CYMATOCERAS PERSTRIATUM (STEUER, 1897) (CEPHALOPODA, NAUTILOIDEA) FROM THE EARLY BERRIASIAN-EARLY VALANGINIAN (LOWER CRETACEOUS) OF CENTRAL CHILE

Christian Salazar [a], Alejandro Martínez [b], Luciano Villanelo [b] and Wolfgang Stinnesbeck [c]
[a] Área Paleontología, Museo Nacional de Historia Natural, Parque Quinta Normal s/n, Casilla 787, Santiago, Chile; christian.salazar@mnhn.cl
[b] Carrera de Geología, Universidad Andrés Bello, Santiago
[c] Institut für Geowissenschaften, Universität Heidelberg, INF 234, 69120 Heidelberg, Germany

ABSTRACT

The nautilid *Cymatoceras perstriatum* was originally recorded by Steuer from the Tithonian of the Mendoza province in central Argentina. Subsequently the taxon was recorded in sediments of Valanginian-Barremian age in the Neuquén province of Argentina. *Cymatoceras* cf. *perstriatum* was also documented from the late Barremian of the Atacama region in Chile. In central Chile, Klohn listed *Cymatoceras perstriatum* from the Early Berriasian-Early Valanginian. Here we revise this latter specimen and discuss its stratigraphical range and provenance. We conclude that the specimen was collected by Klohn from Early Berriasian to Early Valanginian sediments of the Lo Valdés Formation and that this record is presently the oldest in Chile. The taxon appears to be endemic to the Andean Basin.

Key words: *Cymatoceras*, Late Jurassic, Early Cretaceous, Lo Valdes Formation, Chile.

RESUMEN

***Cymatoceras perstriatum* (Steuer 1897) (Cephalopoda, Nautiloidea) del Berriasiano Temprano - Valanginiano Temprano (Cretácico Inferior) de Chile central).** El nautílido *Cymatoceras perstriatum* fue originalmente registrado por Steuer para el Titoniano de la provincia de Mendoza en Argentina Central. Estudios posteriores registraron este taxón en rocas sedimentarias del Valanginiano – Barremiano en la provincia de Neuquén de Argentina. *Cymatoceras* cf. *perstriatum* también fue documentado para el Barremiano tardío de la región de Atacama de Chile. En Chile central Klohn lista *Cymatoceras* cf. *Perstriatum* para el Berriasiano Temprano – Valanginiano Temprano. Aquí, se revisa el único espécimen mencionado por Klohn y discute su proveniencia y rango estratigráfico. Nosotros concluimos que el espécimen recolectado por Klohn proveniente del Berriasiano Temprano al Valanginiano Temprano, son rocas sedimentarias de la Formación Lo Valdés y que este es el registro más antiguo en Chile. El taxón aparentemente es endémico de la Cuenca Andina.

Palabras claves: *Cymatoceras*, Jurásico Tardío, Cretácico Temprano, Formación Lo Valdés, Chile.

INTRODUCTION

Cymatocertas perstriatum is well documented in Argentina. The taxon was established by Steuer (1897), from Tithonian sediments at "Arroyo Cieneguita" in the Mendoza province. Subsequently, Weaver (1931) documented three specimens from the Tithonian-Hauterivian of the Neuquén Province (Argentina). Recently, Cichowolski (2003) registered 280 additional specimens for the Tithonian-Hauterivian of Neuquén, which now allow for a precise evaluation of the morphological variability of the taxon.

In northern Chile *Cymatoceras perstriatum* occurs at Quebrada Meléndez, southeast of Copiapó. The species is there associated with *Sanmartinoceras africanum insignicostatum* (Cichowolski et al. 2004) which indicates a Late Barremian age. In central Chile, the presence of *C. perstriatum* was mentioned by Bíró (1980) for the Late Tithonian, but without a description or illustration of the specimen. Its determination is thus doubtful. The specimen was deposited by Biro in the Colección Paleontológica of the Universidad de Concepción, but could not be founded, despite intensive search by the university staff and detailed revision of the Biró cephalopod material by one of us (Salazar 2012).

Twenty years prior to the Biro (1980) publication, however, *C. perstriatum* was already mentioned

by Klohn (1960), from "Portezuelo Dolores" in the Cruz de Piedra area of central Chile (Fig. 1). The only specimen was there assigned to the Berriasian-Early Valanginian of the Baños del Flaco Formation.

The Klohn (1960) specimen of *C. perstriatum* was recently founded in the collection of invertebrate fossils of the Museo Nacional de Historia Natural at Santiago, Chile (MNHN), along with numerous other specimens of bivalves, gastropods, and ammonoids of the Klohn (1960) collection. It is the only nautilid in this collection and is housed in the Palaeontology Area of MNHN under the number SGO. PI. 14452.

SYSTEMATIC PALAEONTOLOGY

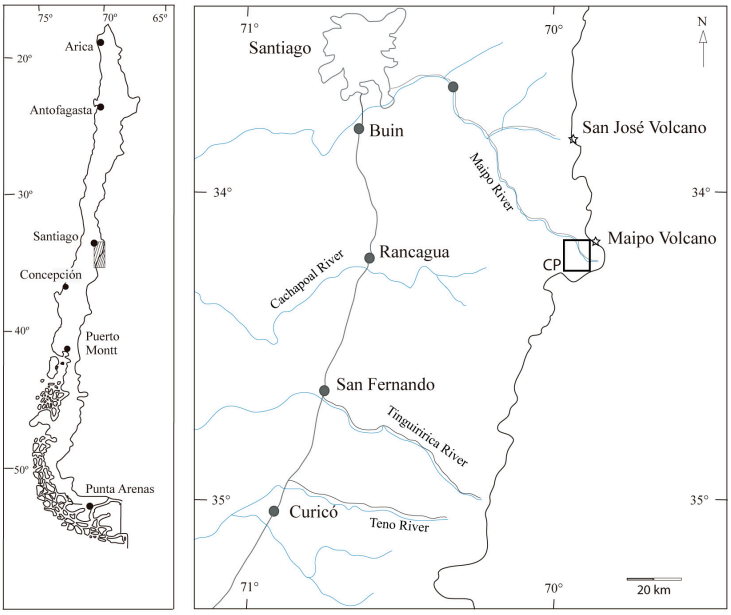

FIGURE 1. Localities in the high Andes Mountain from Central Chile, showing the Cruz de Piedra area, where Klohn (1960) collected the specimen of *C. perstriatum* (modified from Salazar 2012).

Measurements: All dimensions are given in mm. Abbreviations: D: Diameter, Wb: Whorl width, Wh: Whorl height, U: Width of umbilicus. Collections: Abbrevations for repositories are as follows: SGO. PI., Paleontología de Invertebrados, Museo Nacional de Historia Natural, Santiago, Chile. GZG, Geowissenschaftliches Zentrum Göttingen. SNGM, Servicio Nacional de Geología y Minería, Chile.

Order NAUTILOIDEA de Blainville, 1825

Family NAUTILIDAE de Blainville, 1825

Genus *Cymatoceras* Hyatt, 1883-1884

Type species: *Nautilus pseudoelegans* d´Orbigny (1840-1841), by original designation, from the Lower Cretaceous of France.

Cymatoceras perstriatum (Steuer, 1897)

Figures 3 - 4

1897 *Nautilus perstriatus* n. sp. Steuer, p. 78, pl. 24, figs 1-2.
1921 *Nautilus perstriatus* n. sp. Steuer, p. 107, pl. 24, figs. 1-2 (= Steuer 1897)
1931 *Nautilus perstriatus* Steuer; Weaver, p. 392, pl. 43, fig. 297, pl. 44, figs. 304-305.
1950 *Nautilus marucoensis* Giovine; Giovine, p. 35, pl. 1, figs. 3-4.
2003 *Cymatoceras perstriatum* (Steuer); Cichowolski, p. 379, figs. 4a-h, 5a-f.
2004 *Cymatoceras* sp. Cichowolski *et al.*, p.121, pl. 1, figs. 1-6
2004 *Cymatoceras* cf. *perstriatum* (Steuer), Cichowolski *et al.*, p.123, fig-text. 4.

Holotype

By monotypy, the specimen GZG 499-84, figured by Steuer (1897: pl. 24: 1), from the Tithonian of Arroyo Cieneguita, Mendoza province, Argentina. This specimen is refigured here (Figure 2).

Material

A well-preserved phragmocone, SGO. PI. 14452, from Portezuelo Dolores in the Cruz de Piedra area of central Chile. This specimen was collected by Klohn (1960).

Description

The studied specimen from Portezuelo Dolores is an involute and globular nautilicone. The umbilicus is narrow (U/D = 0.09). The whorl section is oval, wider than high (W/H = 1.27). The maximum width is in the lower half of the flank area. The flanks are gently convex and converge towards the widely rounded venter. (Fig. 4). The siphuncle is narrow and located between the centre and the venter of the septum (Figure 4c). The ribs, poorly preserved, are prorsiradiate on the flanks and slightly convex on the venter.

Remarks

Nautilus perstriatus was originally described by Steuer (1897, spanish translation 1921). According to Steuer, *N. perstriatus* is characterized by a narrow umbilicus, rounded venter and arched flanks; whorl section wider than high, and ornamented by narrow prorsiradiate and slightly convex ribs. The ontogeny of *C. perstriatum* was documented by Cichowolski (2003) and complemented here, indicating that the whorl section changes from wider than high to higher than wide (Fig. 2). The assignation to *Cymatoceras* is based on transverse ribs, rounded and inflates venter, sub-central siphuncle, as earlier discussed by Cichowolski (2003).

The single specimen of *Cymatoceras perstriatum* reported by Klohn (1960) and here described and discussed (SGO. PI. 14452), was collected by the author in a dark siltstone unit of the Cruz de Piedra area. The bed rock at "Portezuelo Dolores" was interpreted to form part of the Baños del Flaco Formation which was considered to be Tithonian-Hauterivian in age (e.g. Klohn 1960, Charrier 1980, Aguirre-Urreta and Charrier 1990), even though Hallam et al. (1986) assigned the Baños del Flaco Formation to the Tithonian-Berriasian. The siltstone unit containing *C. perstriatum* was considered by Klohn (1960) to be Berriasian-Early Valanginain in age.

In recent years, we visited the Cruz de Piedra area. Based on this detailed field work, Salazar (2012) and Salazar and Stinnesbeck (submitted a) concluded that the dark siltstone unit present at Cruz de Piedra rather corresponds to lithologies of the Lo Valdés Formation. Siltstone beds are typically scarce in the Baños del Flaco Formation (Salazar and Stinnesbeck, submitted b).

The siltstone unit at "Portezuelo Dolores" is lithostratigraphically indistinguishable from the Placa Roja Member of the Lo Valdés Formation as defined by Salazar and Stinnesbeck (submitted b) or as siltstone member in Salazar (2012). This unit is characterized by the presence of abundant and well preserved ammonites of the Early Berriasian to Early Valanginian, such as *Substeuroceras koeneni*, *Berriasella jacobi* and *Groebericeras roccardi* (see Salazar 2012).

In consequence, the specimen SGO. PI. 14452 of *Cymatoceras perstriatum* collected by Klohn (1960) from "Portezuelo Dolores" and originally attributed to the Baños del Flaco Formation, forms part of the Lo Valdés Formation (Salazar and Stinnesbeck, submitted b) and represents an Early Berriasian to Early Valanginian age.

It therefore represents the oldest record of *Cymatoceras perstriatum* from Chile. This species thus ranges from the Tithonian to Barremian (Steuer 1897, Cichowolski 2003 and Cichowolsky et al. 2004) and is restricted to the Andean Basin, as indicated Salazar (2012). *Cymatoceras* may have had an origin in the Andean Basin, as oldest records are from the Upper Jurassic of Argentina (Steuer 1987). The genus ranges to the Oligocene (e.g. Japan, Kobayashi 1954) but highest abundances and diversity were reached in the Cretaceous, when *Cymatoceras* formed a dominant constituent in nautilid assemblages of the Indo-pacific region.

FIGURE 2. a-c: "*Nautilus perstriatus*", GZG 499-84, the holotype from Steuer (1897-1921); a, ventral view; b, lateral view; c, dorsal view. Figures x 0.6.

TABLE 1. Dimensions of *Cymatoceras perstriatum*

Cymatoceras perstriatum (present study)						
specimen	D	U	W	H	W/H	U/D
SGO. PI. 14452	89.7	8.0	75.6	59.7	1.27	0.09
Nautilus perstriatus (from Steuer 1897)						
specimen	D	U	W	H	W/H	U/D
GZG 499-84	170.0	15.0	75.0	100.0	0.75	0.09
Nautilus perstriatus (from Weaver 1931)						
specimen	D	U	W	H	W/H	U/D
1	90.0	--	70.0	55.0	1.27	--
2	100.0	--	88.0	60.0	1.47	--
3	36.0	--	35.0	20.0	1.75	
Nautilus marucoensis (from Giovine 1950)						
specimen	D	U	W	H	W/H	U/D
	141.0	14.0	110.0	86.0	1.28	0.09
	111.0	9.0	86.0	64.0	1.34	0.08
	71.0	6.0	53.0	41.0	1.29	0.08
	65.0	6.0	51.0	39.0	1.30	0.09
Nautilus perstriatus (from Cichowolski *et al*. 2004)						
specimen	D	U	W	H	W/H	U/D
SNGM 1043 (1)	91	--	60.0	50.0	1.2	--

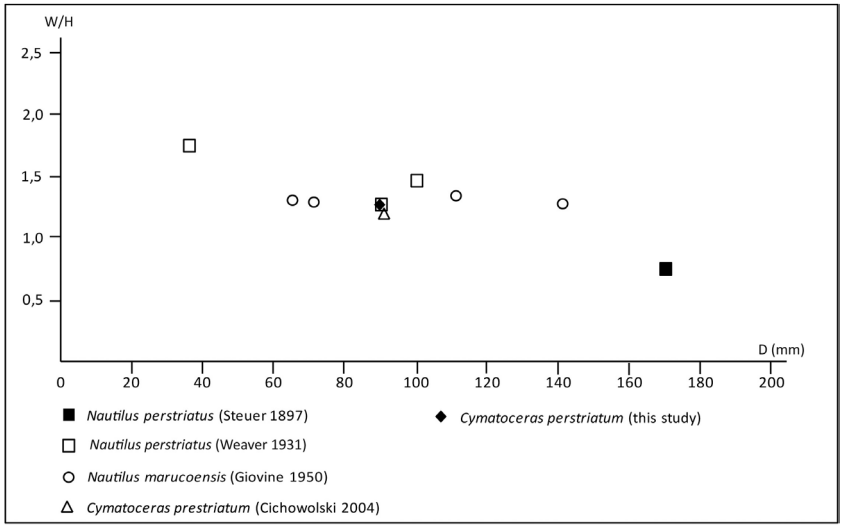

FIGURE 3. Relationship between W/H and D in *Cymatoceras perstriatum* from the Lo Valdés Formation in Chile and elsewhere (literature data).

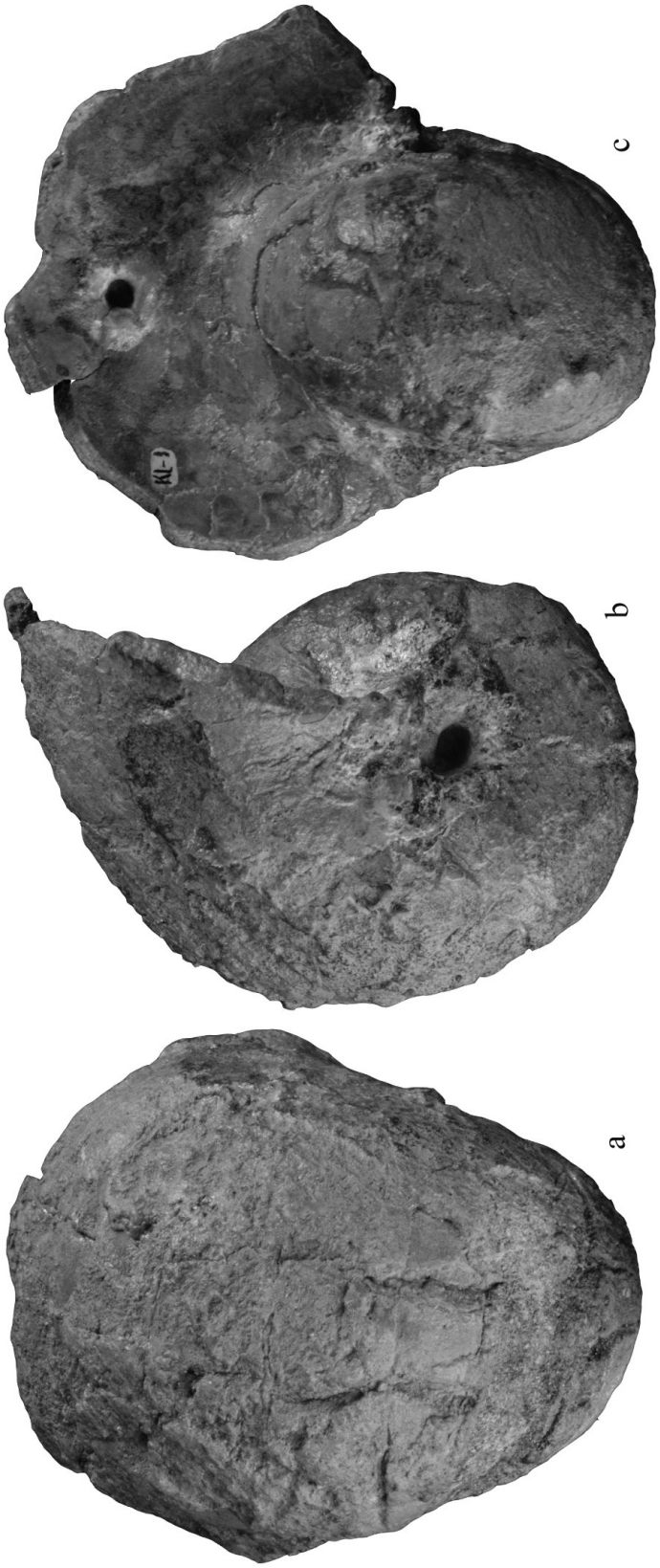

FIGURE 4. *Cymatoceras perstriatum*; SGO. PI. 14452. Dorsal (a), lateral (b) and ventral views (c). All natural size (x1).

ACKNOWLEDGEMENTS

We are grateful to Edwin González (Universidad de Chile) for his assistance in the fossil preparation and to Dr. Mike Reich (GZG, Göttingen, Germany) for providing access to the fossil collection in his care. We especially appreciate the valuable suggestions made to this manuscript by reviewers Dr. Istvan Fözy (Department of Paleontology and Geology, Hungarian Natural History Museum, Hungary), Dr. Horacio Parent (Laboratorio de Paleontología, Universidad Nacional de Rosario, Argentina) and Dr. Sven Nielsen (Instituto de Ciencias Ambientales y Evolutivas, Universidad Austral, Chile). We are grateful to the curators, students and collaborators of the Área de Paleontología del Museo Nacional de Historia Natural de Chile, for their daily support and friendship.

REFERENCES

AGUIRRE-URRETA, M. and CHARRIER, R.
1990 Estratigrafía y amonites del Tithoniano-Berriasiano en las nacientes del Río Maipo, Cordillera Principal de Chile Central. Ameghiniana 27 (3-4): 263-271.

BIRO, L.
1964 Estudio sobre el límite entre el Titoniano y el Neocomiano en la Formación Lo Valdés, Provincia de Santiago, principalmente en base a Ammonoideos. Memoria de Título, Universidad de Chile, Escuela de Geología, 118 p.

BIRO, L.
1980 Estudio sobre el límite entre el Titoniano y el Neocomiano en la Formación Lo Valdés, Provincia de Santiago (33°50`lat. Sur.), Chile; principalmente sobre la base de ammonoideos. Actas II Congreso Argentino Paleontología Bioestratigrafía y I Congreso Latinoamericano de Paleontología, Buenos Aires 1978, 1: 137-152.

BLAINVILLE, H.D., de
1825 Manual de Malacologie et de Conchyliologie. 664 pages, atlas of 87 plates.

CHARRIER, R.
1981 Geologie der chilenischen Hauptkordillere zwischen 34° und 34°30' südlicher Breite und ihre tektonische, magmatische und paläogeographische Entwicklung. Berliner Geowissenschaftliche Abhandlungen, A, 36: 270 p.

CICHOWOLSKI, M.
2003 The nautiloid genus *Cymatoceras* from the Cretaceous of the Neuquén and Austral Basins, Argentina. Cretaceous Research, 24: 375–390.

CICHOWOLSKI, M., MOURGUES, F.A. and PEREZ D'ANGELO, E.
2004 El género *Cymatoceras* (Nautilida) en el Cretácico Inferior de la Cuenca deAtacama, Norte de Chile. Revista Geológica de Chile 31(2): 119-131.

GIOVINNE, A.
1950 Algunos cefalópodos del Hauteriviense de Neuquén. Revista de la Asociación Geológica Argentina, 5: 35-36.

GONZALEZ, O.
1963 Observaciones geológicas en el valle del río Volcán. Revista Minerales, 81: 30-37.

HALLAM, A., BIRO-BAGOCZKI, L. and PEREZ, E.
1986 Facies analysis of the Lo Valdés Formation (Tithonian-Hauterivian) of the High Cordillera of central Chile, and the palaeogeographic evolution of the Andean Basin. Geological Magazine. 123, N 4, p.425-435.

HYATT, A.
1883-1884 Genera of fossil cephalopods. Proceedings of the Boston Society of Natural History 22, 273-338.

KLOHN, G.
1960 Geología de la Cordileera de los Andes de Chile Central, Provincias de Santiago, O'Higgins, Colchagua y Curicó. Instituto de Investigaciones Geológicas Chile. Boletín 8: 38-62.

KOBAYASHI, T.
1954 A new cymatoceratid from the Palaeogene of northern Kyushu in Japan. Japanese Journal of Geology and Geography. Transactions 24, 15–21.

ORBIGNI, A.D'.
1840 Paléontologie Française. Terrains Crétacés, Vol. 1. Céphalopodes. Masson et Cie, p. 1-120.

MPODOZIS, C. and RAMOS, V.
1989 The Andes of Chile and Argentina. In Ericksen, G.E., Cañas, M.T. and Reinemund,J. (eds.) Geology of the Andes and its relation to hydrocarbon and mineral resources, Circum-Pacific Council for Energy and Mineral Resources, Earth Sciences Series, 11:59-90.

SALAZAR, C.
2012 The Jurassic-Cretaceous Boundary (Tithonian-Hauterivian) in the Andean Basin, Central Chile: Ammonite

fauna, Bio- and Sequence Stratigraphy and Palaeobiogeography. Doctoral Thesis. Universität Heidelberg. Germany. 388 p.

SALAZAR, C. and STINNESBECK, W.

(submitted a) Ammonites from the Baños del Flaco Formation (Tithonian-Berriasian?) in Central Chile. Journal of Systematic Palaeontology.

SALAZAR, C. and STINNESBECK, W.

(submitted b) Redefinition, Stratigraphy and Facies of the Lo Valdés Formation (Upper Jurassic-Lower Cretaceous) in central Chile. Journal of South American Earth Science.

STEUER, A.

1897 Argentinische Jura-Ablagerungen. Beitäge zur Kenntnis der Geologie und Paläontologie der argentinischen Anden. Palaeontologische Abhandlungen, 7 (3): 127-222.

STEUER, A.

1921 Estratos Jurásicos Argentinos. Contribución al conocimiento de la Geología y Paleontología de los Andes Argentinos entre el río Grande y el río Atuel. Actas de la Academia Nacional de Ciencias de la República Argentina, 7 (2), 107 p.

WEAVER, C.

1931 Paleontology of the Jurassic and Cretaceous of West Central Argentina. Memoirs of the University of Washington, 1: 392 p.

Received: Sep/5th/2014; accepted: Nov/14th/2014; Supervisor: Jhoann Canto.