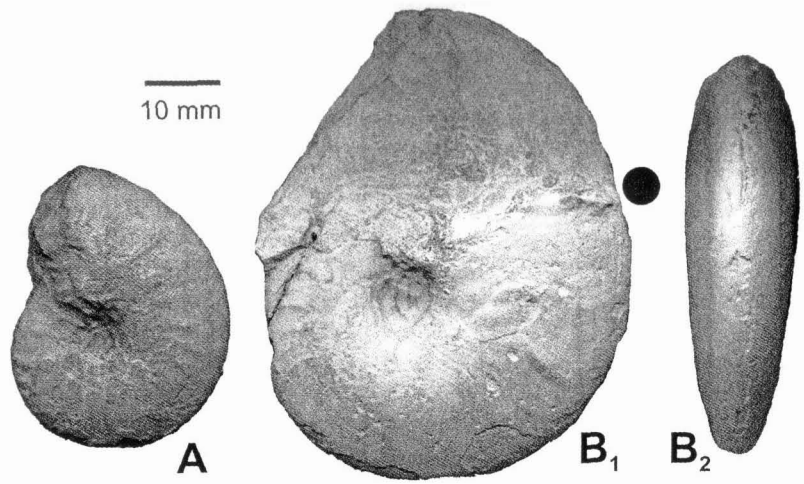

Fig. 4. A-B: "*Neochetoceras*" sp., **A**: juvenile specimen (MOZP 7208), **B_1**, **B_2**: adult macroconch with portion of bodychamber (MOZP 7211); Pampa Tril, Lower Tithonian, *Mendozanus* Biozone, Fauna A. All natural size (× 1), point marks last septum.

chamber (not figured) the primary ribs become stronger and more distant. These ribs bifurcate only exceptionally, and they are reinforced on the umbilical shoulder, tending to vanish from the upper third of the flanks towards the venter. The probable microconch differs not only by its smaller adult size (no lappets are preserved in our material) but also for the ribbing on the bodychamber, which is composed of strong acute primaries irregularly dividing into two or three secondaries, and intercalated ribs between the secondaries. The diameters of adult macroconchs are larger than 130 mm; the diameters of corresponding adult microconchs vary around 90-100 mm.

The taxon names used for these three species are still preliminary. The two species *Choicensisphinctes windhauseni* and "*Torquatisphinctes*" *mendozanus* are pending of revision.

"*Neochetoceras*" sp. [M & ?m] (Fig. 4). This is a new species most probably belonging to a new genus, which shows some resemblance with the oppeliid genus *Neochetoceras* SPATH, 1925. The latter genus appears around the Kimmeridgian/Tithonian boundary of the Submediterranean Province. Possibly these forms give rise to "*Parastreblites*" *comahuensis* described by LEANZA (1980) from the *Zitteli* Biozone higher up in the section, but they differ from the latter by the presence of wide-spaced falcoid secondaries at similar diameter. Closest resemblance of the present macroconch form is with *Ammonites khanikofi* described by OPPEL (1863: pl. 76, fig. 4) from an unknown stratigraphic level of the Himalaya.

Aspidoceratid gen. et sp. indet. [M]. Its occurrence in the 'Fauna A' of the Neuquén-Mendoza Basin is hitherto only documented by the presence of a large Laevaptychus. In the younger part of the Late Jurassic laevaptychi are recorded from the macroconch genera *Aspidoceras*, *Physodoceras* (incl. *Schaireria*, see SCHWEIGERT 1997), *Pseudhimalayites*, and *Hybonoticeras*. This is very interesting, because it points to the presence of immigrants from the Tethyan Realm which could serve as key references for biostratigraphic correlation.

Fig. 5. A-B: *Choicensisphinctes* cf. *windhauseni* (WEAVER, 1931), **A**: complete juvenile macroconch (MOZP 7378), **B**: adult ?microconch with incomplete bodychamber (MOZP 7318/4); Picún Leufú, Lower Tithonian, *Mendozanus* Biozone, Fauna A. **C**: "*Lithacoceras*"? sp., adult macroconch with incomplete bodychamber (MOZP 6865/4) from La Amarga, Lower Tithonian, *Mendozanus* Biozone, Fauna B. All natural size (× 1), point marks last septum.

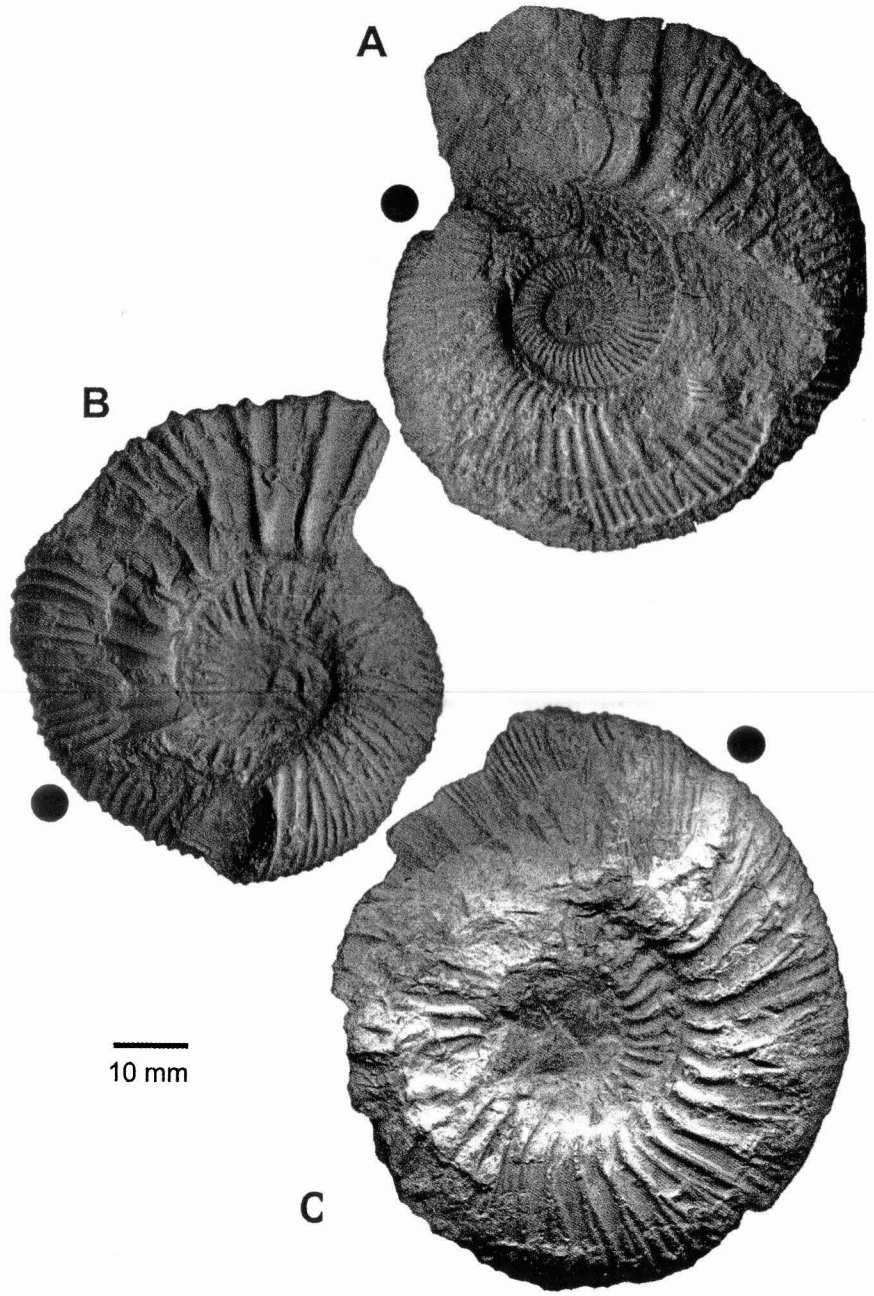

Fig. 6. "*Lithacoceras*"? sp., adult macroconch with almost complete bodychamber (MOZP 6865/1) from La Amarga, Lower Tithonian, *Mendozanus* Biozone, Fauna B. Natural size (× 1), point marks last septum.

2.2. Fauna B

"*Lithacoceras*"? sp. [M] (Figs. 5C, 6): Material of this form comes from La Amarga, Picún Leufú, and probably Pampa Tril. It consists exclusively of moderately involute macroconchs showing a compressed subrectangular whorl section. Its ribbing style is composed of more or less densely spaced, prosocline, acute primaries. Furcation occurs on the middle of the flanks, in a rather irregular virgatotome style; less frequently also dischizotome ribs

occur, just preceding constrictions. On the bodychamber the primaries are wider spaced and divided in shaves of secondaries which cross the venter without interruption. This species differs from the "*Lithacoceras*" n. sp. aff. *malarguense* of the underlying 'Fauna A' by its smaller adult size, a more compressed whorl section throughout the entire juvenile and adult ontogeny, and by a finer and denser ribbing.

3. Comparisons and discussion

Hitherto only few descriptions include earliest Tithonian (*Mendozanus* Bz.) ammonites from the Neuquén-Mendoza Basin.

Río Leñas, Chile: Corvalán (1959) described some Lower Tithonian ammonites, of which the specimen illustrated in his pl. 5, fig. 19 could belong to "*L.*" n. sp. aff. *malarguense.*

Casa Pincheira: Burckhardt (1900) described some ammonites which seem identical to those of 'Fauna A'. The fauna described by Parent (2003: figs. 6-7), from a single faunal horizon, is identical with our 'Fauna A'.

Cerro Lotena: Weaver (1931) described some few ammonites from the *Mendozanus* Biozone, principally including the type specimens of *Choicensisphinctes windhauseni*. More important is to compare the faunas 'A' and 'B' with the material described by Leanza (1980), because it includes several species assigned to the *Mendozanus* Biozone, although the samples were collected from a series of shales with a thickness of 25 m without further subdivisions. This fauna includes some forms morphologically close to species of Fauna A or Fauna B. *Virgatosphinctes mexicanus* (Burckhardt, 1906) in Leanza (1980: pl. 2, fig. 1) resembles "*T.*" cf. *mendozanus* (Fig. 3C-D), but its bodychamber is more inflated and ribs subdivide lower on the flanks. *Pseudinvoluticeras douvillei* Spath, 1925 figured by Leanza (1980: pl. 4, fig. 2) resembles the macroconch of "*L.*" n. sp. aff. *malarguense* (Figs. 2-3A), but it is more inflated and involute, and the ribbing is more irregular, tending to furcate in the lower third of the flank without a defined virgatotome style. *Choicensisphinctes choicensis sutilis* Leanza (1980: pl. 3, fig. 1) closely resembles *C.* cf. *windhauseni* (Fig. 5A-B), but it differs in being more inflated, and the corresponding microconch is less coarsely ribbed. These significant differences respectively with our 'Fauna A' strongly imply that the fauna of Cerro Lotena comes from different horizons, which are most probably younger in age. Moreover, some of these ammonites could likely belong to the *Zitteli* Biozone since identical forms have been recently collected in La Amarga associated with *Pseudolissoceras zitteli* and *Volanoceras krantzense* besides other species (description in progress). The records of *Simocosmoceras* and *Pseudhimalayites* from a level higher up in the Vaca Muerta Formation also indicate the *Zitteli* Biozone (Leanza & Olóriz 1987).

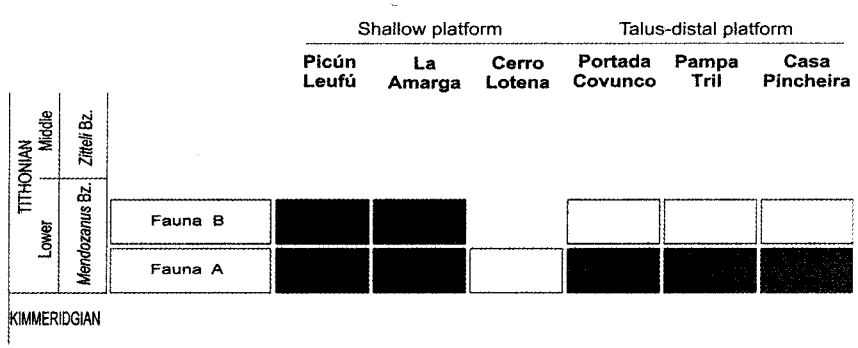

Fig. 7. Biostratigraphy of the Andean Lower Tithonian of the Neuquén-Mendoza Basin based on the succession of Faunas A and B, as defined in the text. Gray boxes for faunas firmly recognized and white boxes for probable occurrence. Biozonation after LEANZA (1981) and PARENT & CAPELLO (1999).

Portada Covunco – Picún Leufú: LAMBERT (1956: 35) described the occurrence of crushed ammonites at the top of the Tordillo Formation, just underlying the "Virgatosphinctinae beds" at the base of the Vaca Muerta Formation. These ammonites could belong to 'Fauna A' because in La Amarga it occurs in the same lithostratigraphic position.

Santa Cruz, southern Argentina (Austral Basin): At this locality "*L.*" n. sp. aff. *malarguense* occurs in the lower Tithonian (see KRAEMER & RICCARDI 1997, PARENT 2003).

Finally, it is interesting to note that the gastropods associated with 'Fauna A' are identical in the Casa Pincheira and Picun Leufú sections (GRÜNDEL & PARENT 2001). These gastropods, most probably benthic, provide additional support to GROEBER's (1952) hypothesis of a wide and quick installation of stable marine conditions all along the basin at the base of the *Mendozanus* Biozone.

4. Conclusions

The lowermost Andean Tithonian ammonoids are now well known in several representative localities all along the Neuquén-Mendoza Basin and from a precise stratigraphic position defining the base of the *Mendozanus* Biozone (Fig. 7). The 'Fauna A' is widely distributed across most parts of the basin and therefore is a good indicator for time-correlation.

'Fauna A' represents the immigration of a new fauna into the basin after an ingression on a rather flat topography provided by the top of the Tordillo Formation. Under these conditions the coastline of the Tithonian transgression reached the southernmost end of the basin (Picun Leufú, La Amarga, Charahuilla) virtually at the same time that in central (Pampa Tril) and northern portions (Casa Pincheira).

Currently biostratigraphic correlation of our faunas 'A' and 'B' with other areas is very difficult. Close morphological relationships between early Tithonian ammonites from the Submediterranean area of Europe and from Mexico suggests that the faunas could be approximately time-equivalent of the basal Tithonian standard Hybonotum Zone. However, this has to be proved either by methods others than ammonite biostratigraphy, or well by further intensive search for time-diagnostic non-endemic species in the studied horizons, e.g. from the Tethyan Realm, by interconnecting seaways according to the palaeogeography shown by ENAY & CARIOU (1997).

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