



## Hemihoplitid Ammonoids from the Austral Basin of Argentina and Chile

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4 Text-Figures and 2 Plates

Argentina  
Chile  
Patagonia  
Cretaceous  
Ammonoidea  
Paleoenvironment

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### Hemihoplitide Ammonoideen aus dem Austral-Becken von Argentinien und Chile

#### Zusammenfassung

Die Auffindung einer gut erhaltenen Ammonitenfauna im Austral-Becken von Patagonien wirft Licht auf Herkunft, Evolutionsrichtung und auf die paläogeographische Verbreitung der Gattung *Hemihoplites*. Zwei Arten aus Patagonien, *Hemihoplites ploskiewiczzi* und *H. varicostatus* waren bereits bekannt: Die erstere stammt aus der *Favrella americana* Assemblage Zone (oberes Unterhauterivium bis unteres Oberhauterivium). Die letztere wurde in Schichten mit *Protaconeceras patagoniense* (*Favrella wilckensi* Assemblage Zone) und *Hatchericeras* spp. (*Hatchericeras patagonense* Assemblage Zone) des unteren Mittelbarremium gefunden. Eine dritte Art, *Hemihoplites feraudianus* (D'ORBIGNY), hier zum erstenmal beschrieben, wird in die europäische *Feraudianus* Zone des oberen Barremium gestellt. Die Zone des *Hemihoplites feraudianus* – zwischen der *Hatchericeras patagonense* Zone des unteren Barremium und der *Colchidites-Sanmartinoceras* Zone des oberen Barremium – wird hier für Südpatagonien eingeführt. Die Auffindung des *H. feraudianus* erlaubt es, eine lange Evolutionsgeschichte der Gattung *Hemihoplites* im Austral Becken mit einem Trend zu zunehmender Größe und gröber werdender Berippung zu postulieren. Das plötzliche Auftreten des *Hemihoplites feraudianus* im europäischen Oberbarremium gibt Anlass, dessen Einwanderung in die Tethysregion anzunehmen.

#### Abstract

The recent finding of a beautifully preserved ammonite fauna in the Austral basin of Patagonia sheds light on the origin, evolutionary trends, and palaeobiogeographic distribution of the genus *Hemihoplites*. Two species were already known from Patagonia: *Hemihoplites ploskiewiczzi* and *H. varicostatus*. The former has been included in the *Favrella americana* assemblage zone (late Early to early Late Hauterivian). The second one has been found in beds with *Protaconeceras patagoniense* (*Favrella wilckensi* assemblage zone, Late Hauterivian) and *Hatchericeras* spp. (*Hatchericeras patagonense* assemblage zone, Early-Middle Barremian). A third species, reported here for the first time, corresponds to this species, *Hemihoplites feraudianus* (D'ORBIGNY). No other ammonites have been recorded but it can be placed in the Late Barremian *Feraudianus* zone of Europe. A zone of *Hemihoplites feraudianus* is proposed here for southern Patagonia; it is placed above the *Hatchericeras patagonense* zone of the Early Barremian and below the *Colchidites-Sanmartinoceras* zone of the Late Barremian. The recent discovery of *Hemihoplites feraudianus* permits to postulate a long history of this genus in the Austral basin, with an evolutionary trend towards increasing body size and coarser ribbing. The sudden appearance of *Hemihoplites feraudianus* in the European Late Barremian also prompts the proposal of an immigration to the Tethyan region.

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## 1. Introduction

The presence of Hemihopliteid ammonoids in the Austral basin is known from the work of RICCARDI & AGUIRRE-URRETA (1989), where two new species were described and illustrated, showing for the first time the presence of sexual dimorphism in *Hemihoplites*. These two new species were recovered from an unusual lower stratigraphic position ranging from the Early Hauterivian to Early and Middle Barremian, when compared with the common location of Hemihopliteids in the *Feraudianus* zone of the Late Barremian in the Mediterranean. More recently, *Hemihoplites* has been recorded in the revised edition of the Treatise as Upper Hauterivian–Barremian and its presence in older rocks of Southern Patagonia as reported by RICCARDI & AGUIRRE-URRETA (1989) has been overlooked (WRIGHT, 1996) or dismissed as unlikely (DELANOY, 1990a).

Thus, the objective of this work is to shed light on the origin, evolutionary trends, and palaeobiogeographic distribution of *Hemihoplites*, based on the recent finding of a beautifully preserved ammonite fauna in the northernmost part of the Austral basin of Southern Patagonia, Argentina.

### Repositories

The described and figured specimens are deposited in the following collection under the catalogue number listed in the text: CPBA – Cátedra de Paleontología, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Ciudad Universitaria, Pabellón 2, 1428 Buenos Aires, Argentina.

### Measurements

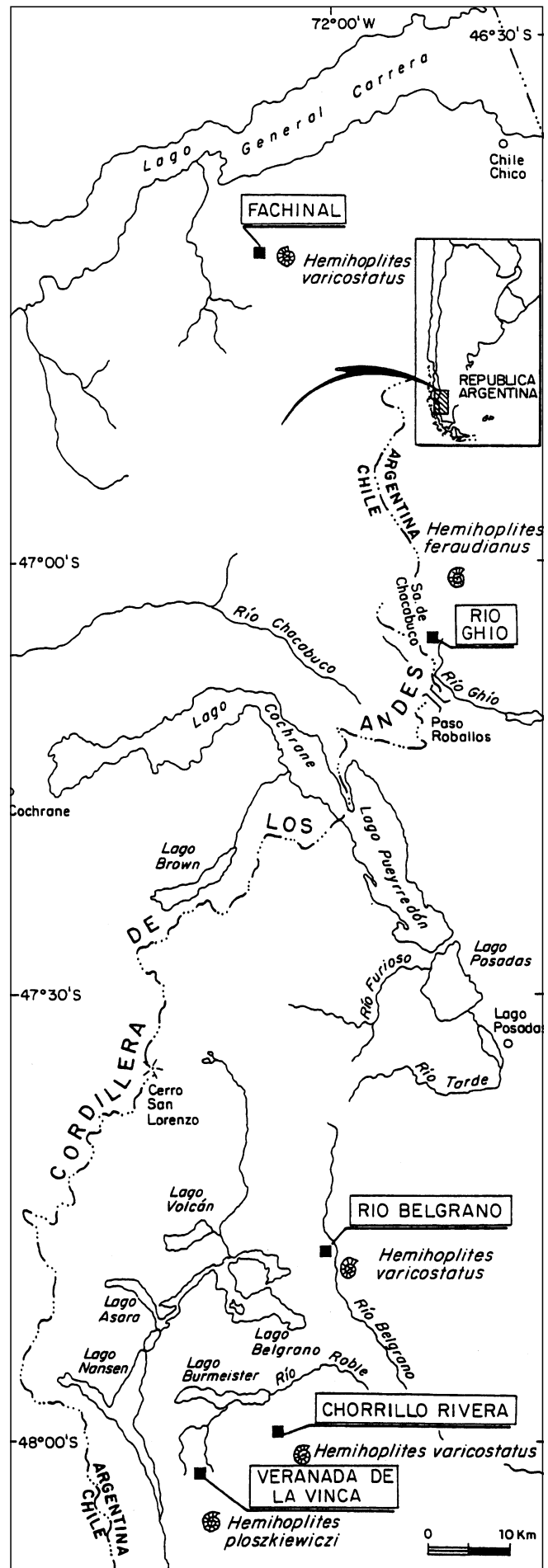
The measurements of the figured specimens as listed in the tables were all taken in the conventional manner, D = diameter; H = whorl height at given D, from umbilical seam to venter in plane of coiling; W = whorl width at given D, perpendicular to plane of coiling; U = umbilical width at given D. Figures in parentheses refer to dimensions as a percentage of diameter.

### Suture terminology

The conventional suture terminology is followed here: I = Internal lobe, U = Umbilical lobe, L = Lateral lobe, E = External lobe.

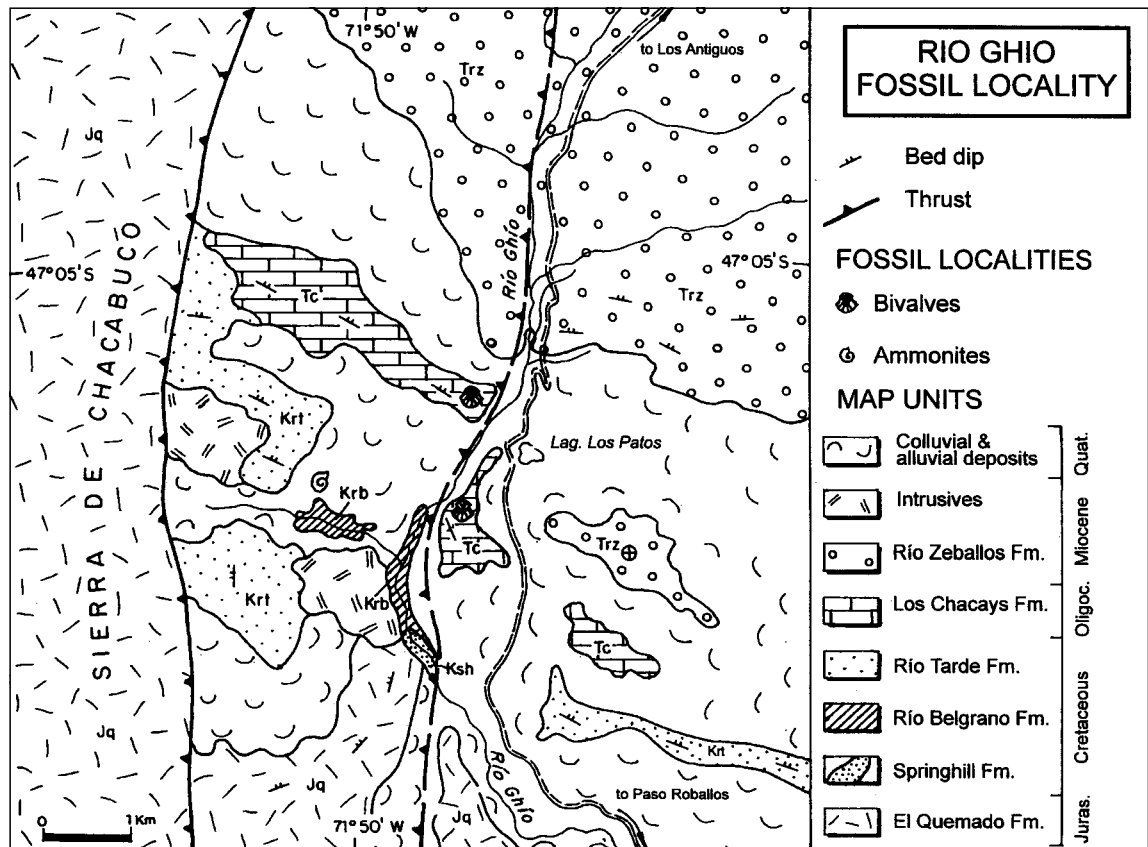
## 2. Stratigraphy and Fossil Locality

The greater part of the Austral basin is located in the eastern border of the Patagonian Cordillera. It was filled with chiefly marine Upper Jurassic to Tertiary sediments (RICCARDI & ROLLERI, 1980). The Jurassic is mainly represented by the volcanic rocks of El Quemado Formation, although in the internal part of the basin, these volcanics are interbedded with fossiliferous rocks bearing Upper Jurassic to Lower Cretaceous invertebrate faunas. A long period of stability produced the quartzose sandstones of Springhill Formation (Tithonian–Hauterivian). This continental to marine unit developed a clastic platform that marks the beginning of the Austral basin subsidence. Basinal facies constituted by marine black shales of the Río Mayer Formation (Valanginian–?Cenomanian) lie on the sandstones and/or the Jurassic volcanics, and are widely distributed throughout the basin. These black shales are overlain by shallow marine to con-



Text-Fig. 1.  
The northernmost region of the Austral basin of Argentina and Chile with localities where different species of *Hemihoplites* have been found.

Text-Fig. 2. Geological map with location of the outcrop of Rio Belgrano Formation in the Rio Ghio locality with *Hemihoplites feraudianus*.



tinental sandstones and conglomerates. The regressive sequence is represented in the northernmost sector of the basin by the marine sandstones of Rio Belgrano Formation (Barremian–Aptian) and the continental deposits of Rio Tarde Formation (Aptian–Cenomanian) (RAMOS, 1979, 1982; RAMOS & DRAKE, 1987). Further south the transition to continental deposits is represented by Kachaik and Piedra Clavada Formations (Albian–Cenomanian) (RICCARDI, 1971). Late Cretaceous sequences comprise continental sediments and pyroclastic rocks in the northern part of the basin, while to the south marine conditions prevailed until Early Tertiary times (RICCARDI & ROLLERI, 1980).

The fossil ammonoids studied here were collected from the Rio Ghio locality in outcrops of the Rio Belgrano Formation. Several localities cited in the text correspond to other species of *Hemihoplites* recorded in the basin and also shown in Text-Fig. 1.

On the western Chilean part of the Austral basin, SUÁREZ & DE LA CRUZ (1996) described some isolated marine sandstone outcrops. Some ammonite specimens were collected in a similar stratigraphic setting in the Fachinal locality (see Text-Fig. 1).

This locality situated in the northwestern corner of the province of Santa Cruz is one of the northernmost outcrops of marine deposits of the Argentine Austral basin. It is located close to the international boundary with Chile, 7 km north of the Roballos Pass along the gravel road that joins the town of Los Antiguos towards the north with the mentioned international pass in the south (Text-Fig. 2).

The Cretaceous outcrops are preserved in the down-thrown block of the Sierra de Chacabuco thrust. This range, mainly composed of Jurassic volcanics of El Quemado Formation, is overriding the upper member of Rio Tarde Formation. The base of the sedimentary sequence is observed in the Ghio river valley where the quartzose sandstones of Springhill Formation are unconformably

deposited on the Jurassic El Quemado volcanics. In this littoral area the Rio Mayer Formation was not developed, because the green sandstones and conglomerates of the Rio Belgrano Formation were deposited directly on the Springhill Formation, with a similar setting observed further south (AGUIRRE-URRETA & RAMOS, 1981).

The fossiliferous section is represented by siltstone layers of Rio Belgrano Formation, close to the contact with the red sandstones of the lower member of Rio Tarde Formation (AGUIRRE-URRETA & RAMOS, 1999). The best ammonites were recovered from big sandy concretions that preserved several specimens, associated with bivalves and carbonaceous debris. Due to the poor exposures a detailed section was not surveyed.

### 3. Systematic Palaeontology

Order: Ammonoidea ZITTEL, 1884  
 Suborder: Ancyloceratina WIEDMANN, 1966  
 Superfamily: Ancyloceratidae GILL, 1871  
 Family: Hemihoplitidae SPATH, 1924  
 Genus: *Hemihoplites* SPATH, 1924

Type species: *Ammonites feraudianus* D'ORBIGNY, 1841, by original designation (SPATH, 1924, p. 84).

#### *Hemihoplites feraudianus* (D'ORBIGNY)

(Pl. 1; Pl. 2, Figs. 1–6; Text-Figs. 3A–E)

- 1841 *Ammonites feraudianus* D'ORBIGNY, p. 324, Pl. 76, Figs. 4–5.  
 1923 *Parahoplites soulieri* (MATHERON), FALLOT & TERMIER, p. 67, Pl. 6, Figs. 1a–c.  
 1966 *Hemihoplites feraudianus* (D'ORBIGNY), WIEDMANN, Pl. 6, Fig. 3.  
 1990a *Hemihoplites feraudianus* (D'ORBIGNY), DELANOY, p. 663, Figs. 1–7, p. 665, Figs. 1–4.  
 1990b *Hemihoplites feraudianus* (D'ORBIGNY), DELANOY, Pl. 1, Figs. 4a–b.

1992 *Hemihoplites feraudianus* (D'ORBIGNY), DELANOY, p. 98, Pl. 12, Figs. 1–2, 5–6, Pl. 13, Fig. 3.

1997 *Hemihoplites feraudianus* (D'ORBIGNY), DELANOY, Pl. 1, Figs. 2–4.

**Material:** Two phragmocones and incomplete body chambers of macroconchs (CPBA 19156–19157), five phragmocones of macroconchs (CPBA 19151–19155), two nearly complete microconchs (CPBA 19162, 19167), four phragmocones and incomplete body chambers of microconchs (CPBA 19158–19161), and three fragments of body chambers of microconchs (CPBA 19164–19166) from Río Ghío.

**Description: Macroconch:** Large size. The phragmocones reach 210 mm in diameter and are quite evolute (U/D = 0.27–0.38). The whorl section is rather compressed (H/W = 1.16–1.48), with rounded umbilical shoulder and steep to shallow inner margin. The flanks are rounded and the venter is flattish to slightly convex (Figs. 3A–C). The ornamentation consists of rounded, strong ribs. They cross the umbilical wall with an adoral projection, and some of them become thick and bifurcate on the umbilical margin in the inner whorl, while later the ribs bifurcate on the dorsal third of the flank. All ribs form a shallow adapical bow on the lower third of the flank, are slightly projected on the upper part of the flank, and cross straight over the venter. The number of ribs is approximately 12 per half whorl in the early and mid growth stages of the phragmocone; they become less marked and decrease in prominence with growth, becoming nearly smooth in the end of phragmocone and body chamber.

The external septal suture (Fig. 3E) is complex. L is slightly deeper than E, moderately wide and asymmetrically trifid; U is located on the umbilical edge, is also trifid but about half as deep as L.

**Microconch:** The adult body chamber is 70 to 83 mm in diameter, rather evolute (U/D = 0.34–0.38), with subrectangular whorl section (H/W = 1.25), shallow inner margin, flattish flanks and slightly convex venter (Text-Fig. 3 D). Thick and blunt flexuous ribs, simple or bifurcating at the umbilical margin or in the dorsal third of the flank are present throughout the ontogeny. The aperture is not preserved.

**Dimensions (in mm):**

	D	H	W	H/W	U
CPBA 19157	232	87 (0.37)	68 (0.29)	1.28	82 (0.35)
	172	65 (0.38)	44 (0.26)	1.48	62 (0.36)
CPBA 19156	200	78 (0.39)	56 (0.28)	1.39	66 (0.33)
CPBA 19158	117	40 (0.34)	—	—	42 (0.36)
CPBA 19151	150	56 (0.37)	42 (0.28)	1.33	50 (0.33)
CPBA 19153	110	47 (0.43)	36 (0.33)	1.30	35 (0.32)
CPBA 19159	110	46 (0.42)	34 (0.31)	1.28	40 (0.36)
	90	33 (0.37)	28 (0.31)	1.18	34 (0.38)
CPBA 19160	105	36 (0.34)	31 (0.29)	1.16	40 (0.38)
CPBA 19152	100	41 (0.41)	33 (0.33)	1.24	30 (0.27)
CPBA 19162	83	35 (0.42)	28 (0.34)	1.25	28 (0.34)

**Discussion:** The specimens described here match perfectly those recently described and figured as *Hemihoplites feraudianus* (D'ORBIGNY) by DELANOY (1992, Pl. 12, Figs. 1a–c, 2, 5a–b, 6; 1997, Pl. 1, Fig. 2), except in the

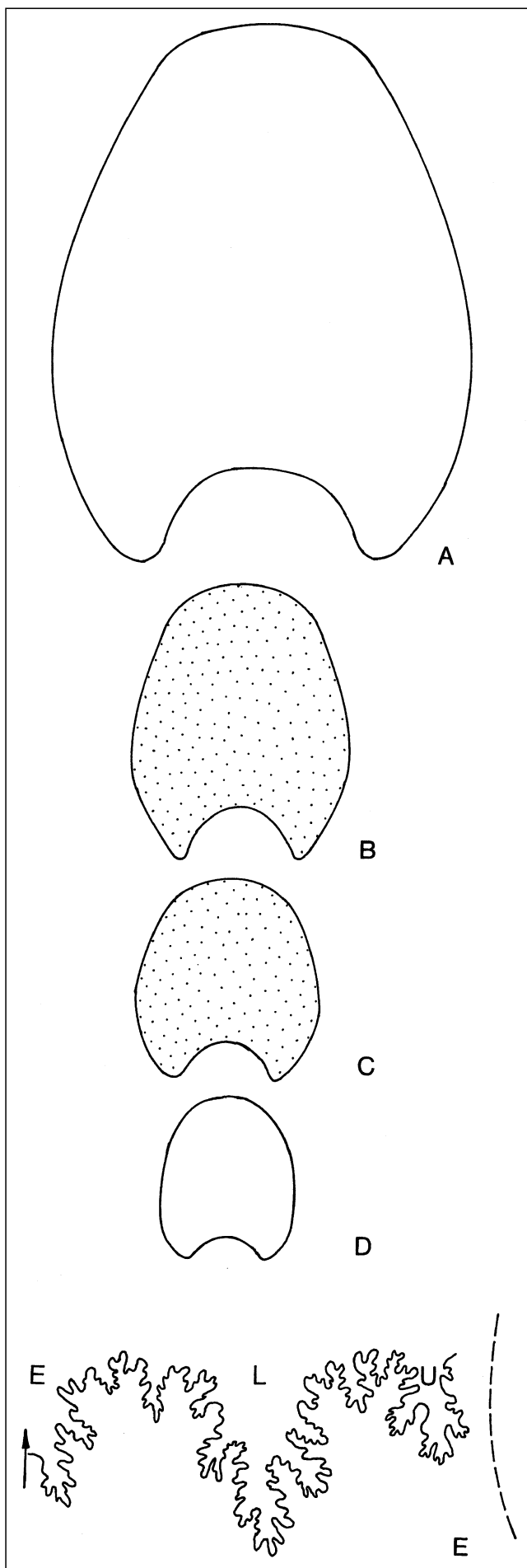
Text-Fig. 3.

Whorl sections and suture line of *Hemihoplites feraudianus*.

A: CPBA 19157, B–C: CPBA 19155, D: CPBA 19164.

E: External septal suture line of CPBA 19152 at whorl height of 35 mm.

Stipples indicate phragmocone. Natural size.



lack of tubercles. This Patagonian material also resembles *Hemihoplites soulieri* (MATHERON) in coiling, but this last species has less bifurcated ribs. The author agrees with DELANOY (1990a) that probably both *H. feraudianus* and *H. soulieri* represent morphotypes of a single, variable species. *Hemihoplites astarte* (FALLOT & TERMIER) is more evolute, with dense, straight, and single ribs (DELANOY, 1992, p. 95, Pls. 11, Figs. 1–3, Pl. 13, Fig. 4). *Hemihoplites feraudianus* is similar to *H. varicostatus* RICCARDI & AGUIRRE-URRETA in evolution and style of ribbing, but the author believes that the latter species is characterised by a different range of variation, in spite of some morphological overlap with *H. feraudianus*. This refers to specimens with more subrectangular whorl section and sparser ribbing, as already stated by RICCARDI & AGUIRRE-URRETA (1989, p. 456). *Hemihoplites ploszkiewiczzi* is smaller, with more dense ribs (RICCARDI & AGUIRRE-URRETA, 1989, p. 458, Pl. 52, Figs. 4–9, Text-Figs. 5g–h).

#### 4. Biostratigraphy

The early appearance of *Hemihoplites* in Southern Patagonia of Argentina and Chile led DELANOY (1990a) to question the age of the *Favrella americana*, *F. wilckensi*, and *Hatchericeras patagonense* assemblage zones. However, these local ammonite zones are reasonable well constraint. *Favrella americana* (FAVRE) is associated with *Aegocrioceras* sp. (RICCARDI, 1984) and is also recorded above Late Valanginian *Chacantuceras ornatum* (AGUIRRE-URRETA & RAWSON, 1999). From this zone the first species of *Hemihoplites*, *H. ploszkiewiczzi* RICCARDI & AGUIRRE-URRETA has been reported. The association of *Favrella wilckensi* (FAVRE) with the Late Hauterivian *Protaconeceras patagoniense* (FAVRE) (KEMPER et al., 1981; RICCARDI et al., 1987) establishes the age of this assemblage zone. Finally, the stratigraphic position of the *Hatchericeras* fauna was bracketed between the Late Hauterivian *Favrella wilckensi* assemblage zone and the Late Barremian *Colchidites-Sanmartinoceras* assemblage zone (AGUIRRE-URRETA & KLINGER, 1986). *Hemihoplites varicostatus* RICCARDI & AGUIRRE-URRETA was found both in the *Favrella wilckensi* and *Hatchericeras patagonense* assemblage zones.

A zone of *Hemihoplites feraudianus* in the Late Barremian of southern Patagonia is proposed here. It is placed above the *Hatchericeras patagonense* zone of the Early Barremian and below the *Colchidites-Sanmartinoceras* zone of the Late Barremian.

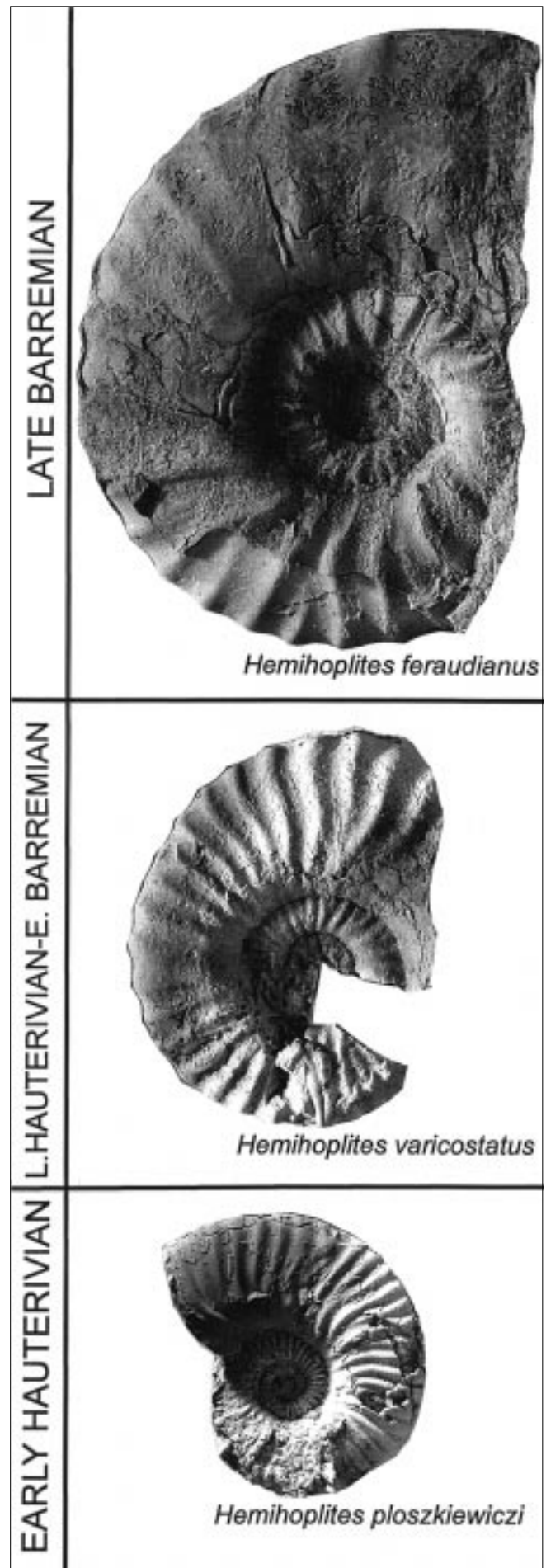
#### 5. Significance of the Fauna

The Tethyan representatives of *Hemihoplites* appear suddenly in the Upper Barremian (DELANOY, 1994). As no direct ancestor was easy to recognise, its origin was postulated from the Late Hauterivian genus *Pseudothurmannia* (WIEDMANN, 1969; WRIGHT, 1996) or from *Emericiceras* of gr. *barremense* (DELANOY, 1990a). Even though these two options failed to show any intermediate form to close the gap between the proposed ancestors and *Hemihoplites*, the early presence of *Hemihoplites* in Patagonia was not taken into consideration (WRIGHT, 1996) or doubted (DELANOY, 1990a).

Text-Fig. 4.

Three different species of *Hemihoplites* found in the Austral basin and stratigraphic range.

*Hemihoplites ploszkiewiczzi* is CPBA 14147 from Veranada de la Vinca, *Hemihoplites varicostatus* is CPBA 11096 from Rio Belgrano, *Hemihoplites feraudianus* is CPBA 19152 from Rio Ghio. There is a clear tendency to increase in body size and stronger ornament.



Thus, the recent discovery of *Hemihoplites feraudianus* permits to postulate a long history of this genus in the Austral basin, with an evolutionary trend towards increasing body size (Deperet's law as described by THENIUS, 1973) and coarser ornamentation (Text-Fig. 4).

The sudden appearance and widespread distribution of *Hemihoplites feraudianus* and allied species in the Late Barremian of the western Tethys and the Caucasus and Turkmenia prompts the author to propose an immigration to

the Tethys from Patagonia, where the oldest *Hemihoplites* has been recorded.

#### Acknowledgements

The author wants to acknowledge Manuel SUÁREZ (SERNAGEOMIN) for the loan of Chilean fossils and geological information. Nina and Victor A. RAMOS (UBA) helped in the field. Milka BRODTKORB (UBA) translated the German abstract and Tina AGUIRRE-URRETA helped with French translations. CONICET PIP 360/98 and UBACYT TW56 grants provided financial support.

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## Plate 1

*Hemihoplites feraudianus*.

Lateral view of phragmocone and incomplete body chamber of macroconch CPBA 19156.  
Río Ghío locality.  
Arrow indicates the end of phragmocone.

Natural size

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## Plate 2

*Hemihoplites feraudianus*.

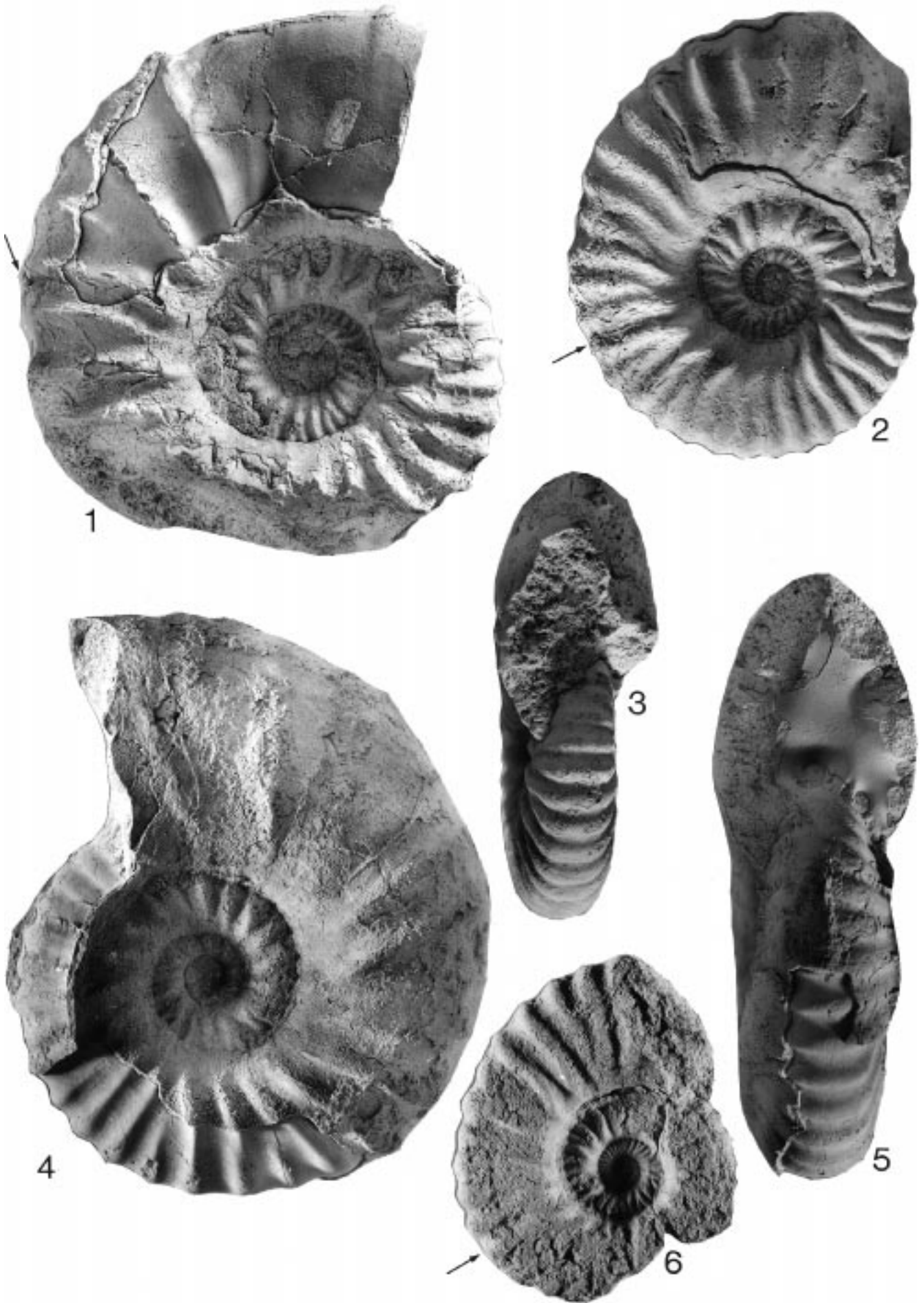
Fig. 1: Lateral view of phragmocone and incomplete body chamber of macroconch CPBA 19159.  
Figs. 2–3: Lateral and apertural views of complete microconch CPBA 19162.  
Figs. 4–5: Lateral and apertural views of phragmocone of macroconch CPBA 19153.  
Fig. 6: Lateral view of nearly complete microconch CPBA 19167.

Río Ghío locality.  
Arrows indicate the end of phragmocone.

Natural size.

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