N. Jb. Geol. Paläont. Abh.
2008, vol. 249/1, p. 9–24, Stuttgart, July 2008, published online 2008

The genus *Ptychoceras* D'ORBIGNY in the Aptian – Albian of Patagonia and Antarctica

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With 4 figures

RICCARDI, A. C. & MEDINA, F. A. (2008): The genus *Ptychoceras* D'ORBIGNY in the Aptian – Albian of Patagonia and Antarctica. – N. Jb. Geol. Paläont. Abh., **249**: 9–24; Stuttgart.

Abstract: Aptian – Albian Ptychoceratidae of southern Patagonia and James Ross Island, Antarctica are described. They are represented by *Ptychoceras adpressum* (J. SOWERBY, 1814), *P. forbesianum* STOLICZKA, 1865 and *P. hamaimense* PERVINQUIÈRE 1907. *P. hamaimense* occurs in the *Peltoceras deeckei* Assemblage Zone (Upper Aptian) of Patagonia and the *Pictetia* Assemblage Zone (Lower Albian) of Antarctica. *P. adpressum* has been recorded from the Upper Albian *Puzosia vegaensis* Assemblage Zone of Patagonia and *Tetragonites* Assemblage Zone of Antarctica. *P. forbesianum* occurs in the Middle–Late Albian of Antarctica.

Key words: Ammonoidea, Ptychoceratidae, Aptian, Albian, Patagonia, Antarctica.

1. Introduction

Ptychoceratidae have been described or recorded, mainly from Upper Hauterivian – Upper Albian strata, from many parts of the globe. However, most species and genera are based on isolated and/or fragmentary specimens. Intraspecific morphological variation, sexual dimorphism, and taxonomic significance of most shell features are therefore poorly known. This was also the case in Patagonia and Antarctica, from where only a few Aptian – Albian specimens referred to that family have been figured (e.g. THOMSON 1974, 1983; RICCARDI 1988), although marine facies of this age is exposed in a large area of the Austral Basin of southern Patagonia and in James Ross and Alexander islands of Antarctica.

We have studied a collection of specimens to clarify the systematics and stratigraphy of ptychoceratids in Patagonia and Antarctica. Here is our stratigraphic summary of the area, with detailed descriptions of the sections from which the fauna was collected, as well as the systematics.

2. Fossil localities and stratigraphy

Patagonia. – The Magallanes or Austral Basin is located on the eastern border of the Patagonian Cordillera, south of 45° S (Fig. 1). The older units recognized in this area include Paleozoic sedimentary and metamorphic rocks and Jurassic volcanics. The basin was filled with chiefly marine, Upper Jurassic to Tertiary sediments (see RICCARDI & ROLLERI 1980).

The Cretaceous of the studied area (see RICCARDI 1988) overlies Jurassic volcanics of the El Quemado Complex and consists of Berriasian-early Valanginian continental to marine sandstones, i.e. the Springhill Formation; late Valanginian – late Albian marine black shales of the Rio Mayer Formation; and Albian – Cenomanian shallow-marine to continental sand-

DOI: 10.1127/0077-7749/2008/0249-0009

0077-7749/08/0249-0009 $ 4.00

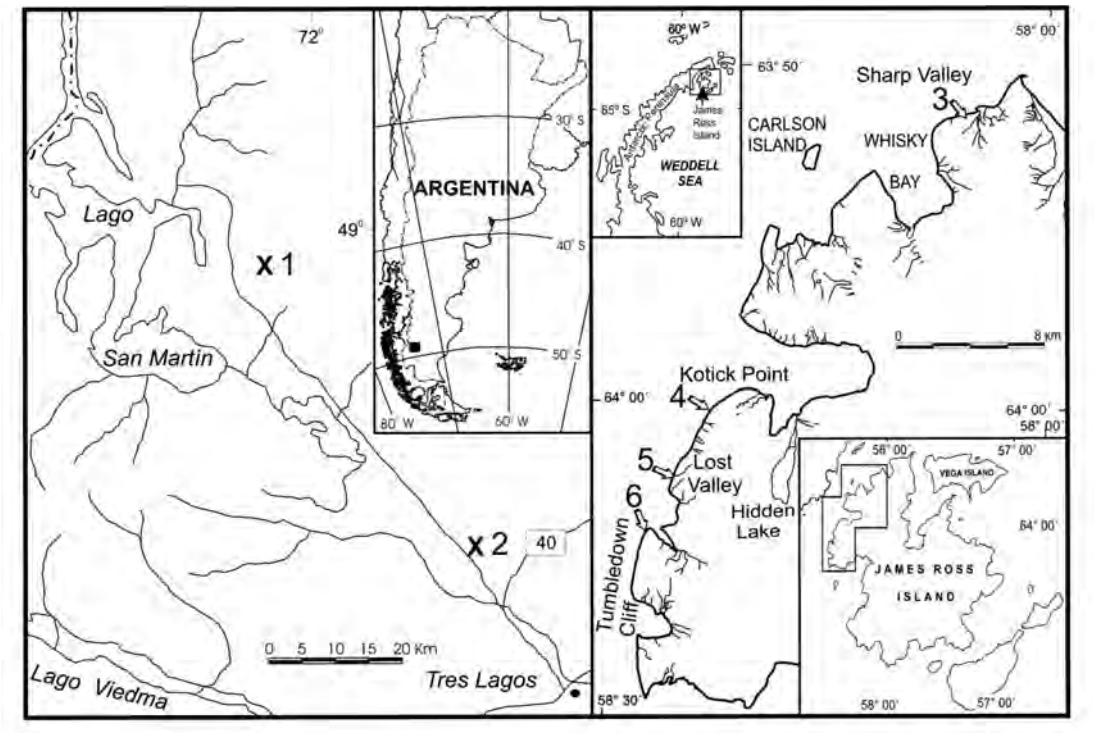

Fig. 1. Index and locality maps of investigated regions in Patagonia and Antarctic Peninsula. Locality numbers as in descriptions of stratigraphic sections.

stones and conglomerates of the Kachaike and Piedra Clavada formations. Late Cretaceous sequences consist of continental and pyroclastic rocks. Marine Upper Cretaceous is mostly restricted to south of 49° 30' S.

1.) Estancia La Federica, Lago San Martin, east of Estancia La Federica, at the headwaters of Arroyo Calafate (see Fig. 1).

General stratigraphy and Lower Cretaceous fossils were studied by Stolley (1912), Bonarelli & Nágera (1921), Piatnitzky (1938), Leanza (1970), Waterhouse & Riccardi (1970), Riccardi (1971, 1976, 1977, 1988), Riccardi et al. (1987), Aguirre Urreta & Riccardi (1988), Riccardi & Medina (2002), and Medina & Riccardi (2005). The succession consists of the Kachaike, Río Mayer and Springhill formations, and has been described in detail by Riccardi & Medina (2002) and Medina & Riccardi (2005).

Material here described under *Ptychoceras hamaimense* Pervinquière comes from a level of the Rio Mayer Formation, 475-500 m above base.

The fossil assemblage includes: *Peltocrioceras deeckei* (Favre), *Tetragonites heterosulcatus* Anthula, *Sanmartinoceras walshense* (Etheridge), *Sinzovia piatnitzkyi* and *S. leanzai* Riccardi et al., *Ptychoceras hamaimense* Pervinquière, *Pseudosilesites russoi* (Leanza), *Neoastieria patagonica* Medina & Riccardi. *Peltocrioceras deeckei* Assemblage Zone (Jacobi Zone), Late Aptian.

2.) Estancia La Vega, c. 34 km NW of Tres Lagos and 7 km E of Estancia La Vega (see Fig. 1).

Ammonoids were first discovered and described by Medina & Martinioni (1999) and Medina & Riccardi (2005, 2007). The succession consists of Piedra Clavada and Río Mayer formations and is well documented and dated by brancoceratid ammonites.

Material here described under *Ptychoceras adpressum* (J. Sowerby), comes from the Rio Mayer Formation, 13-14 m above base, associated with: *Puzosia vegaensis* Leanza, *Dipoloceras cristatum* (Brongniart), *D. elegans* Haas, *Hysteroceras leanzai* Medina & Martinioni, *Eomarshallites espinosum* Medina & Rinaldi, *E. hybridum* Medina &

RINALDI, *Myloceras* spp., *Labeceras* spp., and *Tuberosciponoceras insolitum* MEDINA & RICCARDI. *Puzosia vegaensis* Assemblage Zone (~ Inflatum Zone), Late Albian.

Antarctica. – James Ross Island is adjacent to the northeastern Antarctic Peninsula. Cretaceous strata on James Ross Island comprise a thick succession of Barremian? – Maastrichtian age and are divided into two major lithostratigraphic units: the Gustav Group (INESON et al. 1986) and the Marambio Group (OLIVERO et al. 1986).

The Cretaceous deposits of the Gustav Group are exposed in western James Ross Island forming a belt about 50 km in length. The group includes, from base to top, the Lagelius Point and Kotick Point formations, an unnamed unit, Whisky Bay Formation and Hidden Lake Formation (INESON et al. 1986; MEDINA et al. 1992). The group is characterised by thick sequences of conglomerates, breccias, sandstones and mudstones, all with marked lateral and vertical facies variations. Detailed stratigraphy of the measured sections and fossils indicate that the age ranges from Barremian? – Aptian to Coniacian – Santonian (INESON et al. 1986; MEDINA et al. 1992; MEDINA & BUATOIS 1992).

Ptychoceratidae from Antarctica were described and/or figured by THOMSON (1974, 1983) based on material from Alexander Island, west of the Peninsula, and were unknown from James Ross Island, east of Antarctic Peninsula.

All ammonites here described were collected from the Kotick Point Formation at four different localities at the west side of James Ross Island (Fig. 1). The Upper Albian stratigraphy has been described by MEDINA & RICCARDI (2006).

3.) Sharp Valley, about 1.3 km east of Stoneley Point.

Material here described under *Ptychoceras hamaimense* comes from a level, 291-298 m above base, of the Kotick Point Formation. In this interval three ammonoid levels with Albian ammonoids were found. The lowest with *Pictetia* sp. and *Sobraliceras stoneleyi* MEDINA & RICCARDI; the middle, 5 m higher, with *Ptychoceras hamaimense, Tetragonites heterosulcatus*, and *Phyllopachyceras* sp.; and the uppermost with *Neoastieria antarctica* MEDINA & RICCARDI, and *Feruglioceras* cf. *piatnizkyi* LEANZA. *Pictetia* Assemblage Zone (~ Tardefurcata Zone), Early Albian.

4.) Kotick Point, about 2.1 km southwest of Kotick Point.

Material here described under *P. hamaimense*, comes from a level 205.8-206.2 m above base, of the Kotick Point Formation. The fossil assemblage includes *Tetragonites heterosulcatus, Umsinenoceras* sp. nov., *Piatnitzkyceras thomsoni* MEDINA & RICCARDI and *Sobraliceras*? sp. nov. *Pictetia* Assemblage Zone (~ Tardefurcata Zone), Early Albian.

About 2.1 km south of Kotick Point, one specimen of *Ptychoceras adpressum* was collected from reworked fine-grained clasts that occur within conglomerates of the ?Whisky Bay Formation, at 530 m above the base of the stratigraphic section. These clasts have also yielded *Myloceras* sp. and *Puzosia* sp., indicating Late Albian.

5.) Lost Valley, about 6.2 km southwest of Kotick Point.

The uppermost Albian is exposed in the southern limb of the Lost Valley where the succession of the Kotick Point Formation is 290 m thick (Fig. 1). The upper 270 m are predominantly volcaniclastic. The succession, here described for the first time, is as follows, from above:

20 m (at 270-290): coarse breccias and conglomerates and medium-coarse sandstones.

40 m (at 230-270): fine- to medium grained sandstones with subordinate coarse conglomerates. Abundant and well-preserved inoceramids occur between 230 and 283 m. *Inoceramus carsoni* is abundant between 230-280 m, *Inoceramus shuterlandi* has been recorded mainly between 253-283 m. This interval has yielded a diverse ammonite fauna of *Cymatoceras* cf. *virgatum* (SPENGLER), *Hypophylloceras androiavense* BESAIRIE, *Anagaudryceras buddha* FORBES, *Anagaudryceras pulchrum* (CRICKMANN), *Kossmatella* cf. *agassizianus* (PICTET), *Tetragonites rectangularis* WIEDMANN, *Ptychoceras adpressum* (J. SOWERBY), ?*Eoscaphites* cf. *subcircularis* SPATH, *Myloceras* sp., *Puzosia* sp. *Tetragonites* Assemblage Zone (Inflatum Zone), Late Albian.

35 m (at 195-230 m): coarse conglomerates, sandstones and poorly sorted breccias.

105 m (at 90-195 m): medium to coarse sandstones and siltstones. At base is a 0,7-1,5 m thick level with abundant *Puzosia* sp., *Ptychoceras* cf. *forbesianum* STOLICZKA, a single *Inoceramus* sp. and other bivalves. *Puzosia* sp. has also been recorded in higher beds, especially at 90-128 m. *P. forbesianum* Assemblage Zone, Middle Albian.

20 m: grey-green coarse conglomerates and medium-grained sandstone.

STAGE		EUROPEAN STANDARD	"ASSEMBLAGE ZONES"	
			PATAGONIA	ANTARCTICA
ALBIAN	Upper	Dispar	*Mariella patagonica*	*Tetragonites*
		Inflatum	*Puzosia vegaensis*	
	Middle	Lautus		*P. forbesianum*
		Loricatus		
		Dentatus	*Sanmartinoceras patagonicum*	
	Lower	Mammillatum	*Aioloceras rollerii*	*Aioloceras*
			Aioloceras argentinum	
		Tardefurcata		*Pictetia*
APTIAN	Upper	Jacobi	*Peltocrioceras deeckei*	*Peltocrioceras*
		Nolani	*Australiceras hallei*	*Australiceras*
		Nutfieldiensis		
		Tschernyschewi		
		T. drewi	*Tropaeum magnum*	
	Lower	Bowerbanki		
		Deshayesi		
		Tenuicostatus		

Fig. 2. Aptian – Albian assemblage zones of southern Patagonia and James Ross Island, Antarctica, compared with the European standard chronozones.

70 m: mudstones and siltstones, with subordinate intercalations of fine sandstones. The fauna is relatively rare. The only ammonite found so far is a poorly preserved Desmoceratidae or Silesitidae.

6.) Tumbledown Cliffs.

The succession exposed at the northern end of Tumbledown Cliffs is 245-250 m thick and belongs to the Kotick Point Formation. It is here described for the first time and includes, from above:

70 m: poorly exposed.

115-150 m: interbbed fine to medium grained sandstones and fine grained conglomerates. Upper levels contain a distinctive fauna of bivalves and ammonoids: *Inoceramus carsoni, I. shuterlandi, Aucellina* sp. and *Maccoyella* sp. dominate. These levels have also yielded *Anagaudryceras buddha, A. pulchrum, Tetragonites rectangularis, Puzosia sp., and Ptychoceras adpressum*. *Tetragonites* Assemblage Zone, Late Albian.

60 m: medium to fine grained silty sandstones with intercalated coarse conglomerates, while higher levels of the basal sandstone are mainly mudstones. Coarsed-grained conglomerates and breccia-conglomerates predominate at c. 55 m above the basal sandstone.

3. Biostratigraphy and age

Taxonomic similarity between the Patagonian and Antarctic invertebrate faunas had been assumed for a long time (see THOMSON 1982) because of geographic proximity and identity of geologic setting. The Early Cretaceous faunas from Patagonia, however, are relatively better preserved and known, so that Lower Cretaceous, Patagonian ammonite biostratigraphy is

more detailed and more easily compared with the European zonation (see Fig. 2). Hence, identification of the same species in both regions is relevant in order to improve the Lower Cretaceous biostratigraphy of the whole area.

The existing bio- and chronostratigraphical zonation for the Aptian-Albian of southern Patagonia has recently been discussed by RICCARDI & MEDINA (2002), MEDINA & RICCARDI (2005, 2006) and, for Antarctica, has been dealt with by MEDINA & BUATOIS (1992), with slight modifications and additions by MEDINA et al. (2003) and MEDINA & RICCARDI (2006).

The Patagonian ammonite assemblage zones previously recognized include, from below, the *Tropaeum mangum* Zone (Lower Aptian), *Australiceras hallei – Peltocrioceras deeckei* Zones (Upper Aptian); *Aioloceras argentinum – A. rollerii* (Lower Albian) – *Sanmartinoceras patagonicum* Zones (Middle Albian); and the *Puzosia vegaensis* – ?*Mariella patagonica* Zones (Upper Albian). To the species listed for each zone by MEDINA & RICCARDI (2006), *Ptychoceras hamaimense* is here added to the *Peltocrioceras* Zone, and *Ptychoceras adpressum* to the *P. vegaensis* Zone.

In Antarctica the ammonite assemblage zones now recognized are, from below, the zones of *Australiceras, Peltocrioceras* (Upper Aptian) *Ptychoceras, Aioloceras* (Lower Albian), and *Tetragonites* (Upper Albian). No *Ptychoceras* has been found in Aptian strata, so that no changes or additions are proposed to the previous listings of fossils provided for the Aptian zones by MEDINA & RICCARDI (2006).

In the Albian, the *Ptychoceras* Assemblage Zone is here characterized by *Ptychoceras hamaimense*, which is added to the taxa listed for that zone by MEDINA & RICCARDI (2006). Because *P. hamaimense* also occurs in Upper Aptian levels of other regions, e. g. Patagonia, and the genus *Ptychoceras* ranges into the Upper Albian, as in Antarctica, the name of this zone has to be changed. We propose here to call it the *Pictetia* Assemblage Zone.

Above the succeeding *Aioloceras* Assemblage Zone (= *Anopaea* Zone of MEDINA AND BUATOIS, 1992; see MEDINA et al. 2003; MEDINA & RICCARDI 2006), MEDINA & BUATOIS (1992) recognized a "Faunula of *Tetragonites*", based on material found at Lost Valley and Tumbledown. Taxa included were: *Cymatoceras* cf. *virgatum* (SPENGLER), *Hypophylloceras androiavense* BESAIRIE, *Anagaudryceras buddha* FORBES, *A. pulchrum* (CRICK), *Kossmatella* cf. *agassiziana* (PICTET), *Tetragonites rectangularis* WIEDMANN, ?*Eoscaphites* cf. *subcircularis* SPATH, *Myloceras* sp., *Puzosia* sp., *Inoceramus carsoni* and *I. shuterlandi*. From this zone also comes *Ptychoceras adpressum*.

At Lost Valley, below the *Tetragonites* Assemblage *Zone, is a level with Puzosia sp., Inoceramus sp. and Ptychoceras* cf. *forbesianum*. Although no other diagnostic fossils have been found at this level, it can be dated as Middle – Late Albian.

4. Systematic palaeontology

Terminology and dimensions (in mm): phr., phragmocone; b.ch., body chamber; S_1, S_2, S_3, first, second, and third shaft (from oldest to youngest); L, H, W, length, heigth and width of shaft.

Repository: MLP, División Paleozoología Invertebrados, Museo de La Plata, Paseo del Bosque s/n, 1900 La Plata, Argentina.

Order Ammonitida ZITTEL, 1884
Suborder Ancyloceratina WIEDMANN, 1966
Family Ptychoceratidae GILL, 1871

Remarks: The Family Ptychoceratidae was introduced by GILL (1871: 3), mentioning *Ptychoceras*, with a reference to CHENU (1859: 94) where the genus was atributed to D'ORBIGNY, 1842, and the only species mentioned and figured was "*P. gaultinus*, PICTET" (type species of *Hemiptychoceras* SPATH, 1925). The relationship of *Ptychoceras* and the Ptychoceratidae to other Ancyloceratina was discussed by WIEDMANN et al. (1990) and WIEDMANN & KAKABADZE (1993) using sutural ontogeny and by MONKS (1999) on the basis of cladistic analysis.

Genus *Ptychoceras* D'ORBIGNY, 1842
(= *Diptychoceras* GABB, 1869; *Mastigoceras* BÖHM, 1926; *Tricoloceras* WHITEHOUSE, 1928; *Mastigohamites* BREISTROFFER, 1947)

Type species: *Ptychoceras emericianum* D'ORBIGNY (1842: 555, pl. 137, figs. 1-4, from the Upper Aptian of France; by subsequent designation of DIENER (1925: 77).

Diagnosis: Planospiral initial whorl, followed by a long, straight, slowly increasing first shaft, attached to dorsum of rather long second shaft, and with third shaft tightly overlapping first; smooth or with fine ribbing and constrictions; suture with bifid or trifid lobes.

Remarks: The genus *Ptychoceras* was introduced by D'ORBIGNY (1842: 554) including three species, two of them described by D'ORBIGNY (1842) as *P. emericianum* D'ORBIGNY (1842: 555, pl. 137, figs. 1-4) and *P. puzosianum* (p. 557, pl. 137, figs. 5-7), an a third previously introduced by J. SOWERBY (1814: 140) as *Hamites depressus.*

As stated by Egoian (1968: 230), both species described by d'Orbigny (1842) were based on incomplete specimens. Two examinations of the type material by one of us (ACR) in the Muséum National d´Histoire Naturelle, Paris, has confirmed this observation (see also Busnardo, in Fischer 2006: 162). Furthermore, d'Orbigny's figures of *P. emericianum* (pl. 137, figs. 1-4; fig. 2 refigured in Roman 1938: 49, fig. 5.45a; fig. 1 refigured in Arkell et al. 1957: L216, fig. 242; figs. 1-2 refigured in Orlov 1958, pl. 23, figs. 4a-b, as "*P. puozosianum*") do not agree with either the specimen labeled as "type" in the collection or with the other eight existing specimens (five from "Lioux" and three from "Castellane"). This agrees with d'Orbigny's indication (1842: 557; see also Egoian 1969: 143; Busnardo, in Fischer 2006: 162) that the drawing of his fig. 1 is a reconstruction based on several specimens. d'Orbigny's collection also includes a plaster cast, labeled as "type", (which was designated the lectotype, Busnardo in Fischer 2006: 162, pl. 31, fig. 5, since d'Orbigny did not explicitely designated it as type in his text). The original specimen came from "Barrême (Alpes M^{mes}), Coll. E.N.S.M." (and is in the "Ecole des Mines, Universite de Lyon-Villeurbanne, Rhône"). It consists of two incomplete shafts, the older is 96.9 mm long, with a subcircular section (H = 6.5 - c. 8.5 m, W = 5.2 - 10 mm) and is completely smooth, except for some fine growth lines. The youngest shaft, where part of dorsum is missing, is 36.8 mm long, and has a maximum width of 11.3 mm, and 26 fine scale-like ribs. There is no evidence of the initial stages of the first shaft as depicted in d'Orbigny (1842, pl. 137, fig. 1). The specimen figured by Busnardo (in Fischer 2006, pl. 31, fig. 4, attributed to "Lioux", but labeled as coming from "Castellane"), consists of two parallel not touching shafts.

The "new" specimen of *P. emericianum* figured by Wright (in Wright et al. 1996: 232, fig. 181.3b-c), which is clearly a plaster cast, does not agree with the holotype and was not present in d'Orbigny's collection when one of us (ACR) examined it. Wright's specimen shows the first and second shafts, both tightly attached and with transverse ribs, plus two hooks; the third shaft is missing. Additional material of *P. emericianum* has been figured by Ooster (1860, pl. 58, figs. 5-6), Avram (1970, pl. 1, fig. 1; 1976: 25, pl. 2, fig. 8), and Thomel (1980: 57, fig. 97).

It is quite certain that *Ptychoceras* is a heteromorph characterized by three tightly bent shafts with one initial planspiral whorl (see Mikhailova 1974, 1983; Druzczic et al. 1977; Druzczic & Doguzhaeva 1981; Doguzhaeva & Mutvei 1989, 1993; Wiedmann et al. 1990). There is no published evidence supporting Szives & Monk's (2002: 1140) contention on a possible fourth shaft.

It follows that *Diptychoceras* Gabb (1869: 143), with *D. laevis* Gabb (= *Ptychoceras gabbi* Pervinquière 1907: 91) as type species, is a junior synonym of *Ptychoceras* – both were considered identical but for the alleged difference in the number of shafts, assumed to be two in the first and three in the second.

Mastigoceras Böhm (1926: 202), non *Mastigoceras* Handschin, 1924, = *Mastigohamites* Breistroffer (1947: 100), with *M. adpressum* (Sowerby) as type species, was distinguished on supposed sutural differences (see Spath 1941: 656-657; Breistroffer 1952: 50; Schindewolf 1961: 104-105; Wiedmann 1962: 88-89), but these were rejected by Wiedmann & Dieni (1968: 49) and Wiedmann et al. (1990): the suture of *P. adpressum* does not differ from that of typical *Ptychoceras*.

Tricoloceras Whitehouse (1928: 278-279), proposed without diagnosis for "*Ptychoceras* (?) *closteroides*" Etheridge (1904: 110-112) but based on Etheridge's (1904) assumption that *P. closteroides* agreed with *Ptychoceras*, *Diptychoceras* and *Solenoceras* in the number and disposition of the shafts. However, it is now known that *P. closteroides* has the same generic features shown by other species of *Ptychoceras.*

The other species included by d`Orbigny (1842) in *Ptychoceras*, i. e. *P. puzosianum*, differs from *P. emericianum* by its larger size, compressed (?by diagenesis) whorl section and widely spaced transverse striae. The lectotype, designated by Busnardo (in Fischer 2006: 163, pl. 31, fig. 6) from the five existing syntypes, consists of two shafts (2nd and 3rd) of similar length (L = 60.7 mm), closely attached to each other, compressed and with widely spaced scale-like ribs. It clearly belongs in *Ptychoceras*, despite its supposed close relationship to *Euptychoceras meyrati* (Ooster) mentioned by Busnardo (in Fischer 2006: 163; see also Breistroffer 1952: 51). Other material referred to *P. puzosianum* has been figured by Ooster (1860: 85, pl. 58, figs. 7-8), Uhlig (1883: 95, pl. 14, fig. 1), ?Rouchadze (1938a: 177, pl. 1, fig. 3), Vialli (1949: 58, fig. 22), Druzczic & Kudriavtseva 1960: 266, pl. 11, figs. 3-4), Egoian (1969, p. 147, pl. 7, fig. 6), Neagu (1970, p. 152, pl. 1, fig. 5); Vašiček (1972: 64, pl. 8, fig. 3), Mikhailova (1983, fig. 55), Immel (1987: 127, pl. 14, fig. 6). Barremian-Lower Aptian, France, Austria, Italy, Romania, Germany, Switzerland, Czech Republic, Georgia.

A large number of species and specimens were included in *Ptychoceras* since d`Orbigny`s (1842) inception, but most of them were later transferred to other families and genera.

Ptychoceras aequicostatum Gabb (1864: 74, pl. 13, fig. 20; 1869: 141, pl. 25, fig. 20) became the type species of *Helicancylus* Gabb, 1869. *P. morloti* Ooster (1860: 84, pl. 60, figs. 1-3) and *P. humboldtianus* Karsten (1858: 101, pl. 1, fig. 1; 1886, pl. 1, fig. 1), were considered to belong in, or be transitional to, *Anahamulina* Hyatt, 1900, or *Euptychoceras* (see Breistroffer 1952: 52; Vašiček 1972: 65).

Ptychoceras gaultinum Pictet (in Pictet & Roux 1847: 139, pl. 15, figs. 5-6), as well as *P. tropicum* Kossmat (1895: 150), and *Ptychoceras fauncei* Haas (1942: 185, pl. 45, fig. 2), were placed in *Hemiptychoceras* Spath, 1925. *Ptychoceras smithi* Woods (1896: 74, pl. 2, fig. 2) became the type species of *Metaptychoceras* Spath, 1926.

Ptychoceras pseudogaultinum Yokoyama (1890: 181, pl. 20, figs. 1-3) became the type species of *Polyptychoceras* Yabe, 1927, a genus that also includes *Ptychoceras vancouverense* Whiteaves (1879: 113, pl. 14, fig. 3), and probably the "*Ptychoceras* sp. ind. aff. *gaultinum Pict. aff.*" of Schmidt (1873: 16, pl. 2, figs. 12-16).

Ptychoceras sipho Forbes (1845, p. 118, pl. 11, fig. 5) became the type species of *Phylloptychoceras* Spath, 1953,

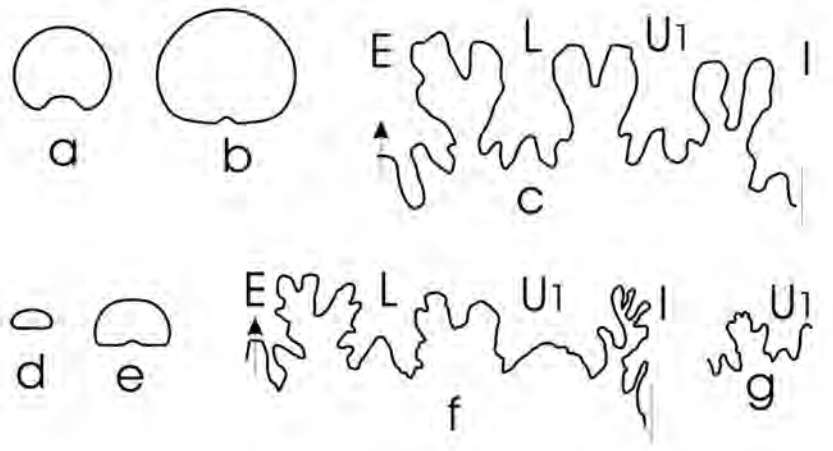

Fig. 3. a-c – *Ptychoceras hamaimense* PERVINQUIÈRE, Lago San Martin, Patagonia, Upper Aptian, MLP 17490; a-b, section of phragmocone (H = 5.4 mm, W = 6.2 mm) and body chamber (H = 7.4 mm, W = 9 mm), x2; c, suture at H = 1.8 mm and W = 2 mm. **d-g** –, *Ptychoceras adpressum* (J. SOWERBY), Kotick Point, Antarctica, Upper Albian, MLP 31856; d-e, section of phragmocone at H = 1.2 mm, W = 2.6 mm and H = 3.1 mm, W = 5 mm, x2; f-g, suture at H = 2.4 mm, W = 3.4 mm, and H = 1.2 mm, W = 2.6 mm.

and *Ptychoceras zelandicum* MARSHALL (1926, p. 157, pl. 32, figs. 11-12) the type species of *Astreptoceras* HENDERSON (1970: 28).

Ptychoceras meekanum WHITFIELD (1880: 457, pl. 16, figs. 1-2) became the type species of *Spiroxybeloceras* KENNEDY & COBBAN (1999), a genus that also includes *Ptychoceras humei* DOUVILLE (1928: 37, pl. 6, figs. 9-10).

Ptychoceras crassum WHITFIELD (1880: 459, pl. 16, figs. 3-5) became the type species of *Oxybeloceras* HYATT, 1900, which according to WRIGHT (in WRIGHT et al. 1996) is a subjective junior synonym of *Solenoceras* CONRAD, 1860. Material from the Campanian – Maastrichtian of USA, referred to *Ptychoceras* but probably belonging in *Solenoceras*, was described under *Ptychoceras mortoni* MEEK (1876: 412, pl. 20, figs. 4a-c), a species also recorded as "*P. solanoense*" by ANDERSON (1902: 90, pl. 9, fig. 184).

Ptychoceras meyrati OOSTER (1860: 82, pl. 59, figs. 1-4; WINKLER 1868: 21, pl. 3, fig. 6; SARASIN & SCHONDELMAYER 1902: 173, pl. 25, figs. 1-2; KARAKASCH 1907: 155, pl. 4, fig. 5, pl. 25, fig. 7; ROUCHADZE 1938a: 177, pl. 1, fig. 4; VAŠIČEK 1972: 66, pl. 10, fig. 1; IMMEL 1987: 127, pl. 14, fig. 9; VAŠIČEK 1999: 218, pl. 1, figs. 4-6; ?including *Ptychoceras inornatum* SIMIONESCU 1898: 122, pl. 2, figs. 5-6, *P. poni* SIMIONESCU, 1898: 121, pl. 1, fig. 12, *P. inostranzewi* [*biassalense*] KARAKASCH, 1907: 155, pl. 4, fig. 1, DRUZCZIC & KUDRIAVTSEVA 1960: 266, pl. 11, fig. 8, FÜLOP 1964, pl. 16, fig. 10, DIMITROVA 1967: 85, pl. 38, fig. 2, *P. natrice* ANDERSON 1938: 218, pl. 61, fig. 2, *P. curnieri* THIEULOY, 1972: 44, pl. 5, fig. 6, *P. dittleri* VAŠIČEK, 1972: 67, pl. 10, figs. 2-3, AVRAM 1970, pl. 1, fig. 4, 1976: 26, pl. 2, fig. 5, and *P. obliquesulcatum* AVRAM, 1976: 26, pl. 2, figs. 6-7, text-fig. 6), from the Upper Hauterivian – Barremian of Switzerland, Central Europe, Caucasus, and ?California, became the type species of *Euptychoceras* BREISTROFFER, 1952 (probably including *Pseudoptychoceras* ETAYO SERNA, 1979, from Colombia, but see KAKABADZE et al. 2004: 532, 539), the only other valid ptychoceratid known besides *Ptychoceras*.

Supposed *Ptychoceras* were also recorded from the Upper Albian of Canada and ?India (*Ptychoceras glaber* WHITEAVES, 1884: 213, pl. 24, fig. 2; KOSSMAT 1895: 150, pl. 20, fig. 7; MCLEARN 1972: 74, pl. 43, fig. 2A-B, pl. 44, figs. 2-3, pl. 45, figs. 1-2, 4); Pliensbachian of Spain (CISNEROS 1935a-b), Lower Aptian of Georgia (ROUCHADZE 1938a: 177, pl. 1, fig. 5; 1938b: 192, pl. 1, figs. 2, 6); Upper Aptian of Madagascar (COLLIGNON 1962: 15, pl. 221, fig. 963); Lower Barremian of Hungary (FÜLOP 1964, pl. 16, figs. 9, 15; pl. 18, fig. 8; pl. 29, fig. 2); Barremian of Cuba (MYCZYNSKI 1977: 163, pl. 6, fig. 6, as "*Ptychoceras* cf. *morloti* OOSTER" =?*Euptychoceras*); Middle Albian of Colombia (ETAYO SERNA et al. 1980: 28, fig. 2a).

Sexual dimorphism in *Ptychoceras* has been mentioned by KENNEDY et al. (2000: 685) for *P. hamaimense* PERVINQUIÈRE. It could be represented by material placed under *P. renngarteni* EGOIAN (1968: 230, fig. 1.1-1.6; 1969: 143, pl. 5, figs. 1-3, pl. 6, figs. 1-3, pl. 22, fig. 20; see also DOGUZHAEVA & MUTVEI 1989, pl. 2, fig. 4), *P. parvum* EGOIAN (1968: 230, figs. 1-7; 1969: 145, pl. 7, figs. 1-3, pl. 22, fig. 21) and *P. laevigatum* EGOIAN (1969: 146, pl. 7, fig. 4, pl. 22, fig. 22), which appears to have similar features, i.e. depressed whorls and presence of fold-like ribs at beginning of second and middle of third shaft, but differs in the larger size of *P. renngarteni.*

Adult *Ptychoceras* are regarded as necto-benthonic (see KAKABADZE & SHARIKADZE, 1993).

Occurrence: *Ptychoceras* is late Aptian – late Albian in age, and has been recorded from England, France, Spain, Italy, Switzerland, Austria, Hungary, west Carpathians,

North Africa, Madagascar, Caucasus, Iran, southern India, Australia, New Zealand, Alaska, British Columbia, California, Mexico, North Atlantic, Colombia, Patagonia, and Antarctica.

Ptychoceras adpressum (J. Sowerby, 1814)
Figs. 3 d-g, 4 a-n

1814 *Hamites adpressus* J. Sowerby, p. 140, pl. 61, fig. 6.
1923 *Ptychoceras Gracillimum*. – Böse, p. 136, pl. 9, figs. 34-41, 58.
1923 *Diptychoceras Mazapilense*. – Böse, p. 137, pl. 10, figs. 1-8.
1926 *Mastigoceras adpressum*. – Böhm, p. 202, pl. 10, figs. 1-5.
1932 *Ptychoceras* cf. *glaber* Whiteaves. – Collignon, p. 24, pl. 4, figs. 20-21.
1941 *Mastigoceras adpressum* (J. Sowerby). – Spath, p. 657, text-figs. 241 a-c, d (Sowerby's specimen refigured), e-m.
?1961 ?*Ptychoceras* sp. – Vella, p. 1, text-figs. 1-6.
1961 *Mastigohamites adpressus* (Sow.). – Schindewolf, p. 739, text-fig. 57 (Spath's 1941, text-fig. 241 l-m refigured).
?1968 *Ptychoceras adpressum* (J. Sowerby). – Wiedmann & Dienei, p. 50, pl. 4, fig. 14, text-figs. 17-18.
1971 *Ptychoceras adpressum* (J. Sowerby). – Hollis, p. 592-594, text-fig. 1a-d.
?1973 *Ptychoceras* sp. – Henderson, p. 80, fig. 3 a-f (Vella's figs. 1-6 refigured).
pars 1974 "*Ptychoceras* sp.". – Thomson, p. 22, pl. 3, fig. o, non fig. l, text-fig. 5 (pars).
1990 *Ptychoceras adpressum* (J. Sowerby). – Henderson, p. 125, fig. 10 A-F.
1997 *Ptychoceras adpressum* (J. Sowerby). – Kennedy et al., p. 467, pl. 7, figs. 7, 11.

Material: La Vega, Santa Cruz province (F. Medina coll.), Late Albian: 2 incomplete specimens, one (MLP 31854) with phragmocone consisting of end of first shaft and complete second shaft, and almost complete body chamber beginning at end of second shaft and extending into third shaft; the other (MLP 31855) consists of two fragments, the smaller with part of the second shaft and the larger with end of phragmocone and body chamber, forming a tight hook. J. Ross. Island, Kotick Point (F. Medina coll.), Late Albian: 1 incomplete phragmocone (MLP 31856) consisting of end of first shaft and almost complete shaft; Lost Valley: 1 almost complete specimen, MLP 31857, with first and second shaft formed by phragmocone and end of second shaft and third shaft by body chamber (VL5); Tumbledown: 1 incomplete specimen (MLP 31858) with part of second shaft and third shaft belonging to end of phragmocone and body chamber.

Description: First phragmocone shaft up to 25 mm in lenght and including adoral end, with subrounded to depressed section (H/W = 0.9–0.63); first with rounded flanks, venter and dorsum, but with narrowly curved flanks and broadly rounded venter when depressed; dorsum becoming flat towards hook, which is tightly bent and asymmetric in outline. Surface smooth.

Second shaft 22.3-42 mm in lenght, consisting of end of phragmocone and beginning of body chamber; section becoming strongly depressed (H/W = 0.89 – 0.64), with broadly rounded venter, narrowly convex flanks and concave dorsum. Surface smooth. Close to shaft beginning and marking inception of a very depressed section, broad and shallow constriction, prorsiradiate on flanks and adapically concave on venter. Body chamber hook tightly bent with an asymmetric outline. Body chamber incomplete on third shaft, preserved only up to 166 mm length, becoming more depressed than in second shaft (H/W = 0.68), with broadly rounded venter, narrowly curved flanks and impressed dorsum. Surface smooth, with oblique slightly asymmetric rib and constriction near end of body chamber. Aperture not preserved.

Suture with E, L, U, I, changing from first to second shaft, U becoming broader (?and asymmetric) and I/U saddle becoming narrower.

Measurements (in mm):

	S1				S2				S3			
	L	H	W	H/W	L	H	W	H/W	L	H	W	H/W
La Vega MLP31854	25	1.7	2.7	0.63	33.5	2.00	2.25	0.89	16	3.0	4.4	0.68
Kotick Pt. MLP31856	+13	1.8	2.6	0.69	22.3	22→31	28→48	0.78→0.64	–	–	–	–
VL5 MLP31857	+14.4	1.5	1.6	0.9	42	2.5	3.7	0.67	–	–	–	–
Tumbledown MLP31858	–	–	–	–	–	–	–	–	17	–	–	–

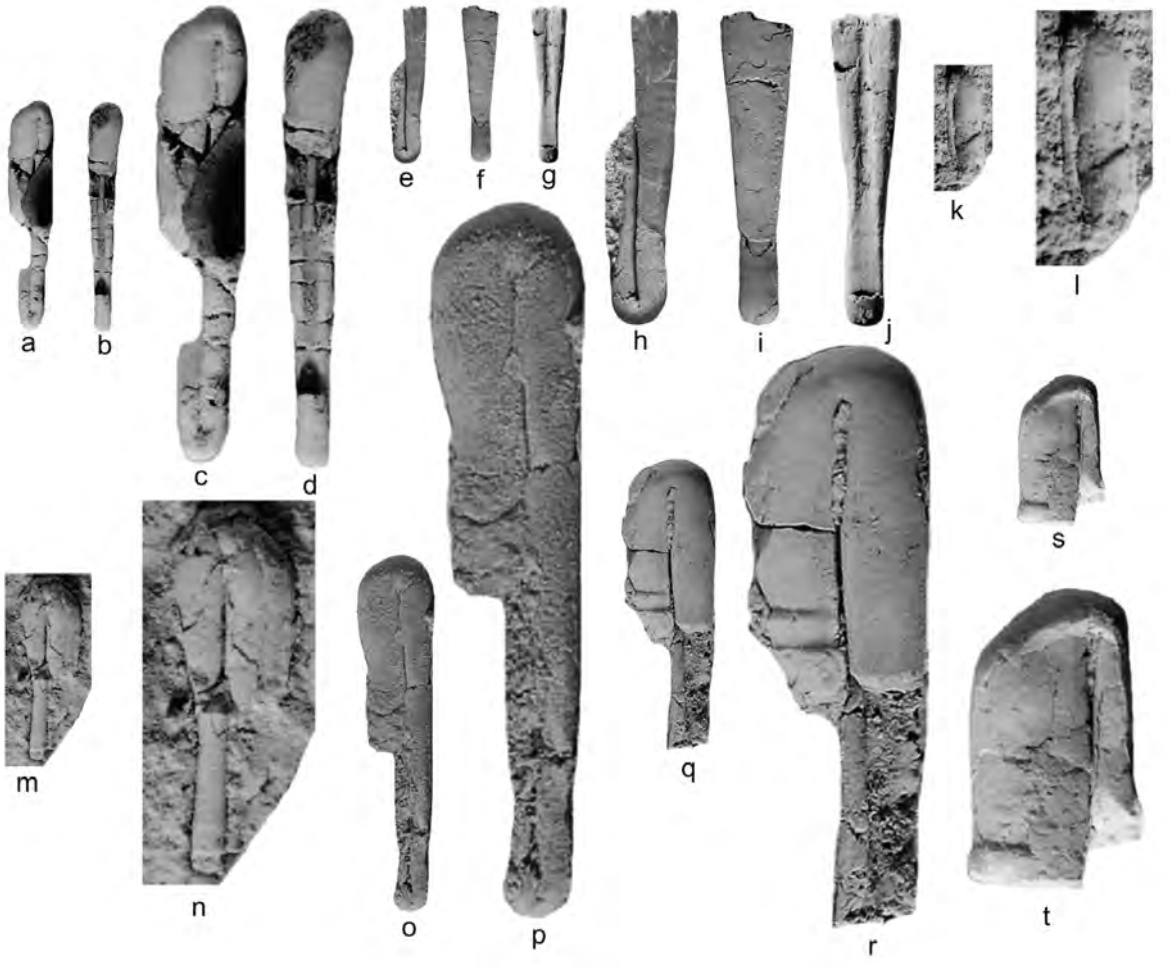

Fig. 4. a-n – *Ptychoceras adpressum* (J. SOWERBY), Upper Albian; a-d, La Vega, Patagonia, phragmocone and body chamber, MLP31855, lateral and apertural views, a-b x 1; c-d, same specimen x 2; e-j, Kotick Point, Antarctica, phragmocone, lateral, ventral and dorsal views, MLP 31856, e-g x 1; h-j, same specimen, x2; k-n, Tumbledown (k-l) and Lost Valley (m-n), Antarctica, phragmocone and body chamber, MLP 318578 and MLP 31857, lateral views, k, m x 1, l, n, same specimens x 2. **o-p** – *Ptychoceras* cf. *forbesianum* STOLICZKA, Lost Valley, Antarctica, Middle-Late Albian, phragmocone and body chamber, MLP 31859, lateral view, o x 1, p same specimen x2. **q-t** – *Ptychoceras hamaimense* PERVINQUIÈRE; q-r, Lago San Martin, Patagonia, Upper Aptian, phragmocone and body chamber, MLP 17490, lateral view, q x 1, r same specimen x 2; s-t, Sharp Valley, Antarctica, Lower Albian, phragmocone and body chamber, MLP 31860, lateral view, s x 1, t same specimen x 2.

Remarks: The original description of *Ptychoceras adpressum* (SOWERBY 1814: 140, pl. 61, fig. 6) was incomplete and based on a single specimen with only parts of the first and second shafts, from the Upper Albian of Folkestone, Kent, England. The species became better known through later topotypes (SPATH 1941: 657, text-fig. 241) and specimens from the region (HOLLIS 1971: 592-594, text-fig. 1). The species is characterized by its small size, smooth shell, and a deep constriction close to the beginning of second shaft, followed in some cases by faint costation. A specimen from the Upper Albian of Sardinia (WIEDMANN & DIENI 1968: 50, pl. 4, fig. 14, text-figs. 17-18) is poorly preserved, but also small and apparently smooth as the type. Material from the Upper Albian of Northern Australia described and figured by HENDERSON (1990: 125, figs. 10A-F) under this species agrees in all features.

Material from other regions placed in this species is coeval, with only minor morphologic differences. The specimen from the (?Late) Albian of the Netherlands (BÖHM 1926: 202, pl. 10, figs. 1-5) is also small and smooth, but has no constrictions on the second shaft. Material from the Upper Albian (Inflatum Zone, Varicosum Subzone) from SW France described and figured by KENNEDY et al. (1997: 467, pl. 7, figs. 7, 11) is typically small, but has irregular transverse ribs, folds, weak constrictions and growth striae.

Other material of this species includes a Late Albian specimen from Mont Raynaud, Madagascar, described by COLLIGNON (1932: 24, pl. 4, figs. 20-21) under "*Ptychoceras* cf. *glaber* WHITEAVES". It is small and smooth, but the first half of the second shaft is not preserved. The poorly preserved specimen from the Middle – Late Albian (STEVENS 1978: 354-357; STEVENS & SPEDEN 1978: 288) of New Zealand named "*Ptychoceras* sp." (VELLA 1961: 1, text-figs. 1-6; refigured in HENDERSON 1973: 80, fig. 3) is also small and smooth.

Material from the Upper Albian of Camacho, Mexico, described under "*Ptychoceras Gracillimum*" and "*Diptychoceras Mazapilense*" by BÖSE (1923: 136-137, pl. 9, figs. 34-41, 58; pl. 10, figs. 1-8), shows the typical features of *P. adpressum*, i.e. small size and smooth shell with a constriction close to beginning of second shaft, but this is followed by few blunt ribs that disappear towards mid-shaft.

The Patagonian and Antarctic material is identical with typical *P. adpressum*, as described by SOWERBY (1814) and SPATH (1941) in the small size, smooth shell with a constriction close to beginning of second shaft, and followed by a sudden expansion of whorl width. There is no evidence of other constrictions, thickenings, ribs or growth lines, as mentioned by HOLLIS (1971) and KENNEDY et al. (1997) for other European material of this species.

Material from Alexander Island, Antarctica, described THOMSON (1974: 22) under "*Ptychoceras* sp." includes two fragments of different size. One of them (pl. 3, fig. o) appears to belong to a small *Ptychoceras*, includes parts of two shafts and hook and, except for one rib, is smooth resembling *P. adpressum*. This specimen came from Succession Cliffs, locality C, and was dated (p. 37) as Albian on the basis of stratigraphic relationships. The larger specimen figured by THOMSON (1974, pl. 3, fig. l) does not belong in *Ptychoceras* and may be a fragment of *Lechites* Nowak. Another specimen from Keystone Cliff, Alexander Island, was compared by THOMSON (1983: 410, fig. 2) with *P. parvum* EGOIAN, but its affinities can not be confirmed on the basis of the provided figure.

Occurrence: Late Albian of England, Sardinia, The Netherlands, France, Mexico, Madagascar, Australia, ?New Zealand, Antarctica, and Patagonia.

Ptychoceras cf. *forbesianum* STOLICZKA, 1865
Fig. 4o-p

?1865 *Ptychoceras Forbesianum* STOLICZKA, p. 195, pl. 90, fig. 11.
?1904 *Ptychoceras* (?) *closteroides*. – ETHERIDGE, p. 110, pl. 15, figs. 6-9.

Material: Lost Valley, J. Ross Island (F. MEDINA coll., VL6), Middle Albian: 1 almost complete specimen (MLP 31859) with 3 shafts of phragmocone and body chamber, is embedded in sediment.

Description: Total length is 51.5 mm. First shaft of phragmocone thightly pressed against second shaft and partially covered by third shaft, near end with slightly depressed section with rounded venter and flanks, smooth, ending in a tightly bent hook; coiling asymmetric. Second shaft 51.5 mm long, consisting of phragmocone and body chamber, section depressed at phragmocone end (H = 4.2 mm, W = 5 mm, H/W = 0.84), with rounded venter and flanks; smooth. Hook on body chamber tightly bent and slightly asymmetric. Body chamber on third shaft almost complete, 20 mm long, slightly compressed near hook (H = 7 mm, W = 6 mm, H/W = 1.16), with rounded venter and flanks; ventral and lateral margins becoming progressively contracted towards aperture (H = 5.4 mm; W = 5.4 mm), which is subrounded and slighlty oblique with shorter ventral margin; smooth. Suture not visible.

Measurements (in mm):

	S2				S3			
	L	H	W	H/W	L	H	W	H/W
MLP	51.5	4.2	5.0	0.84	20	7	6	1.16

Remarks: The specimen from Antarctica is similar to material from the Upper Albian of India and Australia, respectively described under *Ptychoceras forbesianum* STOLICZKA (1865: 195, pl. 90, fig. 11; see also KOSSMAT 1895: 150) and *P. closteroides* ETHERIDGE (1904: 110, pl. 15, figs. 6-9).

The Indian type specimen, from the Upper Albian Moraviatoor (limestone), in the lower part of the Oatatoor (Uttattur) Group (see KOSSMAT 1895: 150), is almost complete. It includes the first shaft, most of the second and the complete third, is slightly smaller than the Antarctic specimen, but agrees in section, smooth surface, progressive contraction of the body chamber and aperture angle.

The Australian material of "*P. closteroides*", collected near Port Darwin, probably came from an assemblage containing also *Labeceras* and *Myloceras*, i.e. Late Albian (HENDERSON 1990; HENDERSON et al. 2000). It consists of the beginning of the phragmocone in first shaft, body chamber represented at end of second shaft, and third shaft. It is slightly smaller than the Antarctic specimen, but agrees in section, smooth surface and contraction of body chamber in third shaft. Similarity between the Indian and Australian material was already mentioned by ETHERIDGE (1904: 112), who nevertheless introduced a new specific name. The possible synonymy between both names was already pointed out by WIEDMANN (1962: 89), who also indicated the possible synonymy of *P. forbesianum* with *P. gabbi* PERVINQUIÈRE (= *Diptychoceras laevis* GABB, 1869: 144, pl. 25, fig. 21). However, as remarked by GABB the Californian species differs by being larger and having faint undulating ribs on larger shafts. Furthermore, presence of constrictions and ribs in this species was also reported from material from the Lower Albian of Alaska by IMLAY (1960: 100, pl. 12, fig. 23).

The Australian material described by ETHERIDGE (1904) as "*P. closteroides*", and here considered a synonymous with *P. forbesianum*, was included without comments in the synonymy of *P. adpressum* by HENDERSON (1990: 125). *P.*

forbesianum, however, differs in larger size and morphogeny, changing from end of phragmocone to end of body chamber from slighlty depressed to slightly compressed, whilst *P. adpressum* is strongly depressed throughout, especially following a broad and deep constriction near beginning of second shaft. This constriction is absent in the Antarctic specimen, but this could not be checked in the Indian and Australian specimens, because the first half of second shaft is missing.

Material similar to *P. forbesianum* was also described by Anthula (1899: 103, pl. 8, fig. 1a-c) from the Aptian of Daghestan, under "*Ptychoceras* sp. aff. *Puzosianum* d'Orb.". This material clearly differs from *P. puzosianum* d'Orbigny (1842, pl. 137, figs. 5-8) in its smoothness, as remarked by Anthula, although Anthula's figures (see 1a, c) show some faint ventral ribs where the second shaft bends into the final hook, as characteristic for the Late Aptian *P. nikchitchi* Rouchadze (1938b: 192, pl. 1, figs. 3-5).

Occurrence: Late Albian of India and Australia, and Middle – Late Albian of Antarctica.

Ptychoceras laeve Matheron, 1842

1842 *Ptychoceras laevis* Matheron, p. 266, pl. 41, fig. 3.
non 1860 *Ptychoceras laeve*. – Ooster, p. 86, pl. 58, figs. 9-10 [= ?*Euptychoceras meyrati* (Ooster)]
non 1869 *Diptychoceras laevis*. – Gabb, p. 144, pl. 25, fig. 21 [= *Ptychoceras gabbi* Pervinquière, 1907]
1933 *Ptychoceras minimum*. – Rouchadze, p. 180, pl. 1, fig. 8.
1957 *Ptychoceras* sp. – Almela & de la Revilla, pl. 9, figs. 10-11.
1960 *Ptychoceras minimum*. – Druzczic & Kudriavtseva, p. 265, pl. 11, fig. 5.
1962 *Ptychoceras laeve laeve* Matheron. – Wiedmann, p. 90, pl. 7, fig. 1, text-figs. 31-32.
1969 *Ptychoceras minimum*. – Egoian, p. 147, pl. 7, fig. 5.
1970 *Ptychoceras* sp. 1. – Avram, pl. 1, fig. 2.
1976 *Ptychoceras laeve* Matheron. – Avram, p. 25, pl. 2, figs. 9-11.
1976 *Ptychoceras* sp. – Fülop, pl. 49, figs. 10, 16.
pars 1979 *Ptychoceras laeve hamaimense* Pervinquière. – Kennedy & Kollmann, p. 4, pl. 1, figs. 8, ?9, non figs. 6-7, 10-13.
?1979 *Ptychoceras* cf. *lave* Matheron. – Renz, p. 365, pl. 2, figs. 7a-c.
1983 *Ptychoceras minimum*. – Mikhailova, fig. 54.
1989 *Ptychoceras laeve laeve* Matheron. – Föllmi, p. 120, pl. 3, fig. 17.
1989 *Ptychoceras minimum*. – Doguzhaeva & Mutvei, p. 94, pl. 1, figs. 1-2, text-fig. 1A.
1990 *Ptychoceras minimum*. – Wiedmann et al., p. 373, fig. 4.
1995 *Ptychoceras* sp. – Seyed-Emami & Immel, p. 382, figs. 16a-b.

Remarks: This species was described and figured by Matheron (1842) based on one Late Aptian specimen from France, characterized by the small and smooth shell with circular section. Material from the Swiss Alps described by Ooster (1860: 86, pl. 58, figs. 9-10), under "*P. laeve*", differs from the type in being larger, with weak constrictions and irregularly spaced ribs on the second and third shaft. Similar features appear to be present in a specimen described, not figured, by de Villoutreys (1950: 155), later discussed by Breistroffer (1952: 48) and referred to *P. emericianum*. Immel (1987: 127) noticed that material from the Lower Albian of Austria described and figured by Kennedy & Kollmann (1979) as *P. laeve hamaimense* Pervinquière includes both, specimens with (pl. 1, fig. 11) and without (pl. 1, fig. 8) ribbing at end of third shaft. Since absence/presence of this feature (see Wiedmann 1962: 90-94) has been used to distinguish *P. laeve laeve* and *P. laeve hamaimense*, and the zoological subspecies concept precludes association of different subspecies at the same locality, Immel (1987: 127) concluded this difference reflects infraspecific variability. However, when the world-distribution of both morphotypes is considered it is evident that these rib types do not always occur together, perhaps supporting an alternative explanation, i.e., the two morphotypes belonging to two different species. This position is adopted here.

As noted above, material from the Swiss Alps described by Ooster (1860: 86, pl. 58, figs. 9-10), under "*P. laeve*" differs from the type in several features. Furthermore the two shafts are not closely attached and under the hook is a "needle-hole", features not present in *Ptychoceras*. These specimens resemble *Euptychoceras meyrati* (Ooster 1860: 82, pl. 59, figs. 1-4; see also Immel 1987: 127, pl. 14, fig. 9), as indicated by Ooster (1860: 86).

As noted by Wiedmann (1962: 90, 94) and Avram (1976: 25-26) "*Ptychoceras minimum*" Rouchadze (1933: 180, pl. 1, fig. 8a-d; Druzczic & Kudriavtseva 1960: 265, pl. 11, fig. 5; Egoian 1969: 147, pl. 7, fig. 5; Mikhailova 1983, fig. 54; Doguzhaeva & Mutvei 1989: 94, pl. 1, figs. 1-2, text-fig-1A; Wiedmann et al. 1990: 373, fig. 4), from the Upper Aptian of Georgia is synonymous with *P. laeve.*

P. laeve differs from *P. forbesianum* in its circular section, which in the latter changes from depressed to compressed.

Occurrence: *P. laeve* is present in Aptian – Lower Albian strata of France, Switzerland, North Africa, Spain, Georgia (Russia), Hungary, Roumania, Iran, and in the Atlantic Ocean off the Iberian Peninsula.

Ptychoceras hamaimense Pervinquière, 1907

Figs. 3a-c, 4q-t

1849 *Ptychoceras Emericianus*. – Quenstedt, p. 293, pl. 21, fig. 21.
1907 *Ptychoceras laeve* Math. var. *Hamaimensis.* – Pervinquière, p. 90, pl. 4, figs. 5-6; text-fig. 21.

1957 *Ptychoceras laeve* Math. var. *hamaimensis* Pervinq. – Almela & de la Revilla, p. 39, pl. 9, fig. 9.
?1960 *Ptychoceras* cf. *P. laeve* (Gabb). – Imlay, p. 100, pl. 12, fig. 23.
1962 *Ptychoceras laeve hamaimense* Perv. – Wiedmann, p. 94, pl. 7, fig. 3.
pars 1979 *Ptychoceras laeve hamaimense* Pervinquière. – Kennedy & Kollmann, p. 4, pl. 1, figs. 6-7, 10-13, non figs. 8, ?9.
1988 *Ptychoceras* sp. – Riccardi, pl. 10, fig. 5.
1997 *Ptychoceras* cf. *laeve hamaiemense* Pervinquière. – Kennedy et al., p. 467, pl. 2, figs. 1-4.
2000. *Ptychoceras laeve hamaimense* Pervinquière. – Kennedy et al., p. 684, figs. 39e, 51d-f.

Material: Lago San Martin, Santa Cruz province, Rio Mayer Formation, Upper Aptian (H. Arbe coll., 78MAF): 1 incomplete (MLP17490); Sharp Valley, J. Ross Island, Lower Albian (F. Medina coll.): 2 incomplete specimens (MLP 31860-31861), second shaft with end phragmocone and body chamber, extending to third shaft; 1 fragment of body chamber (MLP 31676).

Description: Total shell length c. 43 mm. Phragmocone incomplete, comprising most of first shaft, and complete body chamber in end of the second shaft and almost complete third shaft. Phragmocone of first shaft with circular section, 1.8 mm in diameter, smooth. Beginning of body chamber in second shaft 24.7 mm long, with slightly depressed section (H = 4.9 mm, W = 6.4 mm; H/W = 0.76), rounded venter and flanks, tabulate dorsolateral margin and concave dorsum. Hook between second and third shaft tightly bent, becoming more depressed (H = 5.5 mm, W = 8.8 mm; H/W = 0.62) by negative allometry of width; smooth. Hook asymmetric in outline. More openly curved towards third shaft. Body chamber in third shaft, with preserved length of 25.7 mm, pressed against second shaft, becoming less depressed than hook (H = 5.6 mm, W = 8.7 mm; H/W = 0.64); smooth, near end with two slightly asymmetric, sharp and high ribs. Aperture not preserved.

Suture on first shaft (H = 1.8 mm) with lobes, E, L, U and I, L and U bifid (Fig. 3c).

Measurements (in mm):

	S1				S2				S3			
	L	H	W	H/W	L	H	W	H/W	L	H	W	W/H
MLP17490	---	1.8	1.8	1	24.7	4.9	6.4	0.76	25.7	5.6	8.7	0.64

Remarks: The Patagonian specimen is similar to the type described and figured by Pervinquière (1907) from the Lower Albian of Tunis. The Patagonian specimen, however, is about twice as large and the ribs close to the aperture extend almost to the dorsolateral margin. It also resembles the specimen from the Lower Albian of Sierra de Ricote, Murcia, Spain (Almela & de la Revilla 1957), which is also smaller.

P. hamaimense resembles *P. forbesianum* Stoliczka (1865: 195; see also Kossmat 1895: 150; Wiedmann 1962: 88-89) (including *P. closteroides* Etheridge 1904: 110, pl. 15, figs. 6-9) known from material from India and Australia, but excepting an apertural constriction, the last species is completely smooth.

The specimen from the Lower Albian of Alaska, described by Imlay (1960: 100, pl. 12, fig. 23) under "*Ptychoceras* cf. *P. laeve* (Gabb)" resembles *P. hamaimense* in size and ornament. Even if Imlay (1960: 100) mentioned the presence of several constrictions, in his illustration the only visible constriction and ribs are those close to the aperture, whilst the type material of Gabb (1869: 144, pl. 25, fig. 21, as "*Diptychoceras laevis*", = *Ptychoceras gabbi* Pervinquière, 1907: 91) shows constrictions and ribbing on second and third shaft.

Occurrence: *P. hamaimense* is present in Upper Aptian strata of Spain, Mallorca and Patagonia, and Lower Albian of Tunisia, Austria, France, and ?Alaska.

Acknowledgements

Field work and laboratory research were financed by the Consejo Nacional de Investigaciones Científicas y Técnicas and by the Agencia Nacional de Promoción Científica y Tecnológica de la República Argentina. The following persons and their institutions supported all or one of us with good advice and/or facilities: H. Arbe, at that time at Yacimientos Petrolíferos Fiscales (YPF), Argentina; B. J. Quartino, at that time at CIRGEO, and C. A. Rinaldi, at that time at Instituto Antártico Argentino, Buenos Aires, Argentina; G. E. G. Westermann, Canada, improved the English text. The referees, Z. Vašíček, Czech Republic, and an anonymous one are kindly thanked for their critical comments and suggestions.

References

Aguirre Urreta, M. B. & Riccardi, A. C. (1988): Albian heteromorph ammonoids from southern Patagonia, Argentina. – Journal of Paleontology, **62**: 598-614.

Almela, A. & De la Revilla, J. (1957): Fósiles piritosos del Cretáceo de la Sierra de Ricote (Murcia). – Boletín Instituto Geológico Minero de España, **68**: 47-83.

Anderson, F. M. (1902): Cretaceous Deposits of the Pacific Coast. – Proceedings of the Californian Academy of Sciences, 3rd Series, Geology, **2** (1): 1-155.

– (1938): Lower Cretaceous deposits in California and Oregon. – Geological Society of America, Special Paper, **16**: 1-339.

Anthula, D. J. (1899): Über die Kreidefossilien des Caucasus. – Beiträge zur Paläontologie und Geologie Österreich-Ungarns und des Orients, **12**: 55-160.

Arkell, W. J., Kummel, B. & Wright, C. W. (1957): Mesozoic Ammonoidea. – In: Moore, R. C. (Ed.): Treatise on Invertebrate Paleontology. Part L. Mollusca 4: L80-L437; Lawrence (University of Kansas Press).

Avram, E. (1970): Precizari asupra vîrstei depozitelor eocretacice bazinul superior al vaii Tîrlungului. – Studii si cercetari de geologie geografie, Sectia geologie, **15**: 165-174.

– (1976): Les fossiles des flysch Éocrétacé et des Calcaires Tithoniques des Hautes Vallées de la Doftana et du Tirlung (Carpates Orientales). – Institut de Géologie et de Géophysique, Mémoires, **24**: 5-73.

Böhm, J. (1926): Zur Fauna des Oberen Alb mit *Mastigoceras adpressum* Sow. sp. bei Ootmarsum (Holland). – Zeitschrift der Deutschen Geologischen Gesellschaft, **77**: 198-205.

Böse, E. (1923): Algunas faunas cretácicas de Zacatecas, Durango y Guerrero. – Instituto Geológico de México, Boletin **42**: 1-219.

Bonarelli, G. & Nágera, J. J. (1921): Observaciones geológicas en las inmediaciones del Lago San Martín (Territorio de Santa Cruz). – Dirección General de Minería, Geología e Hidrología, Boletín, **27B**: 1-39.

Breistroffer, M. (1947): Sur les zones d'Ammonites dans l'Albien de France et d'Angleterre. – Travaux du Laboratoire de Géologie de la Faculté des Sciences de l'Université de Grenoble, **26**: 17-104.

– (1952): Sur le position systematique du genre *Ptychoceras* d'Orb. – Travaux du Laboratoire de Géologie de la Faculté des Sciences de l'Université de Grenoble, **29**: 47-54.

Chenu, J. C. (1859): Manuel de Conchyliologie et de Paléontologie Conchyliologique. Tome Premier. – i-vii + 97 pp.; Paris (Masson).

Cisneros, D. J. de (1935a): Sobre la posible existencia del genero *Ptychoceras* en el Domeriense del Algayat. – Boletin de la Sociedad Española de Historia Natural, **35**: 227-228.

– (1935b): Acerca del fósil encontrado en el Domeriense del Algayat. – Boletin de la Sociedad Española de Historia Natural, **35**: 443-444.

Collignon, M. (1932): Les ammonites pyriteuses de l'Albien supérieur du Mont Raynaud a Madagascar. – Annales Geologiques Service des Mines Madagascar, **2**: 5-36.

– (1962): Atlas des fossiles caractéristiques de Madagascar (Ammonites), **11**, Aptian, 64 pp.; Tananarive (Service Géologique).

Conrad, T. A. (1860): Descriptions of new species of Cretaceous and Eocene fossils of Mississippi and Alabama. – Journal of the Academy of Natural Sciences of Philadelphia, (2), **4**: 275-298.

Diener, C. (1925): Fossilium Catalogus, I, Animalia; Pt. 29, Ammonoidea neocretacea: 1-244.

Dimitrova, N. (1967): Les Fossiles de Bulgarie, 4, Cephalopoda (Nautiloidea et Ammonoidea). – 236 pp.; Bucuresti (Academia Bulgare des Sciences).

Doguzhaeva, L. & Mutvei, H. (1989): *Ptychoceras* – a hetermorphic lytoceratid with truncate shell and modified ultrastructure (Mollusca: Ammonoidea). – Palaeontographica, (A), **208**: 91-121.

– (1993): Shell ultrastructure, muscle-scars, and buccal apparatus in ammonoids. – Géobios, M.S., **15**: 111-119.

Douvillé, H. (1928): Les Ammonites de la Craie supérieur en Egypte et au Sinaï. – Memoires de l'Academie des Sciences de l'Institut Français, Ser. 2, **59**: 1-43.

Druzczic, V. V. & Doguzhaeva, L. A. (1981): Ammoniti pod Helektronnym microskopom. – 238 pp.; Moscow. (In Russian).

Druzczic, V. V., Doguzhaeva, L. A. & Mikhailova, A. (1977): [The structure of the ammonitella and the direct development of ammonites]. – Paleontological Journal, **2**: 57-69. [In Russian].

Druzczic, V. V. & Kudriavtseva, M. P. (1960): Atlas nizhnemelovoi fauny severnogo Kavkaza i Kryma. – Trudy Vsesoiuznyi Nauchno-Issledovatel'skii Institut Prirodnykh Gazov. – 396 pp.; Moscow. (In Russian).

Egoian, V. L. (1968): Identification of the genus *Ptychoceras* d'Orbigny. – Doklady Akademii Nauk SSSR, Earth Sciences Section, **182**: 228-230.

– (1969): [Ammonites of the Clansayesian beds of the western Caucasus]. – Trudy Krasnodarskogo Filiala Vsesoiuznogo Neftegazovogo Nauchno-Issledovatel'skogo Instituta, **19**: 126-188. [In Russian].

Etayo Serna, F. (1979): Zonation of the Cretaceous of Central Colombia by Ammonites. – Publicaciones Geológicas Especiales del Ingeominas, **2**: 1-186.

Etayo Serna, F., González, H. & Alvarez, E. (1980): Mid-Albian ammonites from northern western Cordillera, Colombia, SA. – Geologia Nordandina, **2**: 25-30.

Etheridge, R. (1904): On the occurrence of the genus *Ptychoceras*(?) and other additional fossils in the Cretaceous Beds of the Northern Territory of South Australia. – Records of the Australian Museum **5**: 108-115.

Fischer, J.-C. (2006): Révision critique de la Paléontologie Française d'Alcide d'Orbigny, vol. IV, Céphalopodes Crétacés. – 292 pp.; Leiden (Backhuys Publishers).

Föllmi, K. B. (1989): Beschreibung neugefundener Ammonoidea aus der Vorarlberger Garschella-Formation (Aptian-Albian). – Jahrbuch der Geologischen Bundesanstalt, (A), **132**: 105-189.

Forbes, E. (1845): Reports on the Fossil Invertebrata from Southern India collected by Mr. Kaye and Mr. Cunliffe. – Transactions of the Geological Society of London, 2nd Ser., **7**: 97-169.

Fülop, J. (1964): Unterkreide-bildungen (Berrias-Apt) des Bakony-Gebirges. – Geologica Hungarica, Serie Geologica, **13**: 1-194.

Fülop, J. (1976): The Mesozoic Basement Horst Blocks of Tata. – Geologica Hungarica, Serie Geologica, **16**: 1-125.

Gabb, W. M. (1864): Description of the Cretaceous fossils. – Geological Survey of California, Palaeontology, **1**: 55-236.

– (1869): Description of Cretaceous Fossils. – Geological Survey of California, **2**: 127-254.

Gill, T. (1871): Arrangement of the Families of Mollusks. – Smithsonian Miscellaneous Collections, **227**: xvi + 49 pp.

Haas, O. (1942): The Vernay collection of Cretaceous (Albian) ammonites from Angola. – Bulletin American Museum Natural History, **81**: 1-224.

Handschin, E. (1924): Die Collembolenfauna des Schweizerischen Nationalparkes, 89-174; Zürich.

Henderson, R. A. (1970): Ammonoidea from the Mata Series (Santonian-Maastrichtian) of New Zealand. – Special Papers in Palaeontology, **6**: 1-82.

– (1973): Clarence and Raukumara Series (Albian-?Santonian) Ammonoidea from New Zealand. – Journal of the Royal Society of New Zealand, **3**: 71-123.

– (1990): Late Albian ammonites from the Northern Territory, Australia. – Alcheringa, **14**: 109-148.

Henderson, R. A., Crampton, J. S., Dettmann, M. E., Douglas, J. G., Haig, D., Shafik, S., Stilwell, J. D. & Thulborn, R. A. (2000): Biogeographical observations on the Cretaceous biota of Australasia. – Memoir of the Association of Australasian Palaeontologists, **23**: 355-404.

Hollis, J. D. (1971): Occurrence of the ammonites *Ptychoceras adpressum* (J. Sowerby) in the Upper Albian of Kent, England. – Palaeontology, **14**: 592-594.

Hyatt, A. (1900): Cephalopoda. – In: Zittel, K. A. v. (Ed.): Textbook of Palaeontology. 1st English ed. (transl. by Eastman, C. R.), p. 502-592; London (Macmillan).

Imlay, R. W. (1960): Early Cretaceous (Albian) Ammonites from the Chitina Valley and Talkeetna Mountains, Alaska. – United States Geological Survey, Professional Paper, **354-D**: 87-114.

Immel, H. (1987): Die Kreideammoniten der nördlichen Kalkalpen. – Zitteliana **15**: 3-163.

Ineson, J. R., Crame, J. R. & Thomson, M. R. A. (1986): Lithostratigraphy of the Cretaceous strata of west James Ross Island, Antarctica. – Cretaceous Research, **7**: 141-159.

Kakabadze, M. V., Hoedemaker, P. J., Bogdanova, T. N. & Sharikadze, M. Z. (2004): On the Barremian-Early Albian biogeography (by ammonites) of Colombia. – Scripta Geologica, **128**: 515-558.

Kakabadze, M. V. & Sharikadze, M. Z. (1993): On the mode of life of heteromorph ammonites (heterocone, ancylocone, ptychocone). – Géobios, M.S., **15**: 209-215.

Karakasch, N. (1907): Le Crétacé inférieur de la Crimée et sa faune. – Trudy Imperatorskogo S.-Peterburgskogo Obshchestva Estestvoispytatelei, **32**: 1-482.

Karsten, H. (1858): Über die geognostischen Verhältnisse des Westlichen Columbien, der heutigen Republiken Neu-Granada und Equador. – Amtlicher Bericht Deutscher Naturforscher und Ärzte zu Wien, **32**: 80-117.

Karsten, H. (1886): Géologie de l'Ancienne Colombie Bolivarienne, Vénézuela, Nouvelle-Grenade et Ecuador. – 62 pp.

Kennedy, W. J., Bilotte, M. & Hansotte, M. (1997): Albian ammonite faunas from Pech de Foix (Ariège, France). – Bulletin du Centre de Recherches Exploration et Production Elf-Aquitaine, **21**: 457-499.

Kennedy, W. J. & Cobban, W. A. (1999): Campanian (Late Cretaceous) ammonites from the Bergstrom Formation in central Texas. – Acta Geologica Polonica, **49**: 67-80.

Kennedy, W. J., Gale, A. S., Bown, P. R., Caron, M., Davey, R. J., Gröcke, D. & Wray, D. S. (2000): Integrated stratigraphy across the Aptian-Albian boundary in the Marnes Bleues, at the Col de Pré-Guittard, Arnayon (Drôme), and at Tartonne (Alpes-de-Haute-Provence), France: a candidate Global Boundary Stratotype Section and Point. – Cretaceous Research, **21**: 591-720.

Kennedy, W. J. & Kollmann, H. A. (1979): Lower Albian Ammonites from the Tannheim Formation near Losenstein, Upper Austria. – Beiträge zur Paläontologie von Österreich, **6**: 1-25.

Kossmat, F. (1895). Untersuchungen über die Südindische Kreideformations. – Beiträge zur Paläontologie und Geologie Österreich-Ungarns und des Orients, **9**: 1-203.

Leanza, A. F. (1970): Ammonites nuevos o pocos conocidos del Aptiano, Albiano y Cenomaniano de los Andes Australes con notas acerca de su posición estratigráfica. – Asociación Geológica Argentina, Revista, **25**: 197-260.

Marshall, P. (1926): The Upper Cretaceous ammonites of New Zealand. – Transactions and Proceedings of New Zealand Institute, **56**: 129-210.

Matheron, P. (1842): Catalogue methodique et descriptif des corps organises fossiles du department des Bouches-de-Rhône et lieu circonvoisins. – Répertoire des Travaux de la Société Statistique de Marseille, 81-341.

McLearn, F. H. (1972): Ammonnoids of the Lower Cretaceous Sandstone Member of the Haida Formation, Skidegate Inlet, Queen Charlotte Islands, Western British Columbia. – Geological Survey of Canada, Bulletin, **188**: 1-78.

Medina, F. A. & Buatois, L. A. (1992): Bioestratigrafia del Aptiano-Campaniano (Cretacico superior) en la isla James Ross. – In: Rinaldi, C. A (Ed.): Geología de la Isla James Ross, 37-45; Buenos Aires (Dirección Nacional del Antártico, IAA).

Medina, F. A., Buatois, L. A. & Lopez Angriman, A. (1992): Estratigrafia del Grupo Gustav en la isla James Ross, Antártida. – In: Rinaldi, C. A. (Ed.): Geologia de la Isla James Ross, 167-192; Buenos Aires (Dirección Nacional del Antártico, IAA).

Medina, F. A. & Martinioni, D. (1999): Los géneros *Hysteroceras* Hyatt y *Dipoloceras* Hyatt (Ammonoidea) en el Albiano Superior de Patagonia, Argentina. – Ameghiniana, **36**: 411-418.

Medina, F. A. & Riccardi, A. C. (2005): Desmoceratidae, Silesitidae and Kossmaticeratidae (Ammonitina) from the Upper Aptian-Albian of Patagonia (Argentina). – Revue de Paléobiologie, **24**: 251-286.

– (2006): Desmoceratidae and Silesitidae (Ammonitida) from the Aptian-Albian of Antarctica. – Neues Jahrbuch

für Geologie und Paläontologie, Abhandlungen, **242**: 289-327.
– (2007): *Tuberosciponoceras*: a new dimorphic ammonoid genus from the Upper Albian of Patagonia, Argentina. – Paläontologische Zeitschrift, **81**: 123-130.
MEDINA, F. A., RICCARDI, A. C. & GHIGLIONE, M. (2003): First record of the Albian ammonite *Aioloceras* WHITEHOUSE in Antarctica. – Alcheringa, **27**: 85-91.
MEEK, F. B. (1876): A report on the Invertebrate Cretaceous and Tertiary Fossils of the upper Missouri Country. – U.S. Geological Survey of theTerritories, **9**: 1-624.
MIKHAILOVA, I. A. (1974): The systematic position of the genus *Ptychoceras* ORBIGNY. – Doklady Akademy Nauk SSSR, **214**: 226-228.
– (1983): [System and phylogeny of Cretaceous ammonoids]. – 279 pp.; Moskva (Nauka). [In Russian]
MONKS, N. (1999): Cladistic analysis of Albian heteromorph ammonites. – Palaeontology, **42**: 907-925.
MYCZYNSKI, R. (1977): Lower Cretaceous ammonites from Sierra del Rosario (Western Cuba). – Acta Palaeontologica Polonica, **22**: 139-172.
NEAGU, T. (1970): Asupra prezentei Antianului în Valea Carelor-Intorsura Buzăului. – Studii si cercetari de geologie, geofizica, geografie, Sectia geologie, **15**: 149-163.
OLIVERO, E. B., SCASSO, R. A. & RINALDI, C. A. (1986): Revision of the Marambio Group, James Ross Island, Antarctica. – Instituto Antártico Argentino, Contribución, **331**: 1-29.
OOSTER, W. A. (1857-1863): Catalogue des Céphalopodes fossiles des Alpes Suisses. – Neue Denkschriften der Allgemeinen Schweizerischen Gesellschaft für die Gesamten Naturwissenschaften, **18**: 1-110.
ORBIGNY, A. DE (1842): Paléontologie française. Terrains Crétacés 1. Céphalopodes. – 448 pp.; Paris (Masson).
ORLOV, J. A. (1958): [Osnovy Paleontologii, Molluskii-Golovonogie, II]. – 359 pp.; Moscow. [In Russian]
PERVINQUIÈRE, L. (1907): Etudes de Paléontologie Tunisienne. I, Céphalopodes des Terrains secondaires. – Carte Géologique de la Tunisie: 428 pp.
PIATNITZKY, A. (1938): Observaciones geológicas en el oeste de Santa Cruz (Patagonia). – Boletín de informaciones Petroleras, **165**: 45-95.
PICTET, F. J. & ROUX, W. (1847-1849): Description des Mollusques Fossiles qui se trouvent dans lers Grès Verts des environs de Genève. – 287 pp.; Genève.
QUENSTEDT, F. A. (1849): Petrefactenkunde Deutschlands; Die Cephalopoden. – 580 pp.; Tübingen (Fues).
RENZ, O. (1979): Lower Cretaceous ammonoidea from the northern Atlantic, Leg 47B, Hole 398D, DSDP. – Reports of the Deep Sea Drilling Project, **47**: 361-369.
RICCARDI, A. C. (1971): Estratigrafía en el Oriente de la Bahía de la Lancha, lago San Martín, Santa Cruz, Argentina. – Revista del Museo La Plata, Geología, **7** (61): 245-318.
– (1976): Paleontología y Edad de la Formación Springhill. – Primer Congreso Geológico Chileno, Actas, **1**: C41-C56; Santiago, Chile.
– (1977): Berriasian Invertebrate Fauna from the Springhill Formation of Southern Patagonia. – Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen, **155**: 216-252.
– (1988): The Cretaceous System of Southern South America. – Geological Society of America, Memoir, **168**: 1-161.
RICCARDI, A. C., AGUIRRE URRETA, M. B. & MEDINA, F. A. (1987): Aconoceratidae (Ammonitina) from the Hauterivian-Albian of Southern Patagonia. – Palaeontographica, (A), **196**: 105-185.
RICCARDI, A. C. & MEDINA, F. A. (2002): The Beudanticeeratinae and Cleoniceratinae (Ammonitina) from the Lower Albian of Patagonia. – Revue de Paléobiologie, **21**: 291-351.
RICCARDI, A. C. & ROLLERI, E. O. (1980): Cordillera Patagónica Austral. – Segundo Simposio de Geología Regional Argentina, **2**: 1173-1306; Córdoba (Academia Nacional de Ciencias).
ROMAN, F. (1938): Les ammonites jurassiques et crétacées. Essai de genera. – 554 pp.; Paris (Masson).
ROUCHADZÉ, J. (1933): Les ammonites Aptiennes de la Géorgie Occidentale. – Bulletin de l`Institut Géologique de Géorgie, **1** (3): 165-273.
– (1938a): Quelques céphalopodes nouveaux ou peu connus de l'Aptien de la Georgie. – Bulletin de l'Institut Géologique de Géorgie, **3** (2): 129-190.
– (1938b): Les ammonites Aptiennes du Caucause du Nord. – Bulletin du Musée de Georgie, **9A**: 191-209.
SARASIN, CH. & SCHÖNDELMAYER, CH. (1902): Étude Monographique des Ammonites du Crétacique Inférieur de Chatel-Saint-Denis. – Mémoires de la Société Paléontologique Suisse, **28**: 1-91.
SCHINDEWOLF, O. H. (1961): Studien zur Stammesgeschichte der Ammoniten. Lief. 1. – Abhandlungen der Akademie der Wissenschaften und der Literatur in Mainz, mathematisch-naturwissenschaftlichen Klasse, **1960** (10): 639-743.
SCHMIDT, F. (1873): Über die Petrefakten der Kreideformation von der Insel Sachalin. – Mémoires de l'Académie Impériale des Sciences de.St.-Pétersbourg, 7 Ser., **19** (3): 1-37.
SEYED-EMAMI, K. & IMMEL, H. (1995): Ammoniten aus dem Alb (Kreide) von Shir-Kuh (N' Yazd, Zentraliran). – Paläontologische Zeitschrift, **69**: 377-399.
SIMIONESCU, I. (1898): Studii Geologice si Paleontologice din Carpatii Sudici. – Academia Romana, Publicatiunile Fondului vasilie Adamachi, **2**: 101-168.
SOWERBY, J. (1814): The Mineral Conchology of Great Britain; London.
SPATH, L. F. (1925): On Upper Albian Ammonoidea from Portuguese East Africa, with an appendix on Upper Cretaceous ammonites from Maputoland. – Annals of the Transvaal Museum, **11**: 179-200.
– (1926): On new ammonites from the English Chalk. – Geological Magazine, **63**: 77-83.
– (1941): A Monograph of the Ammonoidea of the Gault, Part 14, 609-668; London (The Palaeontographical Society).
– (1953): The Upper Cretaceous Cephalopod Fauna of Graham Land. – Falkland Islands Dependencies Survey, Scientific Reports, **3**: 1-60.
STEVENS, G. R. (1978): The late mobile phase: Cretaceous. Paleontology. – In: SUGGATE, R. P., STEVENS, G. R. & TE PUNGA, M. T. (Eds.): The Geology of New Zealand, **2**: 351-366.

Stevens, G. R. & Speden, I. G. (1978): New Zealand. – In: Moullade, M. & Nairn, A. E. M. (Eds.): The Phanerozoic Geology of the World II. The Mesozoic, A, 251-328; Amsterdam (Elsevier).

Stoliczka, F. (1865): Ammonitidae, with revision of the Nautilidae. – In: The fossil Cephalopoda of the Cretaceous rocks of Southern India. – Memoirs of the Geological Survey of India, Palaeontologia Indica, **3** (6-9): 41-216.

Stolley, E. (1912): Über einige Cephalopoden aus der unteren Kreide Patagoniens. – Svenska vetenskapsakademien, Stockholm, Arkiv för Zoologi, **7** (23): 1-18.

Szives, O. & Monks, N. (2002): Heteromorph ammonites from the Tata Limestone Formation (Aptian – Lower Albian), Hungary. – Palaeontology, **45**: 1137-1149.

Thieuloy, J.-P. (1972): Biostratigraphie des Lentilles a Peregrinelles (Brachiopodes) de l'Hauterivien de Rottier (Drome, France). – Géobios **5**: 5-53.

Thomel, G. (1980): Ammonites. – 227 pp.; Nice (Serre).

Thomson, M. R. A. (1974): Ammonite fauna of the Lower Cretaceous of south-eastern Alexander Island. – British Antarctic Survey, Scientific Report, **80**: 1-44.

– (1982): A comparison of the ammonite faunas of the Antarctic Peninsula and Magallanes Basin. – Journal of the Geological Society of London, **139**: 763-770.

– (1983): "European" ammonites in the Lower Cretaceous of Antarctica. – Zitteliana, **10**: 407-412.

Uhlig, V. (1883): Die Cephalopoden der Wernsdorfer Schichten. – Denkschriften der kaiserlich-königlichen Akademie der Wissenschaften Wien, **46** (2): 127-290.

Vašiček, Z. (1972): Ammonoidea of the Těšin-Hradiště Formation (Lower Cretaceous) in the Moravskoslezske in the Moravskoslezské Beskydy Mts. – Rozpravy Ústředniho Ústavu Geologického, **38**: 5-103.

– (1999): Comments on some new occurrences of heteromorph ammonites in the Lower Cretaceous (late Valanginian-early Barremian) of the Eastern Alpine and Western Carpathian systems. – Scripta Geologica, Special Issue, **3**: 215-222.

Vella, P. P. (1961): An occurrence of an Albian ammonite in the Motuan Stage in the upper Awatare Valley. – Transactions of the Royal Society of New Zealand, **1** (1): 1-4.

Vialli, V. (1949): Nuova Fauna ad ammoniti del Barremiano superiore Lombardo. – Atti della Societa Italiana de Ciencias Naturales e del Museo Civico di Storia Naturale in Milano, **88**: 35-64.

Villoutreys, O. de (1950): Au sujet du genre *Ptychoceras* d'Orbigny (Ammonite). – Bulletin de la Muséum National d'Histoire Naturelle de Paris, (2) **22** (1): 155-156.

Waterhouse, J. B. & Riccardi, A. C. (1970): The Lower Cretaceous bivalve *Maccoyella* in Patagonia and its paleogeographic significance for continental drift. – Ameghiniana, **7**: 281-296.

Whiteaves, J. F. (1879): On the fossils of the Cretaceous rocks of Vancouver and adjacent islands in the Strait of Georgia. – Geological Survey of Canada, Mesozoic Fossils, **1** (2): 93-190.

– (1884): On the fossils of the Coal-Bearing Deposits of the Queen Charlotte Islands collected by Dr. G. M. Dawson in 1878. – Geological Survey of Canada, Mesozoic Fossils, **1** (3): 191-262.

Whitehouse, F. W. (1928): The correlation of the Marine Cretaceous Deposits of Australia. – Report of the Eighteenth Meeting of the Australasian Association for the Advancement of Science, **18**: 275-280.

Whitfield, R. P. (1880): Paleontological Report on the Fossils collected by the United States Geological and Geographical Survey of the Black Hills, 329-468.

Wiedmann, J. (1962): Unterkreide-Ammoniten von Mallorca, 1. Lieferung: Lytoceratina, Aptychi. – Abhandlungen der Akademie der Wissenschaften und der Literatur in Mainz, mathematisch-naturwissenschaftliche Klasse, **1962** (1): 1-148.

– (1966): Stammesgeschichte und System der posttriadischen Ammonoideen. – Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen, **127**: 13-81.

Wiedmann, J. & Dieni, I. (1968): Die Kreide Sardiniens und ihre Cephalopoden. – Palaeontographia Italica, **64** (n.s. 34): 1-171.

Wiedmann, J. & Kakabadze, M. V. (1993): Suture investigations and the classification of Cretaceous heteromorph ammonites. – Géobios, M.S., **15**: 393-399.

Wiedmann, J., Kakabadze, M. V. & Sharikadzé, M. Z. (1990): Suture ontogeny in *Ptychoceras* d'Orbigny and its implications for the systematics of Cretaceous heteromorphs. – Neues Jahrbuch für Geologie und Paläontologie, Monatshefte **1990**: 367-384.

Winkler, G. G. (1868): Versteinerungen aus dem bayerischen Alpen-Gebiet mit geognostischen Erläuterungen. 1, Die Neocomformation des Urschlauerachenthales bei Traunstein mit Rücksicht auf ihre Grenzschichten. – 48 pp.; München.

Woods, H. (1896): The Mollusca of the Chalk Rock, part I. – Quarterly Journal of the Geological Society of London, **52**: 68-98.

Wright, C. W., Callomon, J. H. & Howarth, M. K. (1996): Cretaceous Ammonoidea. – In: Kaesler, R. (Ed.): Treatise on Invertebrate Paleontology. Part L, Mollusca 4, Revised. – xx + 362 pp.; Boulder & Lawrence (The Geological Society of America & The University of Kansas Press).

Yabe, H. (1927): Cretaceous stratigraphy of the Japanese Islands. – Science Reports of the Tohoku Imperial University, Ser. 2, **11**: 27-100.

Yokoyama, M. (1890): Versteinerungen aus der japanischen Kreide. – Palaeontographica, **36**: 159-202.

Zittel, K. A. v. (1884): Cephalopoda. – In: Zittel, K. A. (Ed.): Handbuch der Palaeontologie, **1** (2, 3): 329-522; München (Oldenbourg).

Manuscript received: September 17th, 2007.
Revised version accepted by the Stuttgart editor: January 3rd, 2008.

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