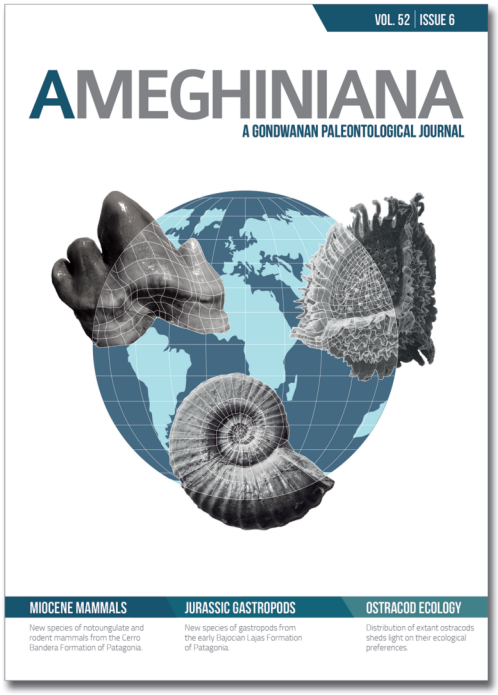
AMEGHINIANA
A GONDWANAN PALEONTOLOGICAL JOURNAL



EARLY BAJOCIAN MARINE GASTROPODS FROM THE NEUQUÉN BASIN, ARGENTINA

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Submitted: March 12th, 2015 - **Accepted:** June 26th, 2015

To cite this article: S. Mariel Ferrari, and Susana E. Damborenea (2015). Early Bajocian marine gastropods from the Neuquén Basin, Argentina. *Ameghiniana* 52: 625–646.

To link to this article: http://dx.doi.org/10.5710/AMGH.26.06.2015.2904

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AMEGHINIANA - 2015 - Volume 52 (6): 625 – 646 ARTICLES

ISSN 0002-7014

EARLY BAJOCIAN MARINE GASTROPODS FROM THE NEUQUÉN BASIN, ARGENTINA

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Abstract. Nine gastropod species are reported from early Bajocian marine deposits at two localities in the Neuquén Basin, supplying the first detailed documentation of six gastropod families from the Middle Jurassic of Argentina at that time.The new gastropod species include *Pleurotomaria bajociana* sp. nov. (Pleurotomariidae); *Cryptaulax weaveri* sp. nov. and *Rhabdocolpus* (*Infacerithium*) *excavatus* sp. nov. (Procerithiidae); *Anulifera sigmoidea* sp. nov. (Protorculidae); *Globularia andina* sp. nov. (Ampullinidae); *Eunerinea*? *neuqueniana* sp. nov. (Eunerineidae) and *Promathildia*? *spinosa* sp. nov. (Gordenellidae). *Leptomaria*? *leufuensis* (Weaver) and *Globularia klingamanni* (Weaver) are also recorded from the same localities. *Rhabdocolpus* (*Infacerithium*) and *Promathildia* are mentioned here for the first time in the Argentinean Mesozoic, and *Cryptaulax*, *Anulifera* and *Eunerinea* extend their chronostratigraphical and paleogeographical distribution into the Bajocian of South America.

Key words. Gastropoda. Systematics. Middle Jurassic. Early Bajocian. Neuquén Basin. Argentina.

Resumen. GASTRÓPODOS MARINOS DEL BAJOCIANO TEMPRANO DE CUENCA NEUQUINA, ARGENTINA. Nueve especies de gastrópodos se registran en depósitos marinos del Bajociano temprano en dos localidades de la Cuenca Neuquina, dando a conocer la primera documentación detallada de seis familias de gastrópodos para el Jurásico Medio en Argentina. Las nuevas especies de gastrópodos incluyen a *Pleurotomaria bajociana* sp. nov. (Pleurotomariidae); *Cryptaulax weaveri* sp. nov. y *Rhabdocolpus* (*Infacerithium*) *excavatus* sp. nov. (Procerithiidae); *Anulifera sigmoidea* sp. nov. (Protorculidae); *Globularia andina* sp. nov. (Ampullinidae); *Eunerinea*? *neuqueniana* sp. nov. (Eunerineidae) y *Promathildia*? *spinosa* sp. nov. (Gordenellidae). *Leptomaria*? *leufuensis* (Weaver) y *Globularia klingamanni* (Weaver) también se registran en las mismas localidades. *Rhabdocolpus* (*Infacerithium*) y *Promathildia* se mencionan por primera vez en el Mesozoico de Argentina, y *Cryptaulax*, *Anulifera* y *Eunerinea* extienden su distribución cronoestratigráfica y paleogeográfica en el Bajociano de América del Sur.

Palabras clave. Gastropoda. Sistemática. Jurásico Medio. Bajociano temprano. Cuenca Neuquina. Argentina.

Middle Jurassic marine gastropods from South America were studied by Weaver (1931), Cox (1956), Gründel (2001) and Gründel *et al.* (2004). Particularly, Weaver (1931) and Gründel *et al.* (2004) provided descriptions of at least 12 gastropod species from the Bajocian/Callovian marine deposits in the Neuquén Basin (Tab. 1). The taxonomic status of most gastropod taxa described so far from the Middle Jurassic of South America are outdated in comparison to those from the western Tethys (Conti and Fischer, 1984; Conti and Szabó, 1987, 1988; Fischer and Weber, 1997; Conti and Monari, 2001; Kaim, 2004, 2008, 2012; Kaim and Conti, 2010; Gründel,1974, 1999, 2006; Gründel and Nützel, 2013; Monari and Gatto, 2013), Africa (Cox, 1965), New Zealand (Bandel *et al.*, 2000), Russia (Gründel, 2005; Guzhov, 2002, 2006, 2014; Gründel and Mitta, 2013) and India (Szabó and Jaitly, 2004). These are just some of the 20th and 21st century contributions to the systematic knowledge of Middle Jurassic marine gastropods globally, but the reference list is far more diverse and complete. Regarding the Argentinean gastropods, there were only few illustrations of the species available in the published literature, and in many cases their taxonomic position was uncertain. The present article provides new data to increase the known biodiversity of Middle Jurassic gastropod faunas from Argentina, recording and describing nine early Bajocian species from Charahuilla and Carro Quebrado localities in central Neuquén Province, from beds that are well-dated by accompanying ammonites. Seven of these species are new to science and belong to the families Pleurotomariidae, Procerithiidae, Protorculidae, Ampullinidae, Eunerineidae and Gordenellidae (Tab. 1).

*Table 1 - Middle Jurassic marine gastropods from South America. Original identifications and references are provided. Note that the new gastropod species here described are highlighted. *= Missing data.*

Taxa	*References*	*Locality*	*Age*	*Family*
Ampullella peruviana Cox, 1956	*Cox, 1956*	*Puerto Caballa, Peru*	*Middle Jurassic (Bajocian–Bathonian)*	*Ampullinidae Cassmann, 1919 (in Cosssmann and Peyrot, 1919)*
Anulifera sigmoidea *sp. nov.*	*Here*	*Carro Quebrado and Charahuilla, Argentina*	*Middle Jurassic (early Bajocian)*	*Protorculidae Bandel, 1991*
Archaeogastropoda? gen. et sp. indet.	*Gründel, 2001*	*Quebrada Asientos, Chile*	*Middle Jurassic (Aalenian)*	*
Bathrotomaria *sp.*	*Cox, 1956*	*Puerto Caballa, Perú*	*Middle Jurassic (Bajocian–Bathonian)*	*Pleurotomariidae Swainson, 1840*
Berlieria *cf.* ledonica *P. de Loriol ,1903*	*Weaver, 1931*	*PicúnLeufú, Argentina*	*Middle Jurassic (Callovian)*	*Patellidae Rafinesque, 1815*
Caenogastropoda gen. et sp. indet. 1	*Gründel, 2001*	*Quebrada de la Profeta, Chile*	*Middle Jurassic (Bathonian)*	*
Caenogastropoda gen. et sp. indet. 2	*Gründel, 2001*	*Quebrada de la Profeta, Chile*	*Middle Jurassic (Bathonian)*	*
Caenogastropoda? gen. et sp. indet. 3	*Gründel, 2001*	*Quebrada de la Profeta, Chile*	*Middle Jurassic (Bathonian)*	*
Cerithium *sp.*	*Weaver, 1931*	*Cerro Lotena, Argentina*	*Middle Jurassic (middle Bajocian)*	*Procerithiidae Cossmann, 1906*
Cossmannea (Cossmannea) *cf.* peruviana *Cox, 1956*	*Gründel, 2001*	*Lomas de los Coligües, Chile*	*Middle Jurassic (Bajocian)*	*NerineidaeZittel, 1873*
Cossmannea (Cossmannea) *sp. 1*	*Gründel, 2001*	*Quebrada el Asientos, Chile*	*Middle Jurassic (Callovian)*	*NerineidaeZittel, 1873*
Cossmannea (Cossmannea) *sp. 2*	*Gründel, 2001*	*Río Figueroa, Chile*	*Middle Jurassic (Callovian)*	*NerineidaeZittel, 1873*
Cossmannea nascaensis *Cox, 1956*	*Cox, 1956*	*Puerto Caballa, Perú*	*Middle Jurassic (Bajocian–Bathonian)*	*NerineidaeZittel, 1873*
Cossmannea peruviana *Cox, 1956*	*Cox, 1956*	*Puerto Caballa, Perú*	*Middle Jurassic (Bajocian–Bathonian)*	*NerineidaeZittel, 1873*
Cryptaulax weaveri *sp. nov.*	*Here*	*Carro Quebrado, Argentina*	*Middle Jurassic (early Bajocian)*	*Procerithiidae Cossmann, 1906*
Cryptaulax? *sp.*	*Gründel, 2001*	*Quebrada de la Profeta, Chile*	*Middle Jurassic (Bathonian)*	*Procerithiidae Cossmann, 1906*
Cylindrites *cf.* minimus *d'Archiac,1843*	*Weaver, 1931*	*Cerro Lotena, Argentina*	*Middle Jurassic (middle Bajocian)*	*Cylindrobullinidae Wenz, 1947*
Eucycloscala? *sp.*	*Gründel* et al., *2004*	*Picún Leufú, Argentina*	*Middle Jurassic (early Bajocian)*	*Eucyclidae Koken, 1897*
Eunerinea? neuqueniana *sp. nov.*	*Weaver, 1931; here*	*Carro Quebrado, Cerro Granito, near Cerro Lotena and Arroyo La Jardinera, Argentina*	*Middle Jurassic (Aalenian/middle Bajocian)*	*Eunerineidae Kollmann, 2014*
Globularia andina *sp. nov.*	*Here*	*Cerro Lotena, Cerro Granito, Carro Quebrado and Charahuilla, Argentina*	*Middle Jurassic (early Bajocian)*	*Ampullinidae Cassmann, 1919 (in Cossmann and Peyrot, 1919)*
Globularia klingamanni (*Weaver, 1931)*	*Weaver, 1931; here*	*Carro Quebrado and Picún Leufú, Argentina*	*Middle Jurassic (Callovian)*	*Ampullinidae Cassmann, 1919 (in Cossmann and Peyrot, 1919)*
Leptomaria? leufuensis *(Weaver, 1931)*	*Weaver, 1931; here*	*Carro Quebrado, Picún Leufú and Vega de la Veranada, Argentina*	*Middle Jurassic (Bajocian–Callovian)*	*Pleurotomariidae Swainson, 1840*
Lissochilus kosslerae *Gründel, 2001*	*Gründel, 2001*	*Estación Gallinazos, Chile*	*Middle Jurassic (middle Bajocian)*	*Neritidae Rafinesque, 1815*
Muricotrochus? *sp.*	*Gründel, 2001*	*Quebrada Iglesias, Manflas, Chile*	*Middle Jurassic (Bajocian)*	*Proconulidae Cox, 1960*
Natica *sp.*	*Weaver, 1931*	*Picún Leufú, Argentina*	*Middle Jurassic (Callovian)*	*Ampullinidae Cassmann, 1919 (in Cossman and Peyrot, 1919)*

Neridomus *sp.*	*Gründel, 2001*	*Quebrada de la Profeta, Chile*	*Middle Jurassic (Bathonian)*	*Neridomidae Bandel, 2008*
Nerinea *cf.* decorata *Piette, 1855*	*Weaver, 1931*	*Picún Leufú, Argentina*	*Middle Jurassic (Callovian)*	*Nerineidae Zittel, 1873*
Nerinea *sp.*	*Weaver, 1931*	*South Central Neuquén, Argentina*	*Middle Jurassic (middle Bajocian)*	*Nerineidae Zittel, 1873*
Nerinella caballensis *Cox, 1956*	*Cox, 1956*	*Puerto Caballa, Peru*	*Middle Jurassic (Bajocian–Bathonian)*	*Nerineidae Zittel, 1873*
Nerinella? *sp. 1*	*Gründel, 2001*	*Sierras Fraga, Chile*	*Middle Jurassic (Bajocian)*	*Nerineidae Zittel, 1873*
Nerinella? *sp. 2*	*Gründel, 2001*	*Lomas de los Coligües and Cerro Piedra Trepada, Chile*	*Middle Jurassic (Bajocian)*	*Nerineidae Zittel, 1873*
Oonia *cf.* euspiroides *Gemmellaro,1878*	*Weaver, 1931*	*Cañada Colorada,Argentina*	*Middle Jurassic (early Bajocian)*	*Ampullinidae Cassmann, 1919 (In Cossmann and Peyrot, 1919)*
Pleurotomaria bajociana *sp. nov.*	*Here*	*Charahuilla, Argentina*	*Middle Jurassic (early Bajocian)*	*Pleurotomariidae Swainson, 1840*
Promathildia? spinosa *sp. nov.*	*Here*	*Carro Quebrado, Argentina*	*Middle Jurassic (early Bajocian)*	*Gordenellidae Gründel, 2000*
Pseudomelania *sp. 1*	*Gründel, 2001*	*Carro Torcazas, Caracoles, Chile*	*Middle Jurassic (Bajocian)*	*Pseudomelaniidae R. Hörnes, 1884*
Pseudomelania *sp. 4*	*Gründel, 2001*	*Manflas, Chile*	*Middle Jurassic (Bajocian)*	*Pseudomelaniidae R. Hörnes, 1884*
Rhabdocolpus (Infacerithium) excavatus *sp. nov.*	*Here*	*Charahuilla and Carro Quebrado, Argentina*	*Middle Jurassic (early Bajocian)*	*Procerithiidae Cossmann, 1906*

GEOLOGICAL SETTING

The Neuquén Basin (Fig. 1.1), which extends between 34° and 41° S, is a Mesozoic back-arc basin located on the western convergent margin of the South American plate (Legarreta and Gulisano, 1989), generated by extension linked to the fragmentation of Gondwanaland and the opening of the South Atlantic Ocean (Uliana and Biddle, 1988). Between 34° and 37° S, it was restricted to a narrow N–S strip but broadened eastwards south of 37° to form the wide Neuquén embayment. It was filled with more than 6000 m of marine and continental sedimentary and extrusive rocks of Late Triassic to Eocene age (Legarreta and Gulisano, 1989; Gulisano and Gutiérrez Pleimling, 1995). The Middle Jurassic marine sequences within the Neuquén embayment are extensively exposed south of Zapala, and were referred by different authors either to the Lajas Formation (Weaver, 1931) or the locally named unit Cura Niyeu Formation (Volkheimer, 1973). Rocks of this unit are mainly composed by sandstones and conglomerates, which were deposited in marginal marine to shallow platform environments. The ammonite associations allowed to assign an early Bajocian–early Callovian age range for the Lajas Formation deposits (see Westermann and Riccardi, 1972, 1979; Legarreta and Gulisano, 1989; Riccardi and Gulisano, 1990; Gulisano and Gutierrez-Pleimling, 1995), and its microflora correlates with the *Ischyosporites marburgensis* Subzone of early Bajocian–late Bajocian age (Martínez *et al.*, 2002). The Lajas Formation reaches a maximum thickness of about 500 m, and was subdivided into 13 depositional sequences or "System Tracts" (Martinez *et al.*, 2002). A detailed sequence stratigraphic analysis of the Lajas Formation was carried out by Zavala (1993, 1996a, b) and Zavala and Gonzales (2001).

The Middle Jurassic marine gastropods here described occur in outcrops of the Lajas Formation at Charahuilla and Carro Quebrado, two well-known Middle Jurassic localities in central Neuquén Province, south of Zapala (Fig. 1.2; see comprehensive geological map in Leanza and Hugo 1997):

Charahuilla (Figs. 1.2.a, 1.3.a). Located about 3 km north of Estancia Charahuilla, 85 km south of Zapala, facing the Arroyo Charahuilla valley, on the tended eastern flank of the Sierra de Chacaico anticline. This section was mentioned and described by several authors (Westermann and Riccardi,

1972, 1979; Volkheimer, 1973; Gulisano *et al.*, 1984; Gulisano and Gutiérrez Pleimling, 1995, fig. 31; Zavala, 1996a, b; Quattrocchio *et al.*, 1996; Leanza and Hugo, 1997; Dietze *et al.*, 2012). Gastropods were collected from three beds in a 25 m thick interval within the *Emileia multiformis* Subzone of the Giebeli Zone (Fig. 1.3.a), but only *"Natica" klingamanni* Weaver had been mentioned before from this locality (Damborenea and Manceñido in Gulisano and Gutiérrez-Pleimling, 1995, p. 71).

Carro Quebrado (Figs. 1.2.b, 1.3.b). The section was logged and sampled on the northern flank of an anticline exposed between Cerro Picún Leufú and Meseta de la Barda Negra, about 30 km south of Zapala, at the southwestern corner of the Barda Negra itself. This structure is continuous with the already mentioned Sierra Chacaico anticline, and extends eastwards to Cerro Lotena and Cerro Granito, from where Weaver (1931) described five Bajocian gastropod species. Early Bajocian marine beds at Carro Quebrado span the Singularis and Giebeli Standard Zones, and gastropods were collected from at least 7 beds in a 60 m thick interval (Fig. 1.3.b). This section was described by Suero (1951) and Westermann and Riccardi (1972, 1979).

The ammonites from the same sections and beds were studied by Westermann and Riccardi (1972, 1979), and a recent revision of those from Charahuilla was published by Dietze *et al.* (2012); they indicate ages spanning the Singularis and Giebeli Zones (early Bajocian) for the gastropod-bearing deposits (Fig. 1.3). The calcareous microfossils (foraminifers and ostracods) from the same sections were studied by Ballent (1986, 1991, 1997).

MATERIAL AND METHODS

Stratigraphic sections at Carro Quebrado and Charahuilla were logged by A. Riccardi, M. Manceñido, and S. Damborenea in 1973 (see Westermann and Riccardi, 1979; Fig. 1.3 here). Only a few gastropod specimens were collected then and are now included in this paper. Both localities were sampled again by Damborenea, Manceñido and S. Ballent in 1980. Recently, abundant Middle Jurassic gastropod material was collected by Damborenea, Manceñido, J. Echevarría (Museo de Ciencias Naturales de La Plata) and M. Ferrari (Centro Nacional Patagónico-CENPAT).

The Argentinean gastropod material is housed in the invertebrate paleontology collections at Museo Paleontológico Carmen Funes, Plaza Huincul and Museo de Ciencias Naturales de La Plata. The specimens were prepared by technical staff at the Museo Paleontológico "Egidio Feruglio" laboratory (Santiago Bessone and Leandro Canessa) and coated with ammonium chloride to enhance sculpture details for photography. Material described by Weaver (1931) was examined by S.D. on loan from the Burke Museum of Natural History and Culture (Seattle), and casts are kept in the La Plata Museum collections.

Institutional abbreviations: **MPEF-PI=** Museo Paleontológico "Egidio Feruglio", Trelew, Chubut, Argentina; **MCF-PIPH=** Museo Paleontológico Carmen Funes, Plaza Huincul, Neuquén, Argentina; **MLP=** Invertebrate Paleontology collection, Museo de Ciencias Naturales La Plata, La Plata, Argentina; **BM=** Burke Museum of Natural History and Culture, Seattle, USA. MB.Ga= Museum für Naturkunde Humboldt-Universität zu, Berlin, Germany.

SYSTEMATIC PALEONTOLOGY

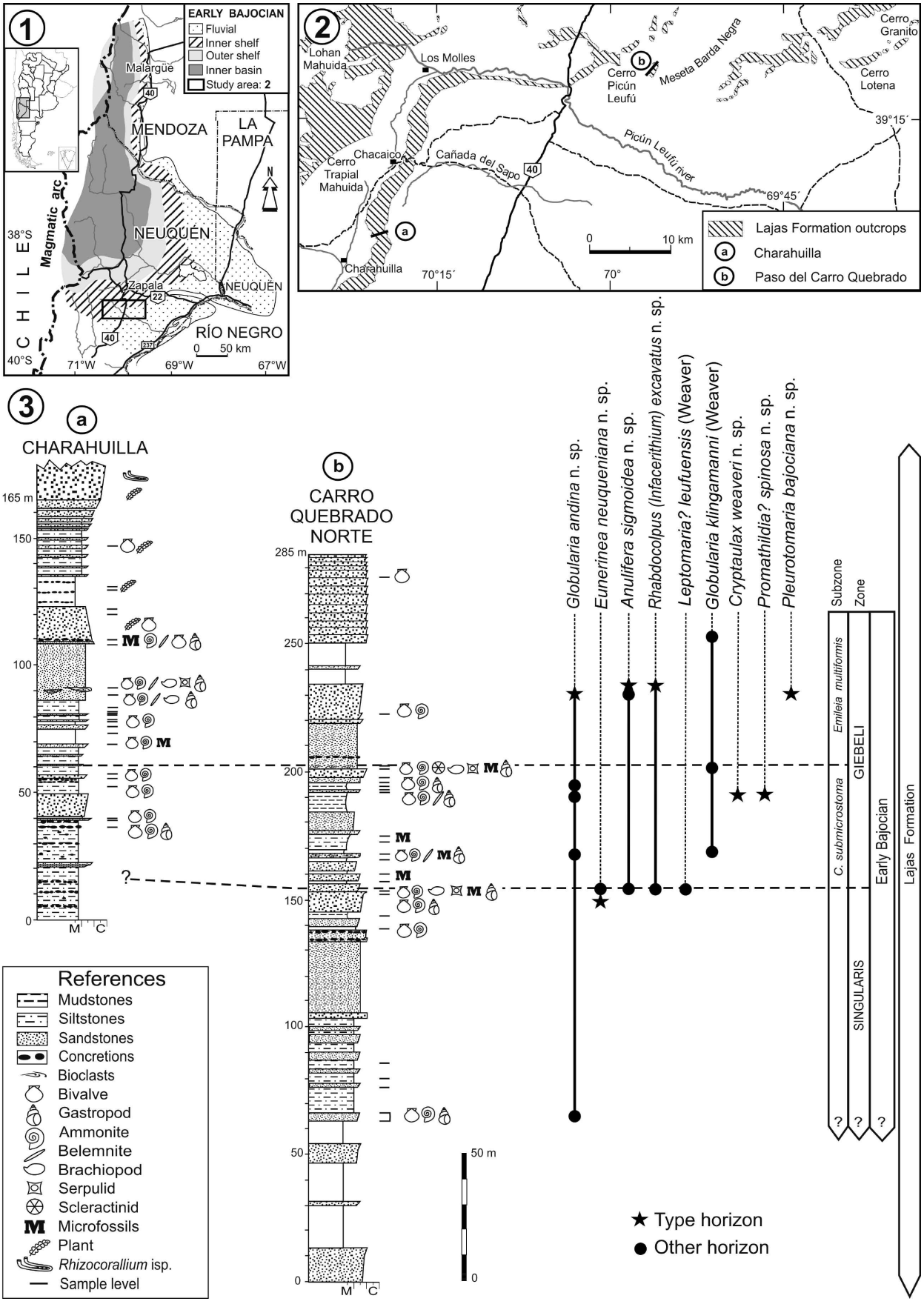
Class Gastropoda Cuvier, 1795
Order Vetigastropoda Salvini-Plawen, 1980
Family Pleurotomariidae Swainson, 1840

Genus ***Pleurotomaria*** Defrance, 1826

Type species. *Trochus anglicus* Sowerby, 1818, by Woodward, 1851; Early Jurassic (late Pliensbachian), south-western England, subsequent designation.

Remarks. The systematic position of the type genus *Pleurotomaria* was recently revised by Monari and Gatto (2013), who proposed a reevaluation of the genus based on seven *Pleurotomaria* species from the Middle Jurassic (early Bajocian) of Luxembourg. They gave a detailed morphological characterization of the genus (see Monari and Gatto, 2013,

Figure 1.1. Paleogeographic map of the Neuquén Basin during early Bajocian times, modified from Legarreta and Uliana (2000); **2.** Study area in the region south of Zapala and extension of the Lajas Formation outcrops (simplified from Leanza and Hugo, 1997); **3.** Sketch of logged sections with indication of gastropod-bearing levels at: **a,** Charahuilla; **b,** Paso del Carro Quebrado.


1
EARLY BAJOCIAN
Fluvial
Inner shelf
Outer shelf
Inner basin
Study area: 2
Malargüe
MENDOZA
LA PAMPA
Magmatic arc
NEUQUÉN
Zapala
NEUQUEN
RÍO NEGRO
CHILE
38°S
40°S
71°W
69°W
67°W
0 50 km
2
Lohan Mahuida
Los Molles
Cerro Picún Leufú
Meseta Barda Negra
Cerro Granito
Cerro Lotena
39°15´
Picún Leufú river
Chacaico
Cañada del Sapo
Cerro Trapial Mahuida
69°45´
Charahuilla
70°15´
70°
0 10 km
Lajas Formation outcrops
a Charahuilla
b Paso del Carro Quebrado
3
a
CHARAHUILLA
165 m
150
100
50
0
M C
b
CARRO QUEBRADO NORTE
285 m
250
200
150
100
50
0
50 m
Globularia andina n. sp.
Eunerinea neuqueniana n. sp.
Anulifera sigmoidea n. sp.
Rhabdocolpus (Infacerithium) excavatus n. sp.
Leptomaria? leufuensis (Weaver)
Globularia klingamanni (Weaver)
Cryptaulax weaveri n. sp.
Promathildia? spinosa n. sp.
Pleurotomaria bajociana n. sp.
Subzone
Zone
C. submicrostoma
Emileia multiformis
GIEBELI
SINGULARIS
Early Bajocian
Lajas Formation
References
Mudstones
Siltstones
Sandstones
Concretions
Bioclasts
Bivalve
Gastropod
Ammonite
Belemnite
Brachiopod
Serpulid
Scleractinid
Microfossils
Plant
Rhizocorallium isp.
Sample level
★ Type horizon
● Other horizon

p. 753). The material here described from the Bajocian of Argentina closely fits their emended diagnosis. Moreover, they outlined the paleobiogeographical history of the genus and suggested that the major Jurassic radiation of *Pleurotomaria* ended in the early Bajocian, though such diversity occurred in a restricted area of the western Tethys. Monari and Gatto (2013) also pointed out that the diversity of *Pleurotomaria* decreased rapidly toward the late Bajocian in the Western European epicontinental region. The new *Pleurotomaria* species here described (see below) supplies new evidence of the record of this genus in the Middle Jurassic of Argentina, confirming its paleobiogeographical distribution in the early Bajocian of the Southern Hemisphere.

Geographic occurrence. Cosmopolitan.

Age range. Early Jurassic–Early Cretaceous.

Pleurotomaria bajociana sp. nov.

Figures 2.1–10

Derivation of name. Referred to the first occurrence of *Pleurotomaria* in the early Bajocian of Argentina.

Type material. Holotype, MCF-PIPH 601; one recrystallized teleoconch.

Geographic and stratigraphic occurrence. Charahuilla, Middle Jurassic (*Emileia multiformis* Subzone, Giebeli Standard Zone, early Bajocian), Lajas Formation (Fig. 1.3), Neuquén Province, Argentina.

Diagnosis. Gradate, phaneromphalous shell; ramp narrowly horizontal; 13–14 rounded to conspicuous nodes delimiting the angulation of whorls; reticulate ornament; broad selenizone at midwhorl; lunulae crowded and opisthocyrt; umbilicus narrow and funnel-shaped.

Description. Dextral, phaneromphalous, trochiform, angular, medium-sized and low-spired shell.The protoconch is not preserved. The earliest teleoconch whorls are turbiniform and gradate. The adult shell is gradate and consists of 5 slightly convex and angular whorls. The ramp of whorls is narrow and horizontal; the outer face is almost flat in juvenile whorls becoming slightly convex toward mature growth stages. Suture is weakly impressed. The peripheral angulation is delimited by a spiral swelling made up of 13–14 rounded to slightly pointed nodes. The shell surface is ornamented by regularly spaced spiral cords which show a zigzag pattern. The spiral cords are intercepted by strongly prosocline and very closely placed growth lines, giving the ornament a reticulate appearance. The selenizone is slightly broad and clearly developed at mid-whorl on the outer face; it is concave and bordered by two sharp spiral cords. Lunulae are very close and strongly opisthocyrtic. The base is flat to slightly convex and ornamented by fine and regularly spaced spiral cords; the spiral elements are intercepted by weak prosocline to slightly opisthocyrtic growth lines, forming very small and pointed nodes at the crossing points. The umbilicus is narrow, deep and funnel-shaped. The umbilical area is also ornamented by fine collabral ribs. The aperture shows a quadrangular shape.

Dimensions (mm). MCF-PIPH 601= Height, 22.8; width, 27.6.

Remarks. According to Cox (1960) and the diagnosis by Monari and Gatto (2013), the species here described shows the typical characters of *Pleurotomaria*, such as a trochiform, moderately depressed, gradate shell, with nodes at the angulations of whorls, selenizone slightly broad located at mid-whorl, and ornament consisting on spiral cords which are dominant on adult shell.

Other *Pleurotomaria* species similar to *P. bajociana* sp. nov. were reported from the Middle Jurassic of South America. *Leptomaria leufuensis* (Weaver, 1931, p. 364, pl. 41, fig. 274, casts MLP 25019, see below), from the Bajocian/Callovian of Neuquén Province (Argentina), differs from the new species by having a less gradate shell outline with more convex whorls, and lacking prominent nodular elements at angulations (see description below). Specimens from the Bajocian of Peru referred to *Pleurotomaria* cf. *subfasciata* d'Orbigny, by Jaworski (1925, p. 112), apparently differ from *P. bajociana* sp. nov. by being larger, having more convex whorls, less developed sutural ramp and thinner spiral cords. Jaworski (1925) did not figure his Peruvian material and based his description on d'Orbigny's form (*Pleurotomaria subfasciata* d'Orbigny, 1850, p. 477, pl. 383, figs. 8–10). *Pleurotomaria gerthi* Weaver, 1931 (p. 367–368, pl. 41, figs. 281–283), from the Lower Cretaceous (late Valanginian–early Hauterivian) of Picún Leufú (Neuquén), is also very similar to *P. bajociana* sp. nov. in general shell morphology and ornament pattern; however, *P. gerthi* is bigger, anomphalous, has more nodes (nearly fifteen on last whorl) which extend adapically on the periphery of the shell, and has better developed spiral elements consisting on fine threads on the shell surface (Cataldo and Lazo, 2012).

Monari and Gatto (2013) proposed a systematic re-evaluation of the genus based on seven species of *Pleurotomaria* from the Middle Jurassic (lower Bajocian) of Luxembourg. One of these species is *Pleurotomaria armata* Münster in Goldfuss (1844), which differs from *P. bajociana* sp. nov. by having a slightly higher spire, a more clearly gradate outline and a steeper outer face, a wider umbilicus, and a selenizone located slightly above the mid-line of the outer face (Monari and Gatto, 2013, p. 756, figs. 4–5). *Pleurotomaria ornata* (Sowerby, 1818) is also very similar to *P. bajociana* sp. nov.; however, the European form has more (23–37) and more closely spaced nodes on the angulation of the outer rim of the ramp, a peripheral angulation with nodes that tend to disappear on last whorl, it presents more conspicuous spiral threads on the base, and has a slightly wider umbilicus (Monari and Gatto, 2013, p. 759, figs. 6–7). *Pleurotomaria actinomphala* J.A. Eudes-Deslongchamps, 1849, differs from *P. bajociana* sp. nov. by having a convex to cord-like selenizone without lunulae on the last whorl, more and smaller nodes at the peripheral angulation, and a wider umbilicus (Monari and Gatto, 2013, p. 762, fig. 8).

Pleurotomaria anglica (Sowerby, 1818), described by Gründel (2001, p. 44, pl. 1, figs. 1–2) from the Lower Jurassic (Sinemurian) of Chile, differs from *P. bajociana* sp. nov. by having a more gradate shell outline and more conspicuous nodes on the angulation of whorls.

Genus ***Leptomaria*** E. Eudes-Deslongchamps, 1864

Type species. *Pleurotomaria amoena* J.A. Eudes-Deslongchamps, 1849, Middle Jurassic (Bajocian), France; original designation.

Remarks. The species described below, originally assigned to *Pleurotomaria* by Weaver (1931), does not fit with the diagnosis of *Pleurotomaria* (see Monari and Gatto, 2013). According to the characterization of Harasewych and Kiel (2007) and Harasewych *et al*. (2009) *Leptomaria* shells are conical or cyrtoconical, anomphalous to broadly phaneromphalous; whorls weakly to strong convex lacking angular shoulder; last whorl rounded at periphery of convex base; selenizone at mid-whorl; and ornament with spiral thread predominantly. The type specimens described by Weaver (1931) lack tubercles and have the ornamentation pattern and the convex shell typical of *Leptomaria*. Nevertheless, the species in only tentatively referred to *Leptomaria* because the Argentine material is poorly preserved and some characters are not clearly visible, such as the position of the selenizone.

Geographic occurrence. Cosmopolitan.

Age range. Early Jurassic–Paleocene (range extended by Pacaud, 2004; see Harasewych *et al*., 2009).

Leptomaria? leufuensis (Weaver, 1931)

Figures 2.11–15

1931 *Pleurotomaria leufuensis* Weaver, p. 364, pl. 41, fig. 274.
2009 *Leptomaria leufuensis* Harasewych *et al*: p. 754, 756, 764 (not figured).

Referred material. The holotype (BM 264/ SA966= cast MLP 25019) is an incomplete specimen from about 9 km NW from Cerro Picún Leufú, in beds assigned by Weaver (1931) to the Callovian.

Our material (MLP 34614) was collected in early Bajocian beds (Singularis Zone) at Carro Quebrado Norte (Fig. 1.3.b), but the species also occurs (MLP 34615) in early Callovian beds at Vega de la Veranada locality (northern Neuquén Province); two recrystallized teleoconchs.

Geographic and stratigraphic occurrence. Carro Quebrado, Middle Jurassic (early Bajocian, Singularis Zone), Lajas Formation; Picún Leufú and Vega de la Veranada, Middle Jurassic (early Callovian), Neuquén Province, Argentina.

Description. Dextral, conical, slightly coeloconoid, medium-sized and moderately low-spired shell. The protoconch is not preserved. The teleoconch consist of 5 convex, non-angular whorls; earliest whorls are slightly flat and become convex toward mature growth stages. Subsutural band is narrowly horizontal and suture is impressed. The selenizone is not clearly visible and appears on the lower portion of whorls coinciding with the outer face; it is slightly concave and delimited by one fine adapical spiral keel. The shell surface is ornamented by regularly spaced spiral cords separated by moderately fine spiral furrows. Fine prosocline axial riblets intersect the spiral elements, forming small and rounded nodes at the intersection points. Lunulae are not clearly visible. The base is flat to slightly angular and ornamented by spiral cords in specimen MLP 34614. The aperture is quadrangular, with the outer lip strongly convex and the columellar lip covering the umbilicus as a callus.

Dimensions (mm). MLP 34614= Height, 28.7; width, 23.5.

MLP 34615= Height, 21.5; width, 30.

Remarks. The specimens here examined are poorly preserved but fit the characterization of *Pleurotomaria leufuensis* Weaver, 1931. However, following the updated diagnosis of Monari and Gatto (2013), they show neither the broad selenizone in the middle of the outer face nor the conspicuous nodes at the angulation of whorls, which are now regarded as typical of the genus. They are here doubtfully referred to *Leptomaria* by the lack of tubercles, convex shaped-shell and by the predominance of spiral cords, although the selenizone appears to be rather low; thus, it is left in open nomenclature. Comparisons with *Pleurotomaria bajociana* sp. nov. are provided above.

Leptomaria sp. (see Ferrari, 2014; p. 571, fig. 4k–m), from the Early Jurassic of Argentina, differs from the species here described by being smaller and having prosocline to opisthocline growth lines. *Leptomaria somhegyensis* Szabó, 1980 (p. 59, pl. 3, figs. 1–3), from the Middle Jurassic (early–middle Bajocian) of Hungary, resembles *Leptomaria*? *leufuensis*; however, the form described by Szabó (1980) has an open umbilicus, a stronger reticulate sculpture and the growth lines are sigmoidal with a prosocline and prosocyrtic pattern. *Leptomaria* cf. *tardita* (Sieberer, 1907), from the Middle Jurassic (middle Bajocian) of Hungary, differs from *Leptomaria*? *leufuensis* by having a stronger spiral ornament pattern and a slightly more gradate shell outline (Szabó, 1980; p. 60, pl. 3, fig. 4). Szabó (1980) described *Pleurotomaria* (*Anodomaria*) *scacchi* Gemmellaro, 1874 (in Szabó, 1980; p. 58, pl. 2, figs. 6–7) and *Pleurotomaria* (*Anodomaria*) *anodosa* Szabó, 1980 (p. 59, pl. 2, figs. 8–9) –both from the Early Jurassic (Pliensbachian) of Hungary–which are very similar to *Leptomaria*? *leufuensis*; these species, however, show a more gradate and pentagonal shell outline and a more reticulate ornament pattern. Moreover *Pleurotomaria* (*A.*) *scacchi* shows also a widely open umbilicus.

Leptomaria larseniana (Wilckens, 1910), from the Paleocene of Antactica, differs from the species here described by being much larger, with the axial ornament limited to fine growth lines, and by having a narrowly opened umbilicus (Harasewych *et al.*, 2009; p. 752, figs. 5–6).

Order Caenogastropoda Cox, 1960

Family Cryptaulicidae Gründel, 1976

Subfamily Cryptaulicinae Gründel, 1976

Genus ***Cryptaulax*** Tate, 1869

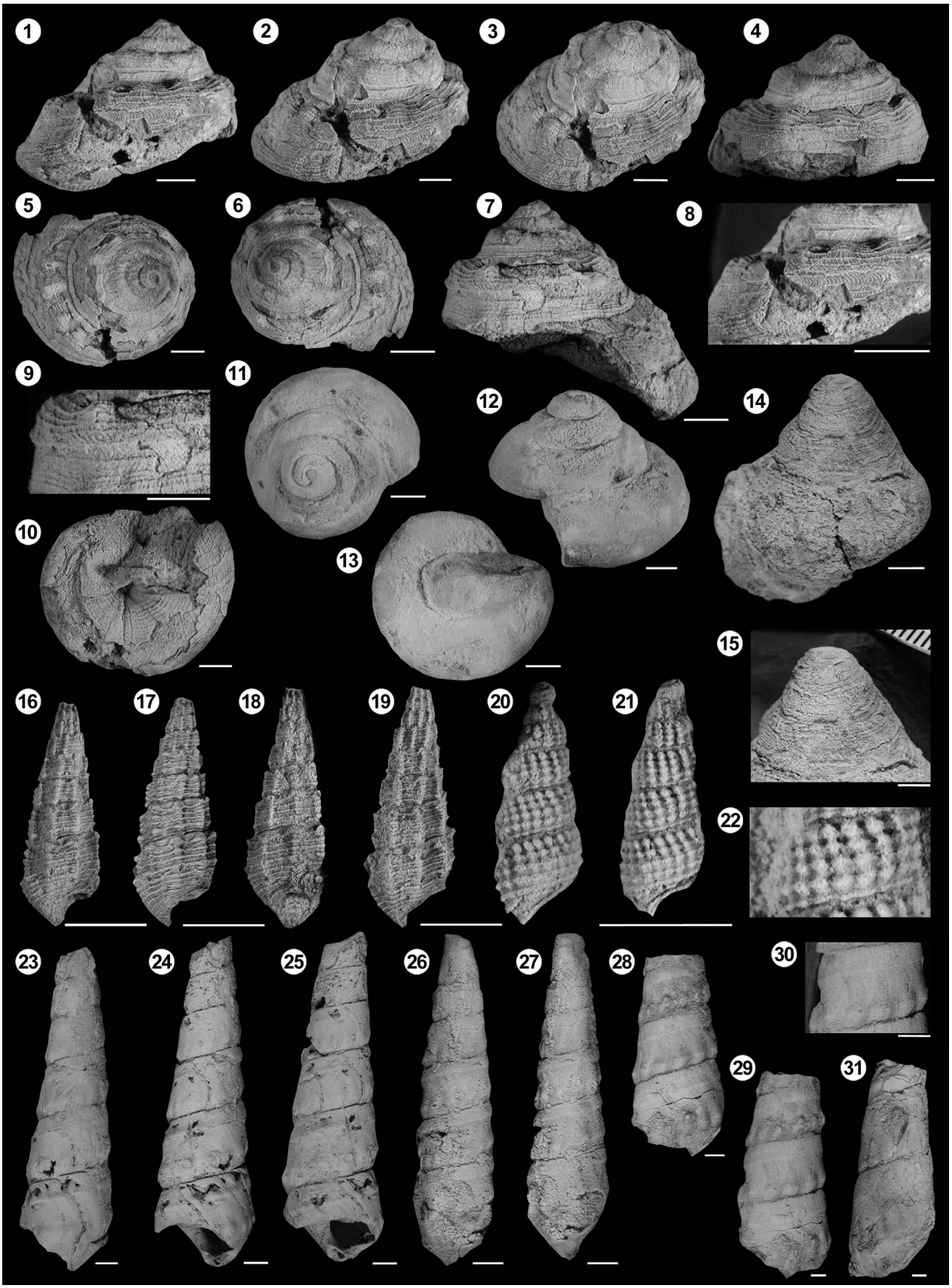
Type species. *Procerithium* (*Xystrella*) *protortile* Cox, 1969, pro *Cerithium tortile* Hébert and E. Eudes-Deslongchamps, 1860, Middle Jurassic (Callovian), France; original designation.

Geographic occurrence. Cosmopolitan.

Age range. Late Triassic–Early Cretaceous.

Remarks. The genus *Cryptaulax* was revised by several authors (Gründel, 1999, 2003; Kaim, 2004; Bandel, 2006; Gründel *et al.*, 2011) who provided detailed diagnoses, and material described below fits with their characterization. The genus was recently reported from the Early Jurassic marine deposits of the Mulanguiñeu Formation, Chubut Province (Argentina) (Ferrari, 2012). *Cryptaulax* species are characterized by the presence of a slender and turriculate teleoconch ornamented by axial ribs arranged in an alternating screw-like pattern. They are crossed by two spiral ribs on the first teleoconch whorl. Later whorls may have more spiral ribs forming tubercles where they cross the axial ribs. In the juvenile shell, the base forms an angle with the sides and it is rounded in the adult shell. The base is commonly ornamented by spiral ribs (see also diagnoses by Gründel, 1999, 2003; Kaim, 2004; Bandel, 2006). The classification of Gründel *et al.* (2011) is followed to assign *Cryptaulax* to the Family Cryptaulicidae and to the Subfamily Cryptaulicinae.

Figure 2. Middle Jurassic gastropods from the Neuquén Basin. **1–10,** ***Pleurotomaria bajociana*** sp. nov., **MCF-PIPH** 601, holotype. **1–4,** lateral views; **5–6,** apical views; **7,** lateral and apertural views; **8–9,** selenizone detail; **10,** basal and umbilical views. **11–15,** ***Leptomaria*****?** ***leufuensis*** (Weaver, 1931). **11–13, MLP** 34615. **11,** apical view; **12,** lateral view; **13,** basal view. **14–15, MLP** 34614; **14,** lateral view; **15,** ornament detail. **16–19,** ***Cryptaulax weaveri*** sp. nov., **MCF-PIPH** 578, holotype. **16, 17, 19,** lateral views; **18,** lateral and apertural views. **20–22,** ***Rhabdocolpus*** **(*Infacerithium*)** ***excavatus*** sp. nov., **MCF-PIPH** 612, holotype. **20–21,** lateral views; **22,** ornament detail. **23–31,** ***Anulifera sigmoidea*** sp. nov. **23–25, MCF-PIPH** 613b, holotype. **23,** lateral view; **24–25,** lateral and apertural views. **26–27, MB.Ga**. 783 (original material described by Gründel, 2001, cast **MPEF-PI** 6016), lateral views. **28–30, MCF-PIPH** 603, paratype. **28–29,** lateral views; **30,** ornament detail. **31, MLP** 34616, lateral view. Scale bar= 5 mm.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Here, the first occurrence of the genus in the Middle Jurassic of Argentina is reported.

Cryptaulax weaveri sp. nov.
Figures 2.16–19

? 1931 *Cerithium* sp. indet.; Weaver, p. 384–385.

Derivation of name. Dedicated to Charles E. Weaver for his substantial contributions to the knowledge of Mesozoic molluscs of Argentina.

Type material. Holotype, MCF-PIPH 578; one recrystallized teleoconch.

Geographic and stratigraphic occurrence. Carro Quebrado, Middle Jurassic (*Chondromileia submicrostoma* Subzone, Giebeli Zone, early Bajocian), Lajas Formation (Fig. 1.3.b), Neuquén Province, Argentina.

Diagnosis. Turriculate, small shell; 8–9 orthocline ribs on the shell surface; 4 primary spiral cords intercalated with 4 secondary cords; nodes stronger at primary spiral cords; base with 6 spiral cords; holostomatous and circular aperture.

Description. Dextral, turriculate, slender, small-sized and high-spired shell. The protoconch is not preserved. The teleoconch consists of 8 flat whorls; suture is distinctly impressed. The ornament is predominantly axial, consisting of 8–9 regularly spaced, strong and orthocline ribs that run from suture to suture, giving the outline of the shell a convex appearance. The axial elements intercept the spiral cords, forming small nodes at the crossing points; 4 primary spiral cords are intercalated with 4 secondary and weaker spiral elements. Secondary spiral cords are clearly visible on mature whorls. Nodes are stronger at the intersections of primary spiral elements. The base is strongly convex and ornamented by 6 regularly spaced spiral cords. The aperture is holostomatous and circular, with the outer lip thin and the columellar lip thickened forming callus.

Dimensions (mm). MCF-PIPH 578= Height, 12.9; width, 4.6.

Remarks. The new species here described shows the typical features of *Cryptaulax* (see above). Ferrari (2009, 2012) indicated that most representatives of the genus are characterized by the mode of occurrence of the weak secondary spiral cords during the ontogeny. The presence of 4 secondary spiral cords between 4 primary spiral cords, clearly visible on mature whorls, separates *C. weaveri* sp. nov. from other Argentinean species of *Cryptaulax*.

The genus was first mentioned in Argentina from the Jurassic of southern Patagonia. Ferrari (2012) reported *Cryptaulax damboreneae* Ferrari, 2009 (p. 452, fig. 3B–D; 2012, p. 325, fig. 2A–H), from the late Pliensbachian–early Toarcian of Chubut Province. *Cryptaulax weaveri* sp. nov. differs from *C. damboreneae* by having more primary and secondary spiral cords on mature teleoconch whorls. *Cryptaulax redelii* Ferrari, 2012 (p. 327, fig. 2I–K), from the Lower Jurassic of Chubut Province, also resembles *C. weaveri* sp. nov. in general shell morphology and ornament pattern; however, the new species has more primary spiral cords. *Cerithium* sp. (Weaver, 1931), from the middle Bajocian of the nearby locality Cerro Lotena, is tentatively included in the synonymy list, although according to Weaver's (1931 , p. 384) description it is larger and has more spiral and axial ribs than *C. weaveri* sp. nov.

Middle Jurassic *Cryptaulax* species very similar to *Cryptaulax weaveri* sp. nov. were described by Gründel (1999) and Kaim (2004). *Cryptaulax quenstedti* (Walther, 1951) (Gründel, 1974, p. 842, pl. 2, figs. 9–15; Gründel, 1999, p. 18, pl. 4, figs. 8–12 identified as *Cryptaulax* ex. gr. *bellayensis* sp. 3; Kaim, 2004, p. 36, fig. 21), from the Middle Jurassic (Bathonian–Callovian) of Poland, differs from the new Argentinean species by having a more gradate shell outline, more conspicuous nodes at the crossing points of spiral and axial elements, and 3 primary spiral cords on mature whorls. *Cryptaulax shiptonensis* (Cox and Arkell, 1950), from the Middle Jurassic (Bathonian) of Great Britain and Poland, is similar to *C. weaveri* sp. nov.; however, the European form has a better developed and almost horizontal sutural ramp, and only 2 secondary spiral cords are located in a median position, between 2 primary spiral cords (Kaim, 2004, p. 34, fig. 20). *Cryptaulax armata* (Goldfuss, 1844), from the Middle Jurassic of Poland, differs from *C. weaveri* sp. nov. by having a better developed sutural ramp, secondary spiral cords reduced on mature whorls, and more conspicuous nodes at the intersection of axial and spiral elements (Kaim, 2004, p. 37, fig. 22).

Cryptaulax weaveri sp. nov. extends the paleobiogeographical and chronostratigraphical distribution of the genus in the Andean region of Argentina to the early Bajocian.

Family Procerithiidae Cossmann, 1906
Subfamily Procerithiinae Cossmann, 1906

Genus ***Rhabdocolpus*** Cossmann, 1906

Type species. *Melania scalariformis* Deshayes, 1830, Middle Jurassic, France; original designation.

Geographic occurrence. Europe, New Zealand, Antarctica and South America.

Age range. Late Triassic–Late? Jurassic.

Remarks. The diagnosis of *Rhabdocolpus* Cossmann was recently emended by Gründel (1999) and Bandel *et al.* (2000). The authors included in this procerithiid genus forms with a 'high-spired and flattened to slightly convex outline shell, with an horizontal to strong sloping subsutural ramp, opisthocyrt axial ribs on the teleoconch, forming nodes at the crossing point with spiral elements, and base with an adapical channel and lacking abapical notch'. The genus is well known from the Jurassic of Europe, and Haas (1953) reported the first occurrence of *Rhabdocolpus* from the Upper Triassic of South America.

Subgenus ***Infacerithium*** Gründel, 1974

Type species. *Procerithium* (*Infacerithium*) *klebyensis* Gründel, 1974, Middle Jurassic (Bathonian–Callovian), Europe; original designation.

Geographic occurrence. Europe and South America.

Age range. Early Jurassic–Middle Jurassic.

Remarks. Gründel (1999) retained the subgenus *Rhabdocolpus* (*Infacerithium*) to include shells with a sloping subsutural ramp, with whorls which are not delimited against each other in a step-like appearance, and the outer face of whorls is nearly convex.

Rhabdocolpus* (*Infacerithium*) *excavatus sp. nov.
Figures 2.20–22

Derivation of name. Referred to the strongly sloped subsutural area, which gives the teleoconch whorls an excavate appearance.

Type material. Holotype, MCF-PIPH 612; one recrystallized teleoconch; paratypes, MCF-PIPH 606, 613a; 2 fragmentary teleoconchs.

Referred material. MCF-PIPH 587, 605, 608, 609; 4 fragmentary teleoconchs.

Geographic and stratigraphic occurrence. Charahuilla and Carro Quebrado (Fig. 1.3), Middle Jurassic (*Chondroemileia submicrostoma* and *Emileia multiformis* Subzones, Singularis and Giebeli Zones, early Bajocian), Lajas Formation (Fig. 1.3), Neuquén Province, Argentina.

Diagnosis. Turriculate, small shell; sutural ramp narrow and sloped; straight to opisthocyrtic axial ribs; 4 spiral cords on the shell surface; nodes strongly developed on the adapical spiral cord; base with 4 spiral cords; aperture oval with an adapical channel.

Description. Dextral, turriculate, slender, small-sized and high-spired shell. The protoconch is poorly preserved, but appears convex and smooth. The teleoconch consist of 6 whorls. Teleoconch whorls are convex; the sutural ramp is narrow and sloped, giving the subsutural area a strongly excavate appearance. The outer face is flat on earlier whorls, becoming slightly convex towards mature growth stages. The ornament consists of axial, spiral and nodular elements. The axial ribs are predominant on all teleoconch whorls; they are straight on juvenile whorls becoming slightly opisthocyrtic towards mature whorls. The spiral cords are regularly spaced, adding up 4 or 5 towards last whorl, forming small and rounded nodes at the crossing points with axial elements. Nodes are slightly stronger at the adapical spiral cord toward mature growth stages. Sutures are impressed in a strongly concave and excavated furrow, and bordered by a fifth weak spiral cord. The base is convex and ornamented by 4 spiral cords, but without collabral ribs. The aperture is oval with an adapical channel; the peristome is continuous at the abapical end.

Dimensions (mm). MCF-PIPH 612= Height, 7.8; width, 3. MCF-PIPH 606= Height, 9.2; width, 3.3. MCF-PIPH 587= Height, 12; width, 4.5.

Remarks. The new species here described fits with the genus and subgenus diagnoses proposed by Gründel (1999, p. 6, 11), who also described two *Rhabdocolpus* (*Infacerithium*) species from the Middle Jurassic of Poland, very similar to *R.* (*I.*) *excavatus* sp. nov. *Rhabdocolpus* (*Infacerithium*) *klebyensis* Gründel, 1974 (in Gründel, 1999, p. 11, pl. 3, figs.1–11), from the Bathonian–Callovian of Poland, differs from the Argentinean form by having a slightly less elongated shell, with a height of about 5 mm, stronger nodes at the adapical spiral cord, and, in some specimens, a better developed reticulate ornament on the last teleoconch whorl. *Rhabdocolpus* (*Infacerithium*) *gristowiensis* (Gründel, 1990) (in Gründel, 1999, p. 12, pl. 3, figs. 12–18), from the Callovian of Germany, resembles *R.* (*I.*) *excavatus* sp. nov.; however, the

European form has more convex whorls, a more excavated whorl outline, stronger spiral cords developed as furrows, and almost imperceptible axial elements.

Another species similar to *R.* (*I.*) *excavates* sp. nov. is *Procerithium* (*Infacerithium*) *nososum* Ferrari, 2012 (p. 333, fig. 5L–R), from the Pliensbachian–Toarcian of Chubut, Patagonia; the Early Jurassic species, however, has a step-like shell, a better developed reticulate ornament, and a stronger nodose adapical spiral cord.

Rhabdocolpus (*Infacerithium*) *excavates* sp. nov. is the first occurrence of the genus and subgenus in the Bajocian marine deposits of South America.

Suborder Ptenoglossa Gray, 1853

Family Protorculidae Bandel, 1991

Genus ***Anulifera*** Zapfe, 1962

Type species. *Zygopleura (Anulifera) variabilis* Zapfe, 1962, Rhaetian (Late Triassic), Austria; original designation.

Geographic occurrence. Europe, Asia, South America.

Age range. Late Triassic–Middle Jurassic.

Remarks. Nützel and Senowbari-Daryan (1999) placed *Anulifera* in the Protorculidae due to the presence of fine spiral grooves on the teleoconch, the presence of knobby spiral rows, the general shell morphology and the relatively large size. They also stated that the spiral ornament of the base resembles that of *Atorcula* Nützel, 1998, which has a typical protorculid larval shell. However, the embryonic shell of *Anulifera* remains unknown, so the placement of the genus into the Protorculidae still needs confirmation (Nützel and Senowbari-Daryan 1999). According to Nützel and Senowbari-Daryan (1999) and Nützel *et al.* (2010) the genus is characteristic of the Upper Triassic of Asia and the Alps (Tethys); it is also known from the Lower Jurassic of Argentina (Ferrari, 2013) and now its range is extended into the Middle Jurassic. Another protorculid, i.e., *Protorcula* sp., was reported by Haas (1953) from the Late Triassic of Peru, although the author assigned his species to the family Coelostylinidae. The species described below extends the chronostratigraphic distribution of *Anulifera* into the Middle Jurassic of South America.

Anulifera sigmoidea sp. nov.

Figures 2.23–31

2001 *Pseudomelania* sp. 3 Gründel, p. 57, pl. 4, figs. 13–14.

Derivation of name. Referred to the characteristic sigmoidal growth lines on the shell surface.

Type material. Holotype, MCF-PIPH 613b; one recrystallized teleoconch; paratypes, MCF-PIPH 602, 603, MLP 34616; three recrystallized teleoconchs.

Referred material. MB.Ga. 783 (original material described by Gründel, 2001); cast MPEF-PI 6016, from the middle Toarcian of Quebrada Plaza, Chile.

Geographic and Stratigraphic occurrence. Quebrada Plaza, Early Jurassic (middle Toarcian), Chile; Charahuilla and Carro Quebrado, Middle Jurassic (*Chondroemileia submicrostoma* and *Emileia multiformis* Subzones, Giebeli Zone, early Bajocian), Lajas Formation (Fig. 1.3), Neuquén Province, Argentina.

Diagnosis. Turriculate, high-spired shell; mature whorls slightly concave; sutures impressed in a spiral furrow; abapical spiral belt with 13–17 rounded nodes; sigmoidal growth lines on the outer face; base with prosocline to prosocyrtic growth lines; aperture oval; columellar lip thickened.

Description. Dextral, turriculate, large-sized and high-spired shell. The protoconch is not preserved. Largest teleoconch fragments comprise 6 whorls. Juvenile teleoconch whorls are flat in outline becoming slightly concave toward mature growth stages. Suture is distinctly impressed. The outer face is ornamented by two spiral swollen belts bordering the sutures in an adapical and abapical positions of each whorl. The adapical spiral belt is smooth and the abapical one is ornamented by a row of 13–17 axially elongated and regularly spaced nodes. Collabral ornament consists of sigmoidal growth lines connecting the adapical and abapical spiral belts. Growth lines are prosocline on the upper portion of whorls and become opisthocyrtic toward the lower portion. The base is strongly convex and ornamented by prosocline to prosocyrtic growth lines. The aperture is prosocyrtic and oval, with a thickened columellar lip; the peristome is continuous.

Dimensions (mm). MCF-PIPH 613b= Height, 65.6; width, 19.25. MB.Ga. 783= Height, 57.6; width, 16. MLP 34616= Height, 79.7; width, 33.2.

Remarks. According to the characterization of Nützel and Senowbari-Daryan (1999), the new species here described seems to be a member of *Anulifera*, showing the diagnostic

features of the genus such as a large and relatively high-spired shell, with knobby rows low on the teleoconch whorls. The presence of distinctive sigmoidal growth lines on the outer face separates the new species from other representatives of the genus.

As mentioned above, *Anulifera* was previously reported in the Lower Jurassic of Argentina with the species *A. chubutensis* Ferrari (2013, p. 585, fig. 3F–G). The former differs from *A. sigmoidea* sp. nov. by being larger, with a less slender shell, by having mature teleoconch whorls slightly more convex, by having a swollen belt of 18 conspicuous nodes, and by lacking sigmoidal growth lines. Gründel (2001) referred an *Anulifera* species to *Pseudomelania* sp. 3 (in Gründel, 2001, p. 57, pl. 4, figs. 13–14), from the Lower Jurassic (Toarcian) of Chile; this species is included here as synonymous of *Anulifera sigmoidea* sp. nov.

Anulifera sigmoidea sp. nov. is also comparable to *A. binodosa* (Fallahi *et al.*, 1983) (Nützel and Senowbari-Daryan, 1999, p. 118, pl. 5, figs. 3–8; Nützel *et al.*, 2010, p. 10, fig. 6.1–6.6) from the Upper Triassic of Iran; however, the Iranian species has a wider outline shell, two rows of 20–26 nodes, and the whorl face is covered by several fine spiral grooves. *Zygopleura*? sp. 1 (Nützel and Senowbari-Daryan, 1999, p. 114, pl. 5, figs. 1–2), also from the Upper Triassic of Iran, is very similar to *A. sigmoidea* sp. nov. but it has well-developed and straight axial ribs on juvenile teleoconch whorls. *Pseudokatosira*? *seminodosa* (Nützel and Senowbari-Daryan, 1999, in Nützel *et al.*, 2010), from the Upper Triassic of Iran, resembles also *A. sigmoidea* sp. nov.; however, the Iranian species has more prominent and elongated nodes and an additional fine spiral striation which covers the whorls surface.

Superfamily CAMPANILOIDEA Douvillé, 1904
Family AMPULLINIDAE Cossmann in Cossmann and Peyrot, 1919

Genus ***Globularia*** Swainson, 1840

Type species. *Ampullaria sigaretina* Lamarck, 1804, Eocene, France; original designation.

Geographic occurrence. Cosmopolitan.

Age range. Triassic?, Jurassic–Holocene.

Remarks. Ferrari (2013) stated that specimens belonging to the genus *Globularia* have been commonly referred to *Natica*, and gave the reasons to keep both genera separate. The author ascribed to *Globularia* some Jurassic species previously referred to *Natica*, and reported the southernmost occurrence of the genus in the Early Jurassic of Argentina. In the present research, the classification criteria of Ferrari (2013) is followed.

Globularia andina sp. nov.
Figures 3.1–13

1931 *Natica* cf. *N. adducta* Phillips; Weaver, p. 376.

Derivation of name. Referred to the Andean region of Argentina, where the material was found.

Type material. Holotype, MCF-PIPH 604; one recrystallized teleoconch; paratypes, MCF-PIPH 571, MLP 34617, MLP 34619; eight recrystallized teleoconchs.

Geographic and stratigraphic occurrence. Carro Quebrado (north and south) and Charahuilla, Middle Jurassic (Singularis and Giebeli Zones, early Bajocian), Lajas Formation (Fig. 1.3); Cerro Granito, Bajocian, Neuquén Province, Argentina.

Referred material. MCF-PIPH 568, 569, 570, 572 to 575, 585, 593, 596, 599, 610, 613c; thirteen recrystallized teleoconchs. MLP 34618, MLP 34620, MLP 34621; four recrystallized teleoconchs.

The material described by Weaver (1931, p. 376, BM 277/ SA 127, cast MLP 25025) is an incomplete young shell from Bajocian beds 10 km west of Cerro Lotena at Cerro Granito, central Neuquén (see location in Fig. 1.2).

Diagnosis. Globular to slightly gradate shell; teleoconch with five strongly convex whorls; sutural ramp horizontal and convex; very fine prosocline growth lines on the outer face of last whorl; columellar lip thickened as a callus.

Description. Dextral, anomphalous, globular to slightly gradate, low-spired and small-to medium-sized shell. The protoconch is incomplete. The teleoconch comprises 5 strongly convex whorls. Sutural ramp is weakly developed on earliest whorls, becoming wide and horizontal to slightly concave toward mature growth stages. Earliest whorls are strongly convex and mature whorls become gradate, giving the shell outline a step-like appearance. Last teleoconch whorl is markedly more expanded than the spire. Sutures are weakly impressed. Very fine prosocline growth lines appear on the outer face of last whorl. The angulation of whorls is delimited by a swollen spiral belt. The base is strongly

convex and ornamented by weak and very fine prosocline growth lines. The aperture is obliquely oval with a developed adapical channel and an expanded abapical lip. The outer lip is very fine and strongly convex, and the columellar lip thickened as a callus covering the umbilicus.

Dimensions (mm). Table 2.

Remarks. The globular, low-spired, and convex shell with a closed umbilical area suggests an assignment to *Globularia*. The genus was previously reported from the Lower and Middle Jurassic of Argentina and Chile and referred to *Natica* (Behrendsen, 1891, 1922; Weaver, 1931; Feruglio, 1934; Wahnish, 1942; Pérez, 1982). *Globularia* cf. *catanlilensis* (Weaver, 1931, in Ferrari, 2013, p. 587, figs. 3H, 4A–C), from the Pliensbachian–Toarcian marine deposits of Chubut, Patagonia, differs from *G. andina* sp. nov. by being larger, having a less gradate shell outline with weak spiral cords on the last teleoconch whorl, and by lacking growth lines. "*Natica*" *klingamanni* Weaver, 1931 (p. 374, pl. 42, figs. 279–280; MLP 25018, see below), from the Bajocian–Callovian of Argentina, differs from *G. andina* sp. nov. by being larger, with a height of 85 mm and a width of 58 mm, and has a slightly more open umbilicus. *Globularia khadirensis* Szabó and Jaitly, 2004 (p. 18, pl. 2, figs. 17–19, 22–23), from the Bathonian of India, is comparable to the Argentinean species; however, the Indian form has more convex and less gradate teleoconch whorls, and a strongly convex and less conspicuous spiral belt on the angulations. *Ampullospira besairieri* Cox, 1965 (p. 164, pl. 28, figs. 10, 11 a–b, 12 a–b, 13), from the Bajocian of Africa, is also very similar to *G. andina* sp. nov. in general shell morphology, with a wide and horizontal sutural ramp and a gradate shell outline; however, the African species is much larger, with a maximum height of 52 mm, and has a slightly more acute apex. *Ampullospira quennelli* Cox, 1965 (p. 165, pl. 29, figs. 2a–c, 3a–c), from the Upper Jurassic (Kimmeridgian) of Africa differs from *G. andina* sp. nov. by being slightly larger with a more convex shell outline.

Globularia klingamanni (Weaver, 1931)
Figures 3.14–17

v 1931 *Natica klingamanni*; Weaver, p. 374–375, pl. 42, figs. 279–280.

Type material. The holotype (BM 275/ SA 966= cast MLP 25018) is an incomplete teleoconch from 9 km NW of Cerro Picún Leufú; our material –three recrystallized teleoconchs

Table 2 - Dimensions (mm) of **Globularia andina** *sp. nov. *=Additional material.*

Specimen	*Type*	*Height*	*Width*
MCF-PIPH 604	*Holotype*	*24.2*	*21.4*
MCF-PIPH 571-1	*Paratype*	*21.2*	*18.2*
MCF-PIPH 571-2	*Paratype*	*20.9*	*19.5*
MCF-PIPH 571-3	*Paratype*	*22.8*	*21.5*
MCF-PIPH 571-4	*Paratype*	*23.8*	*21.6*
MCF-PIPH 571-5	*Paratype*	*19.6*	*19.7*
MCF-PIPH 571-6	*Paratype*	*11.8*	*13.2*
MLP 34619	*Paratype*	*23.4*	*19*
BM 277/SA 127	*	*16*	*12.5*
MCF-PIPH 599	*	*24.4*	*24.7*
MLP 34617	*	*20*	*14.9*
MLP 34618a	*	*26*	*224*
MLP 34618b	*	*22.8*	*18*
MLP 34620	*	*29.9*	*22.7*
MLP 34621	*	*18.8*	*17*

(MLP 34622 to 34624)– was recovered from early Bajocian beds at Carro Quebrado north and south sections.

Geographic and stratigraphic occurrence. Carro Quebrado (north and south) and Picún Leufú, Middle Jurassic (early Bajocian–Callovian?), Lajas Formation, Neuquén Province, Argentina.

Description. Dextral, globose, moderately gradate, low-spired and medium to large-sized shell. The protoconch is not preserved. The incomplete teleoconch consists of 4 whorls; the 3 earliest whorls are slightly convex; the last one is straight or even concave. The subsutural band is narrowly horizontal and excavated. The suture is impressed. The upper portion of the last whorl, just below the subsutural band, is strongly convex, and becomes slightly concave toward the ramp. On the lower portion of the last whorl, a second convex swollen belt appears edging the base. The shell is smooth. The base is strongly convex and smooth. The aperture is broken, with the columellar lip strongly thickened. The umbilicus is missing.

Dimensions (mm). MLP 34622= Height, 57; width, 45.7. MLP 34623= Height, 28.9; width, 24. MLP 34624= Height, 63; width, 57.7. Cast MLP 25018= Height, 85; width, 58.

Remarks. The material here analyzed fits with the characterization of "*Natica*" *klingamanni* Weaver (1931, p. 374, pl. 42, figs. 179–280). The specimen described by Weaver, however, is bigger and has an umbilicus represented by a long open groove. According to Weaver (1931) his specimen was found in Callovian beds.

Comparisons with *Gobularia andina* sp. nov. are provided above. *Globularia khadirensis* Szabó and Jaitly, 2004 (p. 18, pl. 2, figs. 17–19, 22–23), from the Middle Jurassic (Bathonian) of Hungary, differs from *G. andina* nov. sp. by being smaller, by having more gradate whorls, a more acute spire and last whorls markedly more expanded. *Globularia michelini* (d'Archiac, 1843), from the Middle Jurassic (Callovian) of Hungary, has more convex whorls than *G. andina* sp. nov., lacks the second convex swollen edging the base, has a less excavated subsutural band, a more convex base, and the last whorl is markedly more expanded (Szabó and Jaitly, 2004; p. 18, pl. 2, figs. 11–13).

Order HETEROBRANCHIA Haszprunar, 1988

Family EUNERINEIDAE Kollmann, 2014

Genus ***Eunerinea*** Cox, 1949

Type species. *Nerinea castor* d'Orbigny, 1850, by original designation; Late Jurassic (late Oxfordian), France.

Geographic occurrence. Cosmopolitan.

Age range. Middle Jurassic (Bajocian)–Late Cretaceous (Cenomanian).

Remarks. Cataldo (2013) discussed the relationships between *Eunerinea* and *Cossmannea* Pchelintsev, 1927, and considered the presence of a long and oblique anterior canal and three internal folds as the most diagnostic features of *Eunerinea*, while *Cossmannea* lacks a parietal fold. The author pointed out that nerinoids are rather scarce elements in the Jurassic and Cretaceous faunas of South America, and described a new *Eunerinea* species from the Lower Cretaceous of Mendoza Province. The new *Eunerinea* species described below supplies new –albeit doubtful– evidence of the genus occurring in the Jurassic of Argentina, and may extend its chronostratigraphic distribution in this region into the early Bajocian. The systematic position of the genus was recently revised by Kollmann (2014).

Eunerinea? neuqueniana sp. nov.

Figures 3.18–22

1931 *Nerinea* cf. *N. acicula* d´Archiac; Weaver, p. 381–382.

Derivation of name. Referring to Neuquén Province, Argentina, where the type material was found.

Type material. Holotype, MCF-PIPH 588; one recrystallized teleoconch; paratypes, MCF-PIPH 584, 590, MLP 15853a/ b/ c; twenty five(approximately) recrystallized teleoconchs.

Referred material. MCF-PIPH 583, 586, 589, 592, 594, 595, 597, 598. MLP 34625, MLP 34626; fourteen (approximately) recrystallized teleoconchs.

Weaver (1931) examined several specimens from Cerro Granito and other localities along the same belt of Bajocian outcrops.

Geographic and stratigraphic occurrence. Carro Quebrado, Middle Jurassic (Singularis Zone, early Bajocian), Lajas Formation (Fig. 1.3); Cerrito near Cerro Lotena (Aalenian–Bajocian); Arroyo La Jardinera (early Bajocian); Cerro Granito (Weaver, 1931, locality 127) (middle Bajocian), Neuquén Province, Argentina.

Diagnosis. Thin shell; whorls with strongly concave flanks;

sutural region strongly convex; smooth surface; five spiral cords near mid-whorl; rhomboidal aperture; strongly elongate anterior canal.

Description. Dextral, subcylindrical, elongated, small to medium-sized and high-spired shell.The protoconch is not preserved. The teleoconch consists of up to 15–16 whorls. The teleoconch whorls are strongly concave, with the maximum concavity at mid-whorl. Periphery is well defined and delimited by two strong angulations. Suture is weakly impressed at the angulations. Growth lines cover the shell surface and are strongly prosocline at the upper portion of whorls and become orthocline towards the lower portion; growth lines intercept five irregularly spaced spiral cords which are placed at mid-whorl and on the outer face.The spiral cords are more conspicuous on juvenile whorls, becoming weaker toward mature growth stages. The base is angular and ornamented by fine spiral cords which are intercepted by growth lines. The aperture is rhomboidal and the umbilicus closed. The anterior canal is strongly elongated. A longitudinal section does not show preserved inner folds.

Dimensions (mm). Table 3.

Remarks. According to the characterization of Cataldo (2013), the material here analyzed agrees with diagnostic features of *Eunerinea*, considering the acute shell, with strongly concave whorls and convex sutural region, rhomboidal aperture and elongated anterior canal as its most diagnostic features. However, *Eunerinea*? *neuqueniana* sp. nov. does not show preserved inner folds and thus is left in open nomenclature.

As mentioned above, *E.*? *neuqueniana* sp. nov. represents the first –although doubtful– occurrence of the genus in the Middle Jurassic of Argentina which may extend extends its chronostratigraphic distribution in the region into the early Bajocian. Other nerineoid species were previously described by Weaver (1931) from the Middle Jurassic (Bajocian–Callovian) of the Neuquén Basin.The description of one of them (referred by Weaver to *Nerinea* cf. *acicula* d´Archiac, but not figured) fits with the features of this new species, and it is thus included here in its synonymy list. *Nerinea* sp. (Weaver, 1931, p. 382, pl. 42, fig. 286, casts MLP 25016), from the middle Bajocian of Cerro Granito, has a much larger shell with a wider apical angle than *E.*? *neuqueniana* sp. nov. *Nerinea* cf. *decorata* Piette, 1855 (in Weaver, 1931, p. 383, pl. 41, figs. 275–276) from the Callovian of the Neuquén Basin is comparable to *E.*? *neuqueniana* sp. nov.; however, it has a less elongated shell with up to 8–10 teleoconch whorls, and the surface is ornamented by prominent growth lines and 4–5 weak spiral cords.

Cossmannea (*Cossmannea*) cf. *peruviana* Cox, from the Bajocian of Chile (Gründel, 2001, p. 64, pl. 6, fig. 9), is very similar to *E.*? *neuqueniana* sp. nov., but it is larger.

Eunerinea mendozana Cataldo (2013, p. 53, fig. 3), from the Lower Cretaceous of Mendoza Province, differs from *E.*? *neuqueniana* sp. nov. by having a more cyrtoconoid shell, teleoconch whorls slightly concave, and smooth surface without spiral ornament. Moreover, *E. mendozana* has a clearly visible parietal fold. *Cossmannea nascaensis* Cox, 1956 (p. 1181, pl. 127, figs. 4–6), from the Middle Jurassic (Bajocian/ Bathonian) of Peru, differs from the Argentinean form in lacking spiral cords at mid-whorl.

Superfamily Mathildoidea Dall, 1889

Family Gordenellidae Gründel, 2000

Table 3 - Dimensions (mm) of **Eunerinea? neuqueniana** *sp. nov. *=Additional material.*

Specimen	*Type*	*Height*	*Width*
MCF-PIPH 588	*Holotype*	*12.87*	*2.94*
MCF-PIPH 590	*Paratype*	*21.67*	*5.35*
MCF-PIPH 584	*Paratype*	*15.16*	*3.29*
MLP 15853a	*Paratype*	*31.6*	*6.06*
MCF-PIPH 597	*	*28.07*	*4.32*
MLP 34626	*	*29.6*	*7.71*

Genus ***Promathildia*** Andreae, 1887

Type species. *Mathilda janeti* Cossmann, 1885, subsequent designation by Gründel and Nützel (2013); Middle Jurassic (Bathonian), France.

Geographic occurrence. Europe, South America.

Age range. Early Jurassic (Hettangian)–Late Jurassic (Oxfordian).

Remarks. Gründel and Nützel (2013) recently reassigned *Promathildia* to the family Gordenellidae and considered the genus as synonym of *Clathrobaculus* Cossmann, 1912. The authors grouped into *Promathildia* slender shells, with a relatively large size and many whorls, teleoconch with 3 or 4 primary spiral ribs, convex with distinct suture, angulated at two of the primary ribs or with one primary spiral rib as keel, numerous fine axial ribs or strong growth lines, and with the teleoconch ornament not changing during ontogeny.

Representatives of the family Gordenellidae were previously reported in South America from the UpperTriassic of the Pucara Group. Haas (1953) described 16 *Promathildia* species from Central Peru, outlining that the most remarkable difference between this genus and *Mathilda* is the presence of straight growth lines in the last one. The criteria of Gründel and Nützel (2013) are adopted here.

Promathildia*? *spinosa sp. nov.

Figures 3.23–28

Derivation of name. Referred to the strongly spinose nodes at the angulation of whorls.

Type material. Holotype, MCF-PIPH 579; one recrystallized teleoconch.

Geographic and stratigraphic occurrence. Carro Quebrado, Middle Jurassic (*Chondromileia submicrostoma* Subzone, Giebeli Zone, early Bajocian), Lajas Formation (Fig. 1.3), Neuquén Province, Argentina.

Diagnosis. Turriculate, angulated whorls; sutural ramp oblique; two strong angulations on the outer face of whorls; 16 spinose nodes per whorl and on each spiral cord; axial ribs opisthocyrt; base angular; aperture circular.

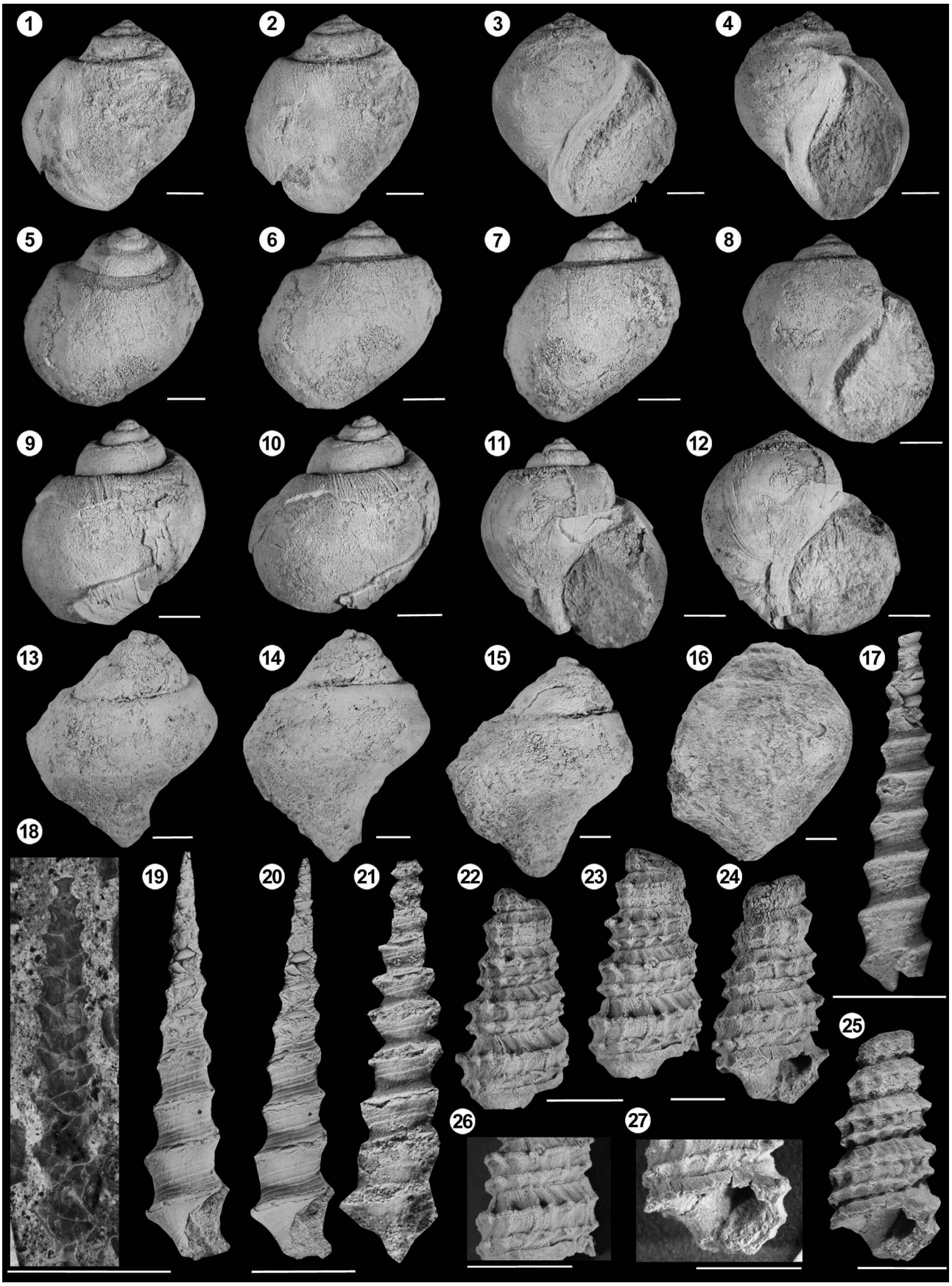
Description. Dextral, gradate, turriculate, small to medium-sized and high-spired shell. The protoconch and early teleoconch whorls are missing. The incomplete teleoconch consists of 5 convex whorls. Sutural ramp is oblique and inclined approximately 45°. Suture is distinctly impressed. The outer face of whorls is delimited by 2 strong angulations; the lower one is somewhat above the abapical suture and the upper one is somewhat above mid-whorl; secondary spiral cords are absent. On the angulations, 16 strong, acute, spinose and spaced nodes appear. Nodes are developed at the intersection of the angulations with the axial ribs. Axial ribs are distinctly opisthocyrt toward mature growth stages. Among axial ribs, fine prosocline to opisthocyrt growth lines appear. The base is angular; the peristome is continuous. The outer lip is thin and indented by peripheral angulations. The basal and columellar lip are thickened.

Dimensions (mm). MCF-PIPH 579= Height, 16.02; width, 7.76.

Remarks. According to the generic characterization of Gründel and Nützel (2013), the single specimen here described seems to belong to *Promathildia*; however, the diagnostic hyperstrophic protoconch, several spiral threads on the base, and a narrow umbilical chink or a funnel-shaped umbilicus are not observed in the Argentinean material. Due to the scarce and relatively fragmentary available material, it is left in open nomenclature.

Promathildia? *spinosa* sp. nov. is the first (although doubtful) report of the genus from the Middle Jurassic of Argentina and South America. As mentioned above, Haas (1953) reported *Promathildia* species from the Upper Triassic of Peru, which are similar to the specimen here described; however, Haas's species do not show the prominent and spinose nodes at the crossing points of spiral and axial elements, a feature typical of *Promathildia*? *spinosa* sp. nov.

Mathilda schmidti (Walther, 1951, in Kaim, 2004, p. 116, fig. 94), from the Bajocian of Germany, resembles *P.*? *spinosa* sp. nov.; but, the European form is smaller, has 3 prominent and 1 subsutural spiral cords, the whorls are slightly angulated, axial ribs are stronger, and nodes at intersections of spiral and axial elements are almost imperceptible. *Mathilda makowskii* Kaim, 2004 (p. 117, fig. 95), from the Middle Jurassic (Callovian) of Poland differs from the Argentinean form by being smaller, having a less gradate and more convex shell shape, a more reticulate ornament, and less spinose nodes. *Mathilda valanginiana* Kaim, 2004 (p. 119, fig. 98), from the Cretaceous (Valanginian) of Poland, is also similar to *P.*? *spinosa* sp. nov.; however, *M.*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valanginiana has a more developed reticulate ornament, with blunt nodes at the crossing points of axial and spiral elements.

CONCLUDING REMARKS

The present paper provides the description of seven new gastropod species from early Bajocian marine deposits of the Lajas Formation in central Neuquén Basin, and supplies the first detailed documentation of six gastropod families in Argentina at that time. The new gastropod species are *Pleurotomaria bajociana* sp. nov., *Cryptaulax weaveri* sp. nov., *Rhabdocolpus* (*Infacerithium*) *excavatus* sp. nov., *Anulifera sigmoidea* sp. nov., *Globularia andina* sp. nov., *Eunerinea*? *neuqueniana* sp. nov. and *Promathildia*? *spinosa* sp. nov. New records of *Leptomaria*? *leufuensis* (Weaver, 1931) and *Globularia klingamanni* (Weaver, 1931) are also reported.

A more detailed research of Middle Jurassic gastropod faunas, including the investigation of new fossil localities in Argentina, the collection of new gastropod material with accurate geographical and stratigraphical data, and the revision of all described gastropod groups, is currently in progress. Nevertheless, the new gastropod association from the Neuquén Basin reported here provides updated data on its taxonomic composition during the early Bajocian, recording for the first time the genera *Cryptaulax*, *Anulifera*, *Eunerinea*, *Promathildia,* and the subgenus *Rhabdocolpus* (*Infacerithium*) in Argentina at that time.

The new findings reported here show that new localities of South American Jurassic gastropods may greatly expand our knowledge and stimulate further research in the future, facilitating appropriate interpretation of the paleobiogeographical distribution of gastropods in the Jurassic of the southern hemisphere.

ACKNOWLEDGMENTS

We are grateful to A. Riccardi, M. Manceñido, S. Ballent, and J. Echevarría (Museo de Ciencias Naturales de La Plata) for their help during the fieldwork in the Neuquén Basin outcrops. We also thank R. Coria (Museo Carmen Funes, Plaza Huincul, Neuquén, Argentina) for arranging the loan of the gastropod material collected by the authors. We extend our gratitude to S. Bessone (Centro Nacional Patagónico, Puerto Madryn) and L. Canessa (MPEF) for the preparation of the gastropod specimens. Late V. Standish Mallory, then in charge of the collection at the Burke Museum, Seattle, is thanked for arranging the temporary loan of material from Argentina described by Weaver, and V. Melemenis (MLP) for making casts of those specimens. A. Kaim and J. Gründel read an earlier version of this MS and provided suggestions which greatly improved the text.This project was supported in part by the Palaeontological Association (PalAss), United Kingdom, under the Sylvester-Bradley Award; I thank the Palaeontological Association for this financial support. Finally, this study is part of a long-term project financed by CONICET grants, last one PIP 112-200801-01567.

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Figure 3. Middle Jurassic gastropods from the Neuquén Basin. **1–12, *Globularia andina*** sp. nov. **1–5, MCF-PIPH** 604, holotype. **1–2,** lateral views; **3–4,** lateral and apertural views. **5–8, MCF-PIPH** 571, paratype. **5–7,** lateral views; **8,** lateral and apertural views. **9–12, MCF-PIPH** 599. **9–10,** lateral views; **11–12,** lateral and apertural views. **13–16, *Globularia klingamanni*** (Weaver, 1931). **13–15, MLP** 34623, lateral views. **16, MLP** 34622, lateral view. **17–21, *Eunerinea? neuqueniana*** sp. nov. **17, MCF-PIPH** 588, holotype, lateral view. **18, MCF-PIPH** 584, paratype, columellar section. **19–20, MLP** 15853a, paratype, lateral views. **21, MCF-PIPH** 590, paratype, lateral view. **22–27, *Promathildia? spinosa*** sp. nov., **MCF-PIPH** 579, holotype. **22–23,** lateral view; **24–25,** apertural view; **26,** ornament detail; **27,** apertural detail. Scale bar= 5 mm.

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doi: 10.5710/AMGH.26.06.2015.2904

Submitted: March 12th, 2015

Accepted: June 26th, 2015