Ammonoids (Crioceratitinae, Hauterivian) from the Austral Basin, Chile

Beatriz AGUIRRE-URRETA1, Manuel SUÁREZ2, Rita DE LA CRUZ2 and Victor A. RAMOS1

Abstract. The low diversity of the Austral Basin ammonoid faunas was traditionally associated with a high degree of endemism. However, as reported herein, the ammonoids belonging to the Family Ancyloceratidae, Subfamily Crioceratitinae have affinities with European forms. Therefore, the Hauterivian ammonoids of the Austral Basin represent a mixture of endemic (Favrella Douvillé), with typical Tethyan examples (Hemihoplites Spath, Crioceratites Léveillé), and faunas that are characteristic of Northwestern Europe on the margins of the Boreal realm (Protaconeceras Casey, Aegocrioceras Spath), although the endemic forms dominate in number of specimens. The following species are described here: Aegocrioceras patagonicum sp. nov. Aguirre-Urreta, Crioceratites (C.) apricum (Giovine) and Crioceratites sp. aff. C. (C.) schlagintweiti (Giovine). This rare and localized appearance of taxa of the Northern Hemisphere suggests periods of sea level rise that permitted widespread migration from this region to peripheral basins.

Resumen. Amonoides (Crioceratitinae, Hauteriviano) de la cuenca Austral, Chile. La baja diversidad de las faunas de amonoides de la cuenca Austral ha sido tradicionalmente asociada a su alto grado de endemismo. Sin embargo, aquí se describe una fauna de amonoides de la Familia Ancyloceratidae, Subfamilia Crioceratitinae que muestra afinidades con formas europeas. De este modo, los amonoides haueterivianos de la cuenca Austral representan una mezcla de géneros endémicos (Favrella Douvillé), con típicos ejemplos tethyanos (Hemihoplites Spath, Crioceratites Léveillé) y faunas características del noroeste de Europa en los márgenes del reino Boreal (Protaconoceras Casey, Aegocrioceras Spath), aunque las formas endémicas dominan en número de ejemplares. Se describen las siguientes especies: Aegocrioceras patagonicum sp. nov. Aguirre-Urreta, Crioceratites (C.) apricum (Giovine) y Crioceratites sp. aff. C. (C.) schlagintweiti (Giovine). Esta rara y localizada aparición de taxones del Hemisferio Norte sugiere períodos de nivel del mar global alto, lo que habría permitido la migración desde esta región a cuencas periféricas.


Introduction

The Austral Basin of Southern Patagonia was a retroarc basin open to the Pacific Ocean during most of the Cretaceous (figure 1.A). The early stages of the basin are characterized by a clastic nearshore platform during Berriasian to Early Hauterivian times followed or interbedded with dark shales with abundant calcareous nODULES of a basinal setting spanning from the Valanginian to the Albian (Hatcher, 1900; Riccardi and Rolleri, 1980). Ammonoids are abundant in the shaly facies, although the faunas show a low diversity (Aguirre-Urreta, 2002a).

In this article we describe an assemblage of ammonoids in Patagonia; while one genus is of Tethyan origin, the other is only known in the margins of the Boreal realm. These ammonoids occur in outcrops of the Katterfeld Formation exposed in the headwaters of Estero Lechoso, to the north of Puerto Ibáñez, on the northern side of lago General Carrera in Chile (figure 1.B). The fauna is represented by Aegocrioceras patagonicum sp. nov. Aguirre-Urreta, Crioceratites (C.) apricum (Giovine) and Crioceratites sp. aff. C. (C.) schlagintweiti (Giovine).

Consequently, a new biogeographic scheme is proposed here for the Hauterivian of the Austral Basin, based on the correlation of present fauna with coeval elements in the Tethyan and Boreal realms. A brief summary on the biostratigraphy of this interval was advanced elsewhere (Aguirre-Urreta et al., 2000).
Geological setting

The northwestern sector of the oil-bearing late Mesozoic Austral Basin of southern Chile and Argentina (e.g. Biddle et al., 1986), is exposed in the area of present day central Patagonian Cordillera. The eastern margin of the basin expands to the east between 45°-47° S latitude, forming the Río Mayo Embayment (Aguirre-Urreta and Ramos, 1981; Ramos and Aguirre-Urreta, 1994). The cordilleran outcrops studied by Suárez et al. (1996) and Bell and Suárez (1997) represent a retroarc basin developed on continental crust to the east of a magmatic arc. This arc, which is now represented by the Patagonian batholith and Late Jurassic and Early Cretaceous volcanic rocks, was formed by the subduction of a Pacific oceanic plate beneath the South American continental margin (Hervé et al., 2000; Suárez and De La Cruz, 2001).
The northwestern part of the basin was partially filled by the Coyahique Group (Haller and Lapido, 1980; De La Cruz et al., 2003), a marine succession diachronically overlying a Middle to Late Jurassic volcanic succession of the Ibáñez Formation of the Lago La Plata Group, and underlying Late Aptian subaerial volcanic rocks of the Divisadero Group.

The early stages of the basin are characterized by a clastic nearshore platform of the Springhill Formation developed as a stable shelf in the eastern margin during Berriasian to Early Hauterivian times. In the inner western part of the basin the oyster beds, submarine pyroclastic deposits, volcanic turbidites, and tuffites (ash siltstones and sandstones) of the 100 m thick Toqui Formation (Suárez et al., 1996) equivalent to the Springhill Formation, were deposited on high-energy shorelines and near-shore environments adjacent to the active volcanic arc.

The Katterfeld Formation, a succession of marine dark shales up to 500 m thick was deposited in still-water anoxic conditions during Valanginian to Hauterivian times (Ramos, 1981; Olivero and Aguirre-Urreta, 2002). The Katterfeld Formation, the deepest facies of the sedimentary infilling of the Late Jurassic-Early Cretaceous Río Mayo Embayment is characterized by a low diversity of its fossil fauna. This formation is represented by a geographically widespread unit of black shales, commonly bearing the ammonoids Favrella sp. aff. F. steinmanni (Favre) and Favrella americana (Favre) of Hauterivian age, of local character and endemic of the Austral Basin (Riccardi, 1988).

In the uppermost levels of the Katterfeld Formation near Puerto Ibáñez, Chile, Aegocrioceras patagonicum sp. nov. Aguirre-Urreta, Crioceratites (C.) apricum (Giovine) and Crioceratites sp. aff. C. (C.) schlachtweiti (Giovine) form a distinctive association. This assemblage is present in a single locality within 120 m of black shales, and located more than 200 m above the widespread ammonoid Favrella americana (Favre).

The Apeleg Formation, of Middle to Late Hauterivian to Early Aptian age, is the youngest of the three formations of the Coyahique Group (Ramos, 1981). It is a succession up to 1,200 m thick of well-sorted sandstones and mudstones characterized by mud-drapped ripples and a well preserved, and varied trace fossil assemblage (Bell and Suárez, 1997). The sediments were mainly deposited as offshore tidal sandbars or sand ridges on a shallow marine shelf (Bell and Suárez, 1997), and locally they represent easterly-derived deltaic facies (Ramos, 1981; González-Bonorino and Suárez, 1995). Sediment accumulation was terminated by Late Aptian deformation, tectonic inversion, uplift and erosion. This tectonic episode was followed in the Late Aptian, by a major dacitic to andesitic volcanic event which produced the unconformably/paraconformably overlying Divisadero Group.

Lithostratigraphy and fossil locality

In the study area the black shales of the Katterfeld Formation rest directly on the Ibáñez Formation and crop out over a large area in the catchments of Estero Lechosó, reaching a thickness of 500 m (Bruce, 2001). The underlying Ibáñez Formation in the area is composed of silicic tuffs, mainly ignimbrites, surge and ash fall deposits, silicic extrusive and subvolcanic rocks, and intercalations of lacustrine, fluvial and deltaic deposits. Extrusive basaltic and andesitic rocks form a minor part of this formation. The contact of the Katterfeld Formation with the Ibáñez Formation is not well exposed, but both units occur very closely, suggesting a direct contact relationship (Bruce, 2001). In turn the Katterfeld Formation is conformably overlain by the Apeleg Formation.

A section surveyed in the Katterfeld Formation at the headwaters of Estero Lechosó (46°11'53"S, 71°52'48"W) is shown in figure 1.C (see also the appendix).

Systematic palaeontology

The material described here has been collected by the authors and is stored in the Palaeontological collections of the Geological Survey of Chile (SERNAGEOMIN). Type material has been examined in the Palaeontological collections of the University of Buenos Aires. This systematic part is by the senior author (B.A-U).

Dimensions of specimens are indicated as follows: D = diameter; H = whorl height; W = whorl breadth; U = umbilical diameter. Figures in parentheses are ratios expressed as a percentage of the total diameter. The suture terminology followed here is: I = internal lobe; U = umbilical lobe; L = lateral lobe; E = external lobe.

Order Ammonoidea Zittel, 1884
Suborder Anxyloceratina Wiedmann, 1966
Family Anxyloceratidae Gill, 1871
Subfamily Crioceratitinae Gill, 1871

Genus Aegocrioceras Spath, 1924

Type species. Hamites capricornu Roemer, 1841, by original designation.

Diagnosis. A genus with crioceratitid coiling and...
strong, single, radial ribs. Tubercles, mainly ventro-

eral, are common in juveniles but disappear with
growth (Rawson, 1975, p. 137).

Comments. Aegocrioceras was the dominant am-

monoid across the whole NW Europe (Rawson, 1995), occurring in both the north German and

English “middle” Hauterivian. It is a very distinctive

genus due to its simple, strong ribbing, which clear-

ly differentiates it from Crioceratites and allied forms.

It appears suddenly, and according to Rawson

(1995), it arose by allopatric speciation from a

Tethyan Crioceratites immigrant in the margins of

the Boreal realm. Rawson (1970, 1975) has extensively

monographed the species of Aegocrioceras especially

from Speeton Clay in England, and although there

are no modern reviews of the German material, new

illustrations by Kemper (1992) and the multiple re-

ferences to those species from Rawson (1975) are use-

ful to have a good general picture of this peculiar

crioceratitid.

Aegocrioceras patagonicum sp. nov. Aguirre-Urreta

Figures 2.A-K

Holotype. The specimen SERNAGEOMIN 1650, headwaters of

Estero Lechoso, Puerto Ibáñez, Chile.

Type locality. Headwaters of Estero Lechoso, Puerto Ibáñez,

Chile.

Material. Besides the holotype, 17 specimens comprising the body

chamber and crushed phragmocones (SERNAGEOMIN 1648-49,

1651-65), 1 specimen comprising an incomplete phragmocone and

incomplete body chamber (1666) and more than 25 fragments of

whorls.

Diagnosis. A slightly compressed species with

rounded whorl section; radial, usually non-tubercu-

lated ribs, with some very rarely bifurcating on the

flank or at the umbilical edge.

Description. The coiling is crioceratitid, in an open

spire, with whorls in contact. The whorl section is

nearly equidimensional. The dorsum is concave, the

umbilical edge rounded to slightly angular, the flanks

slightly arched, and the venter broad and rounded.

The maximum width is at mid-flank. The ornamenta-

tion consists of dense, simple ribs. At intermediate

growth stages there are 21-23 ribs per half whorl, be-

coming denser with growth (26-31 ribs per half

whorl). They are represented as striae concave to the

aperture in the dorsum. They arise at the umbilical

development and turn slightly backwards and forwards on

the flank and cross the venter without interruption.

Some rare bifurcations occur at the umbilical edge or

in the middle of the flank. No tubercles are noticeable

in most of the specimens, but a single specimen with

innermost whors preserved (D = 7 mm, SERNAGEO-

MIN 1666) shows at least two rows of tubercles, ver-

tal and ventrolateral on each rib. The suture line is

not well preserved but is quadrilobate, typically

crioceratitid, quite simple, with L the largest lobe.

Dimension of figured specimens (in mm)

<table>
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<th>W (±0.32)</th>
<th>H/W</th>
<th>U</th>
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<td>0.95</td>
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</tr>
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<td>1.04</td>
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</tr>
<tr>
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<td>22.6</td>
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<td>26.8</td>
<td>1.06</td>
<td><strong>43.8 (0.50)</strong></td>
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</table>

* approximate measurement

Discussion. Aegocrioceras patagonicum sp. nov. Aguirre-Urreta is very close to Aegocrioceras quadra-

tium (Crick, 1898) regarding degree of coiling and style and density of ribbing, but differs in the whorl

section which is quadrate in this species (Crick, 1898; Rawson, 1975). A. spathi Rawson differs from A.

patagonicum sp. nov. Aguirre-Urreta in the degree of evolution and in having a much more compressed,

subrectangular whorl section with flat dorsum. Several other species have been described in detail

from Speeton Clay but all of them differ from A. patagonicum sp. nov. Aguirre-Urreta in at least one


Etymology. For Patagonia, the geographic region

where the species is recorded.

Occurrence. Aegocrioceras patagonicum sp. nov. Aguirre-Urreta is only known from the headwaters

of Estero Lechoso, upper part of Katterfeld Formation, late Early-early Late Hauterivian.

Genus Crioceratites Léveillé, 1837

Type species. Crioceratites duvali Léveillé by subsequent designa-

tion of Diener (1925, p. 191).

Diagnosis. Typically coiled in equiangular spiral, but spiral angle may increase with age; whorl oval to

subquadrate; ribs generally dense, rounded, single or

bundled at umbilical edge and nontuberculate; stronger major ribs with ventrolateral or umbilical,

lateral and ventrolateral spines; constrictions may be

present (modified from Wright, 1996, p. 211).

Figure 2. Aegocrioceras patagonicum sp. nov. Aguirre-Urreta, Estero Lechoso, Austral Basin, Chile / Esta-

ro Lechoso, cuenca Austral, Chile. A-C, lateral views of body chambers / vistas laterales de cámaras habita-

ciones (SERNAGEOMIN 1653-1652-1651 respectively / respectivamente) ; D, lateral view of holotype corre-

sponding to an almost complete body chamber / vista lateral del holotipo que corresponde a una cá-

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mara habitación casi completa (SERNAGEOMIN 1650); E-F, lateral and ventral views of body chamber / vistas lateral y ventral de la cámara habitación (SERNAGEOMIN 1654); G, lateral view of body chamber / vista lateral de cámara habitación (SERNAGEOMIN 1657); H-I, ventral and lateral views of body chamber / vistas ventral y lateral de cámara habitación (SERNAGEOMIN 1655); J-K, lateral and ventral view of body chamber / vistas lateral y ventral de cámara habitación (SERNAGEOMIN 1656). All specimens coated with ammonium chloride. Natural size / todos los ejemplares cubiertos con cloruro de amonio. Tamaño natural.
**Comments.** Léveillé (1837) erected the genus *Crioceratites* for three species of France. Briefly after that, d’Orbigny (1840) referred to *Crioceras* instead, and the generic name was afterwards extensively employed for Hauterivian and Barremian (frequently only referred as Neocomian) European species, although sometimes confused as initial spires of the uncoiled Barremian-Aptian *Anycloceras* d’Orbigny. The confusion was cleared when Pictet (1863, p. 9, pl. 1, fig. 2) illustrated a complete specimen of "*Crioceras* duvalii" with the aperture preserved. Interpretation of *Crioceratites* is difficult, especially when there are numerous names for Hauterivian and Barremian forms both from the Boreal and Tethyan realms.

The wide range of morphological variation of *Crioceratites sensu latu* led Wiedmann (1962) to include the genera *Emericiceras*, *Sarkar* and *Paracriloceras* Spath as junior synonyms of *Crioceratites*, but *Pseudothurmannia* Spath was retained as a subgenus of *Crioceratites*. Subsequently Immel (1978, 1979a, 1979b) and Klinger and Kennedy (1992) followed Wiedmann’s views. Although a thorough discussion on the status of *Crioceratites* is beyond the scope of this paper, the inclusion of this myriad of forms in a single genus may be an oversimplification.

*Crioceratites* Rouss., 1829

*Crioceratites (Crioceratites) apricum* (Giovine, 1952)

*Figures 3.A-H*

1952. *Crioceras apricum* n.sp.: Giovine, p. 72, pl. 1, figs. 1-5.
1988. *Crioceratites apricus* (Giovine). Riccardi, pl. 7, figs. 3-5.

**Material.** 7 specimens comprising phragmocones and incomplete body chambers (SERNAGEOMIN 1636-38, 1643-46), 4 specimens comprising incomplete phragmocones (SERNAGEOMIN 1639-42) and 10 fragments from the headwaters of Estero Lechoso, Puerto Ibáñez, Chile.

**Description.** The coiling is crioceratitid, open, with single ribs that arise at the umbilical edge, bend back-wards in the flanks with a feeble curve and cross the venter without interruption. There are two kinds of ribs: fine, simple, dense ribs, intercalated with stronger trituberculated ones. In the inner whorls the trituberculate ribs are much thicker, and only one or two fine intermediaries occur. With increasing diameter, the tubercles are more pronounced: the smallest is on the umbilical edge, a stronger one has a ventro lateral position and the third, and strongest, is on the edge of the siphonal line. In well preserved specimens, there are spines instead of tubercles. The number of intercalatories is now 2-4. With increasing diameter, and up to the largest preserved diameter, the tubercles diminish in size and nearly disappear, but the ribs are still strong, and the fine intercalated ribs vary from 4 to 6. The suture line is typically crioceratitid, not very complicated, with large and trifid L, longer than E and U; U longer than E. Saddle between U/L taller than that between L/E.

<table>
<thead>
<tr>
<th>Specimen</th>
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<th>W *</th>
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* approximate measurement

**Discussion.** *Crioceratites (Crioceratites) apricum* compares well with *C. (C.) nolani* (Kilian, 1910) and allied species in coiling, whorl section, and ornamentation. This group presents a widespread and nearly cosmopolitan distribution, and the stratigraphic position is somewhat restricted to the lower-upper Hauterivian boundary (Kemper *et al.*, 1981).

**Occurrence.** This species is known from several localities of the Neuquén Basin (west-central Argentina) in the lower part of the Agua de la Mula Member of the Agrio Formation, (*Crioceratites schlagintweiti* assemblage zone) (Aguirre-Urreta and Rawson, 1997; Aguirre-Urreta *et al.*, 2005); from a single specimen recovered in a core from the Springhill Formation in the eastern side of the Austral Basin (Aguirre-Urreta and Erlicher, 2003) and in the upper part of the Katterfeld Formation, western side of the Austral Basin. Its age is early Late Hauterivian.

Figure 3. A-H, *Crioceratites (C.) apricum* (Giovine). Estero Lechoso, Austral Basin, Chile / *Estero Lechoso, cuenca Austral, Chile*. A-C, lateral views of phragmocones and incomplete body chambers / vistas laterales de fragmoconos y cámaras habitaciones incompletas (SERNAGEOMIN 1636, 1637, 1638 respectively / respectivamente); D-E, ventral and lateral views of incomplete phragmocone / vistas ventral y lateral de fragmocono incompleto (SERNAGEOMIN 1641); F-H, lateral views of incomplete phragmocones / vistas laterales de fragmoconos incompletos (SERNAGEOMIN 1639, 1635, 1640). I, *Crioceratites sp. aff. C. (C.) schlagintweiti* (Giovine), Estero Lechoso, Austral Basin, Chile, lateral view of body chamber / *Estero Lechoso, cuenca Austral, Chile, vista lateral de cámara habitación* (SERNAGEOMIN 1634). All specimens coated with ammonium chloride. Natural size / todos los ejemplares cubiertos con cloruro de amonio. Tamaño natural.
Crioceratites (Crioceratites) sp. aff. C. schlagintweiti (Giovine, 1950)

Figure 3.1

1950. Crioceras schlagintweiti n. sp. Giovine, p. 51, pl. 3, fig. 1; pl. 5, figs. 2-4; text-fig. 3.
2004. Crioceratites aff. schlagintweiti (Giovine). Mourguès, fig. 5a.
2005. Crioceratites schlagintweiti (Giovine). Aguirre-Urreta et al., fig. 7f.

Material. Four incomplete specimens corresponding to incomplete phragmocones and body chambers (SERNAGEOMIN 1632-1635) from the headwaters of Estero Lecho, Puerto Ibáñez, Chile.

Description. The coiling is crioceratid, in an open spire, with whors not in contact, becoming more uncoiled with growth. The whorl section is equidimensional at first, but tends to become more compressed with growth. The dorsum is flat, the umbilical edge rounded to slightly angular, the flanks slightly arched, and the venter, narrow and rounded. The maximum width is at mid-flank. The ribs are simple, arise at the umbilical edge, turn slightly backwards and forwards on the flanks, and cross the venter without interruption. Tubercles are absent. With increasing diameter paired strong ribs, separated by a constriction appear. The posterior rib of each pair is always the strongest and these ribs are separated by 2-3 fine ribs at first but with increasing diameter up to 5 simple ribs are intercalated. All the ribs are straight on the flanks and cross the venter with a slight apertural bend. Sporadically weak, pointed umbilical tubercles can be seen on the posterior strong rib.

Dimension of figured specimen (in mm)

<table>
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<th>Specimen</th>
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* approximate measurement

Discussion. Crioceratites (Crioceratites) schlagintweiti is very close to the type species C. (C.) davauli (Léveillé) and similar species in coiling, whorl section, and ornamentation. This group, together with the C. (C.) nolani group presents an extensive distribution, and a defined stratigraphic position limited to the lower-upper Hauterivian boundary (Kemper et al., 1981).

Occurrence. This species is known in the Neuquén Basin (west-central Argentina) where it characterizes the second ammonoid zone of the Agrio Formation (Crioceratites schlagintweiti assemblage zone) (Aguirre-Urreta and Rawson, 1997; Aguirre-Urreta et al., 2005). Mourguès (2004) illustrated one specimen with open nomenclature from the Chañarcillo (formerly Atacama) Basin from northern Chile. Here it is reported in the upper part of the Katterfeld Formation, western side of the Austral Basin. Its age is early Late Hauterivian.

Biostratigraphy and palaeobiogeography

The ammonoids recovered in the study section have been dated as Hauterivian in several regions of the world, but their relative position within the Austral Basin permits to suggest some precisions regarding their age.

Crioceratites (C.) apricum (Giovine) and C. (C.) schlagintweiti (Giovine) are known from the lower Upper Hauterivian in the Neuquén Basin where they characterize the Crioceratites schlagintweiti zone (Aguirre-Urreta and Rawson, 1997; Aguirre-Urreta et al., 2005). In the Austral Basin, Crioceratites (C.) apricum was previously known from a single specimen recovered from a core of the Springhill Formation (Aguirre-Urreta, 1998; Aguirre-Urreta and Erlicher, 2003). These Argentine species are very close to the European Crioceratites (C.) nolani (Kilian) and C. (C.) duvalii (Léveillé) that are typical of the base of the Upper Hauterivian (sayni zone) of the Tethyan realm (Kemper et al., 1981; Rawson, 1995).

Aegocrioceras is a genus restricted to the inversum and speetonensis/staffi zones of the late Early Hauterivian-early Late Hauterivian of England and Germany. A single dubious specimen is referred from the base of the sayni zone in the Tethys (Kemper et al., 1981) and Aegocrioceras sp. has also been recorded from the Argentine side of the Austral Basin in the Favrella americana assemblage zone (Riccardi, 1984; Riccardi et al., 1987), although none of these two records were described or figured.

Thus, the association of Aegocrioceras and species of Crioceratites places the fauna as latest Early Hauterivian-early Late Hauterivian.

Previously, Hauterivian ammonoids of the Austral Basin were grouped in two zones: a basal Favrella americana assemblage zone assigned as late Early Hauterivian to early Late Hauterivian and an upper “Favrella” wilckensi assemblage zone assigned as Late Hauterivian (Riccardi, 1984, 1988; Riccardi et al., 1987; Aguirre-Urreta, 2002a, 2002b). The former included, besides the nominal species, Aegocrioceras sp. and Hemihoplites ploskiewiczii Riccardi and Aguirre-Urreta, and the latter contained “Favrella” wilckensi (Favre), Protaconeceras patagoniense (Favre), and Hemihoplites variocostatus Riccardi and Aguirre-Urreta.

Thus, the presence of Aegocrioceras and Crioceratites above Favrella americana (Favre) indicates that the F. americana assemblage zone is best placed as Early Hauterivian. “Favrella” wilckensi (Favre), although not recorded in the study section, is assigned
to the Late Hauterivian because of its association with Protaconeceras patagoniense (Favre). Protaconeceras is a moderately common genus in the gottschei zone of England (beds C4 of Speeton) (Casey, 1954; Kemper et al., 1981; Riccardi, 1984; Riccardi et al., 1987). Figure 4 shows the proposed biostratigraphy for the Hauterivian of the Austral Basin and its correlation with the Boreal and Tethyan zones.

The proposed zonal sequence shows the fauna that dominated in successive periods of time in Patagonia. There, Aegocrioceras and Crioceratites occur in a clearly defined horizon, showing that their immigration was brief and that they did not evolve in news species in the area. Thus, these forms are of exceptional value in correlation as clearly pointed out by Kemper et al. (1981).

The low diversity of the Patagonian ammonoid faunas was traditionally associated with a high degree of endemism, but more recent studies have proved that some faunas show a more pandemic character with elements that are also present elsewhere in the Southern Hemisphere, or are related to Tethyan forms. Thus, the Hauterivian ammonoids of the Austral Basin of Patagonia represent a mixture of endemic taxa (Favrella), with Tethyan taxa (Hemihoplites, Crioceratites), and faunas from Northwestern Europe which was part of the margins of the Boreal realm (Protaconeceras, Aegocrioceras), although numerically dominated by the endemic forms. The rare and localized appearance of species abundant in the Northern Hemisphere points to periods of sea level rise that permitted widespread migrations (Kemper et al., 1981) to peripheral basins along the Pacific margin of western Gondwana.

Acknowledgements

The authors are most grateful to Z. Bruce (University of Canterbury, New Zealand) and D. Quiroz (Servicio Nacional de Geología y Minería, Santiago, Chile) for many discussions on the geology and for the collection of some specimens. Special thanks to L. Zúñiga (Coyhaique, Chile) for his invaluable help in the field. To H. Klinger (Iziko Museum, Cape Town, South Africa) and E. Olivero (Centro Austral de Investigaciones Científicas, Ushuaia, Argentina) for reviewing the manuscript. Partial funding from Fondo de Desarrollo Científico y Tecnológico, project N° 1030162 to Suárez and De La Cruz; Universidad de Buenos Aires, project X-084, and Fondo de Desarrollo Científico y Tecnológico - Incentivo a la Cooperación Internacional N° 70030017 to Aguirre-Urreta and Project Aysén de Servicio Nacional de Geología y Minería to Suárez and De La Cruz are greatly acknowledged.

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**Appendix**

Stratigraphic section of the Katterfeld Formation with ammonoid levels in the locality Estero Lechoso.

- **Top**: Grey to greenish sandstones of Apeleg Formation.
- 90 m. Black shales partially covered.
- 2 m. Fine greenish sandstones.
- 37 m. Black shales.
- 40 m. Black shales with three fossiliferous levels: the upper one with *Aegocrioceras patagonicum* sp. nov. Aguirre-Urreta, an intermediate one with numerous carbonate nodules with *Aegocrioceras patagonicum* sp. nov. Aguirre-Urrreta, *Crioceratites* (C.) *apricum* (Giovine), *Crioceratites* sp. aff. *C. (C.) schlagintweitii* (Giovine), *Entolium* sp. and other bivalves, and a lower level with calcareous nodules with indeterminate bivalves and carbonized wood.
- 25 m. Black shales interbedded with two thin calcareous horizons and one thicker bed of greenish to grey, coarse, laminated sandstones.
- 37 m. Black shales.
- 18 m. Black shales with at least two levels of calcareous nodules, the upper one with *Aetostreon* sp. and the lower one with *Aegocrioceras patagonicum* sp. nov. Aguirre-Urrreta and *Crioceratites* sp.
- 85 m. Black shales, 26 meters above base a level with septarias.
- 87 m. Black shales partially covered.
- 30 m. Black shales.
- 1 m. Grey to greenish medium sandstones.
- 20 m. Black shales with calcareous nodules with *Favrella americana* (Favre) and septarias.
- 25 m. Black shales partially covered.
- 92 m. Black shales, 80 meters above base a level with septarias.
- Base: Volcanic rocks of Ibáñez Formation.

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Recibido: 15 de agosto de 2006.
Aceptado: 29 de noviembre de 2006.