Early Jurassic Bivalvia of northern Chile.
Part III. Order Trigonioida

ERNESTO PÉREZ, MARTIN ABERHAN, RENATO REYES & AXEL VON HILLEBRANDT


Abstract. In this work, 238 specimens of the bivalve order Trigonioida have been studied. They belong to the Early to early Middle Jurassic fauna collected at 23 localities of northern Chile, between 21°39'S (II Región de Antofagasta) and 32°25,5'S (V Región de Valparaíso). Thirty-one taxa belonging to 11 genera are described. Three genera, Neuenenitrigonia, Prosogyrotrigonia, and Psilotrigonia, are recorded from Chile for the first time. Eight species are new: Neuenenitrigonia plazaensis, Prosogyrotrigonia tenuis, Quadratojaworskiella acarinata, Psilotrigonia vegaensis, Myophorella (M.) bolitoensis, Myophorella (M.) reginae, Scaphorella susanae, and Vaugonia hectorleanzai. The described species are from the Hettangian to Early Aalenian and occur most frequently in the Sinemurian, Pliensbachian, and Toarcian. Most of the stratigraphic ages of species are controlled through the association with ammonites.

- Mollusca, Bivalvia, Trigonioida, new species, Early Jurassic, Early Aalenian, northern Chile, South America


- Mollusca, Bivalvia, Trigonioida, neue Arten, Unterer Jura, Unterer Aalenium, nördliches Chile, Südamerika

Resumen: En este trabajo se estudiaron 238 ejemplares de Trigonioida que forman parte de la fauna recolectada en los perfiles estratigráficos levantados en 23 localidades jurásicas del norte de Chile, comprendidas entre los 21°39’S (II Región de Antofagasta) y 32°25,5’S (V Región de Valparaíso). Se describen 31 taxones asignados a 11 géneros. En este conjunto se reconocen tres géneros no citados hasta ahora para Chile: Neuenenitrigonia, Prosogyrotrigonia y Psilotrigonia, y se proponen ocho especies nuevas: Neuenenitrigonia plazaensis, Prosogyrotrigonia tenuis, Quadratojaworskiella acarinata, Psilotrigonia vegaensis, Myophorella (M.) bolitoensis, Myophorella (M.) reginae, Scaphorella susanae y Vaugonia hectorleanzai. Las especies descritas corresponden en su mayoría al Jurásico Inferior (en algunos casos alcanzan al Aaleniano inferior), con una mayor incidencia en los pisos Sinemuriano, Pliensbachiano y Toarciano. Las edades asignadas se basan en la asociación con ammonites de Zona.

- Mollusca, Bivalvia, Trigonioida, especies nuevas, Jurásico Inferior, Aaleniano inferior, norte de Chile, América del Sur

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Introduction

This study continues the taxonomic and biostratigraphic
work on the Early Jurassic trigonioid bivalve fauna of
Chile, as previously reported by PÉREZ & REYES (1977,
1979, 1997) and PÉREZ et al. (1995). Following the taxo-
nomic analyses of the bivalve subclasses Palaeotaxo-
donta, Pteriomorpha, and Isofilibranchia (ABERHAN 1994)
and the Anomalodesmata (ABERHAN 2004), it is also the
third part of a monograph on Early Jurassic and earliest
Middle Jurassic bivalves of northern Chile. Herein, we
widen and detail our knowledge of the taxonomy and
chronostratigraphy of the order Trigonioidea. Based on
238 specimens of different degrees of preservation we
recognise 31 taxa, grouped in 11 genera, three of which
are reported from Chile for the first time. Eight new
species are introduced. The fauna is distributed over
the following 23 localities in northern Chile between 21°39'S
(II Región de Antofagasta) and 32°25.5'S (V Región de
Valparaíso) (Text-fig. 1): West of Quillagua (21°39'S;
Text-fig. 1. Map of localities from which trigonioid bivalves were collected.
Temporal distribution of Early Jurassic Trigonioida from northern Chile

In previous studies on this topic, Pérez & Reyes (1977, 1991, 1997) reported the absence of trigonioids from the Hettangian, a strong increase in abundance and richness in the Sinemurian and the use of Frenguelliella, Jaworskiella, and Quadratojaworskiella as guide fossils for the Early Jurassic of Chile. In the following, we present an updated account of the temporal distribution of the Trigonioida from the Early Jurassic of northern Chile.

Hettangian

We now recognise the genera Prosogyrotrigonia Krumbeck (1924) and Quadratojaworskiella Reyes & Pérez (1980) in this stage.

During the Late Triassic, Prosogyrotrigonia was restricted to the east and southeast of Asia (Fleming 1987). It has been recorded from the Early Jurassic of Japan (Kobayashi & Mori 1954) and the Hettangian of Yukon, Canada (Poultson 1979). Quadratojaworskiella appears to be endemic to Chile and previously was only known from the Sinemurian and Pliensbachian. The following species occur in the Hettangian (Text-figs. 1-2): Prosogyrotrigonia tenuis sp. nov., Late Hettangian, Badouxia canadensis Zone, Cerros de Cuevitas (loc. 4), and west of Quillagua (loc. 1); Prosogyrotrigonia sp. 3, Late Hettangian or earliest Sinemurian, Quebrada Doña Inés erected by Hupé (1854), Burmeister & Giebel (1861), Gottsche (1878), Morick (1894), Philippi (1899), Jaworski (1916), Groeber (1924), Leanza (1942), Lambert (1944), and Reyes & Pérez (1980).

In this monograph, we adopted the classification scheme proposed by Cooper (1991) for the Trigonioida. Morphological terms and measured dimensions are detailed in Text-fig. 3. The size of specimens is expressed using the scale of Saveliev (1958), and the description of the dentition follows Douville (1912, 1913). In specimens lacking a true marginal carina, we use the term 'marginal angulation' in the sense of Cooper (1989). The description of species is accompanied by tables of measurements using the following abbreviations: H = height; L = length; W = inflation of single valve; lv = left valve; rv = right valve; 2v = double-valved; [ ] = estimated value.

The studied specimens were prepared mechanically. In silicified shells the non-silicified rock matrix was dissolved using diluted acetic acid. This technique yielded valves with complete hinge structures and details of the ornamentation. For optimal contrast the specimens were coated with magnesium oxide prior to taking photographs. The material is deposited in the Museo Geológico del Servicio Nacional de Geología y Minería, Chile (acronym SNGM), No. 1993, Nuevo, Santiago. E. Pérez and R. Reyes carried out the systematic descriptions, whereas A. von Hillebrandt and M. Aberhan contributed the geological background, determination of the associated fauna and the stratigraphic assignments of the fauna. The previously studied and illustrated specimens SNGM 8264 and SNGM 8265 of Groeberella neuquensis (Groeber 1924) (Pérez et al. 1995) are reillustrated herein (Pl. 1, Figs. 1-5).

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Chica (loc. 6); Quadratojaworskiella acarinata sp. nov., Middle/Late Hettangian, Sunrisites peruvianus Zone, Quebrada Cachina (loc. 5).

**Sinemurian**

In addition to *Prosogyrotrigonia* and *Quadratojaworskiella*, the genera *Groberella* Leanza (1993), *Frenguelliella* Leanza (1942), *Jaworskiella* Leanza (1942), *Pilotrigonia* Cox (1952), and *Vaugonia* Crickmay (1930) occur in the Sinemurian.

*Groberella* appears to be endemic to South America (Argentina and Chile), where it is most abundant in the Sinemurian and Pliensbachian, but is also known from the Lower Bajocian of Argentina (Pérez et al. 1995) and the Toarcian to Early Aalenian of Chile (this study). The possible occurrence of this genus in the North American Triassic (Leanza 1993) is as yet unconfirmed.

*Frenguelliella* is a cosmopolitan genus. According to Tamura (1959) and Nakano (1960), the oldest representative would be *Trigonia* (Kimatrigonia) tanoensis Tamura (1959) from the Carnian of Japan. *Frenguelliella* extends into the Late Cretaceous, although the Early Cretaceous species are poorly known (Nakano 1963). *Frenguelliella* is unknown from Japan after the Triassic (Nakano 1960, 1963). In Europe, this genus flourished during the Jurassic and declined in the Cretaceous (Nakano 1960, 1963). It has been reported from the Middle Jurassic and the Late Cretaceous of India (Nakano 1960, 1963). *Frenguelliella* has been documented from the Sinemurian and Toarcian of North America (Poultón 1979), and in South America (Peru, Chile and Argentina) this taxon also appears to be confined to the Early Jurassic (Pérez & Reyes 1991).

*Jaworskiella* is present in the Sinemurian-Pliensbachian of North America (Poultón 1979), whereas in Portugal, it occurred during the Late Jurassic (Cox 1952, 1969b). In South America (Argentina and Chile) it extends from the Sinemurian to the Toarcian (Pérez & Reyes 1991).

*Pilotrigonia* apparently occurred in the Early Pliensbachian in Canada (Poultón 1979). In Europe (England and Italy), it is present in the Bajocian (Cox 1952, 1969a; Nakano 1963; Kobayashi & Mori 1954). *Pilotrigonia* apparently immigrated to New Zealand at the end of the Jurassic (Tithonian?) (Fleming 1964, 1987). In South America (Chile) its age is Late Sinemurian or Early Pliensbachian.

*Vaugonia* has a cosmopolitan distribution during the Jurassic. In Japan, from where it apparently spread to other parts of the world (Kobayashi & Mori 1955; Gillet 1965), it ranges from the Hettangian to the Middle Jurassic, becoming less common after the Bajocian. In North America, it existed from the Sinemurian to the Kimmeridgian, and is common in the Early and Middle Jurassic but rare above the Early Oxfordian (Poultón 1979). It is particularly well represented in the Middle Jurassic of Europe. It ranges from the Early to the Middle Jurassic in Chile and occurs in the Middle Jurassic of Argentina (Leanza 1996; Pérez & Reyes 1997).

?Trigonioidea indet. is so far only known from the Upper Sinemurian of Chile.

The following species occur in the Sinemurian of northern Chile (Text-figs. 1-2): *Groberella nequensis* (Groeb 1924), Late Sinemurian, Quebrada Chanaquín (loc. 18a); *Prosogyrotrigonia tenuis* sp. nov., earliest Sinemurian, Cerros de Cuevitas (loc. 4); *Prosogyrotrigonia* sp. 1, earliest Sinemurian, west of Quillagua (loc. 1); *Prosogyrotrigonia* sp. 2, earliest Late Sinemurian, Asteroceras obtusum Zone, Sierra Limón Verde (loc. 3); *Quadratojaworskiella acarinata* sp. nov., earliest Late Sinemurian, Asteroceras obtusum Zone, Quebrada Yerbas Buenas (loc. 10); *Frenguelliella poultoni* Leanza (1993), Sinemurian, Quebrada Pan de Azúcar (loc. 7), Late Sinemurian, Quebrada Pinte (loc. 21); *Jaworskkiella* (Moricke 1894), Río Manflas (loc. 16) and Quebrada del Pobre (loc. 23). Late Sinemurian; *Jaworskiella* sp., earliest Late Sinemurian, Asteroceras obtusum Zone, Sierra Limón Verde (loc. 3); *Pilotrigonia* vegensis sp. nov., Late Sinemurian or Early Pliensbachian, Vega Redonda (loc. 11); *Vaugonia hectorleanzai* sp. nov., earliest Late Sinemurian, Asteroceras obtusum Zone, Sierra Limón Verde (loc. 3); ?Trigonioidea indet., Late Sinemurian, Quebrada Pinte (loc. 21).

**Pliensbachian**

The genera *Groberella*, *Frenguelliella*, *Jaworskiella*, *Quadratojaworskiella*, *Pilotrigonia*, and *Vaugonia* persist, whereas the oldest records of *Myophorella* Bayle (1878) are from the Pliensbachian.

*Myophorella* is a cosmopolitan genus ranging from the Early Jurassic to the Early Cretaceous. In Europe, it is the most common trigniod of the Jurassic (Gillet 1965). In Japan, *Myophorella* appears in the Middle Jurassic and is common in the Upper Jurassic. It is known from the Pliensbachian to the Kimmeridgian of North America where it is most abundant during the Middle Jurassic (Poultón 1979). In New Zealand, it occurs in the Middle Jurassic (Temaikan) and persists into the Upper Jurassic (Puaroan; Fleming 1964, 1987). In South America (Peru, Argentina, and Chile), it ranges from the Early Jurassic (Sinemurian, in Argentina and Peru) to the Early Cretaceous (Pérez & Reyes 1991; Leanza 1993).

The following species occur in the Pliensbachian of northern Chile (Text-figs. 1-2): *Groberella nequensis* (Grober 1924), Late Pliensbachian, Fanninoceras fannini Zone (horizon with *F. fannini*), Quebrada Asientos
Text-fig. 3. Explanation of morphological terms and dimensions that were measured in this study.

**A** DORSAL

![Diagram of dorsal view with labeled parts: Internal carina, Width, Arc, Median carina.]

**B** LATERAL

![Diagram of lateral view with labeled parts: Umbo, Costae, Height, Area, Posterior margin, Flank, Intercostal spaces, Marginal carina, Antecarinal sulcus.]

Toarcian

The genera *Groeberella*, *Myophorella*, and *Vaugonia* persist, whereas *Neuquenitrigonia* *Leanza & Garate* 1987 and *Scaphorella* *Leanza*, *Pérez & Reyes* 1987 make their first appearance. Also *Trigonia* *Bruguier* 1789 reappears, after having been absent form the Chilean fossil record since the Anisian.

*Neuquenitrigonia* is endemic to South America (Argentina and Chile) and is known from the Middle Toarcian to the Bajocian (*Leanza* 1993 and this study).

*Scaphorella* is known from the Late Toarcian to the Early Callovian of South America (Argentina and Chile) (*Leanza* et al. 1987 and this study) and from the Middle Bajocian of North America (*Leanza* et al. 1987).

Except for boreal regions, *Trigonia* is a cosmopolitan genus, which ranges from the Middle Triassic (Anisian) to the Late Cretaceous, and which has been widely distributed since the Middle Jurassic (*Kobayashi & Mori* 1954). In Europe, it occurs from the Late Triassic to the Middle Cretaceous (*Nakano* 1961). It is known from the Early Jurassic to the Bajocian of Japan (*Nakano* 1960) and the Middle and Late Jurassic of India (*Nakano* 1961). In North America, it is relatively well represented in the Jurassic (*Poult 1979*). Australian records are from the Early and Middle Jurassic (*Nakano* 1961). It is known from New Zealand in the Anisian, Bajocian and Late Aptian (*Fleming* 1987). The oldest records from South America are from the Anisian (Chile) and Norian (Peru); it reappears in the Sinemurian (Peru) and the Toarcian (Chile) and extends into the Late Jurassic and Early Cretaceous (Colombia, Peru, Argentina and Chile) (*Pérez & Reyes* 1991).

The following species occur in the Toarcian of northern Chile (Text-figs. 1-2): *Groeberella neuquensis* (*Groebere
1924), Middle Toarcian, Collina chilensis Zone, Quebrada Pinte (loc. 21); *Myophorella reginae* sp. nov., Late Toarcian, ‘Pleydelia lotharingica’ Zone, La Guardia (loc. 14) and Middle Toarcian, Phymatoceras toroense Zone?, Quebrada Plaza (loc. 19); *Vaugonia hectorleanzai* sp. nov., Early Toarcian, Dactylioceras hoelderi Zone (loc. 2); *Vaugonia* cf. *gottschei* (Mörvicek 1894), Late Toarcian, Quebrada La Totora/Quebrada El Corral (loc. 17); *Vaugonia* cf. *substriata* (Burmeister & Giebel 1861), Middle Toarcian, Collina chilensis Zone, Quebrada Pinte (loc. 21); *Vaugonia* sp. 1, Middle Toarcian, Phymatoceras toroense Zone?, Quebrada Plaza (loc. 19); *Scaphorella susanae* sp. nov., Late Toarcian, ‘Pleydellia flütians’ Zone, Quebrada El Bolito (loc. 12); *Trigonia* sp. 1, Middle Toarcian, Collina chilensis Zone, Quebrada La Totora/Quebrada El Corral (loc. 17) and Middle Toarcian, Collina chilensis Zone, Quebrada Pinte (loc. 21); *Trigonia* sp. 2, Middle Toarcian, Collina chilensis Zone, Quebrada Pinte (loc. 21).

**Early Aalenian**

In addition to the Early Jurassic Trigonioida of Chile described herein, we include some Middle Jurassic taxa (Early Aalenian, *Bredyia manflasensis* Zone; Text-figs. 1-2). *Groeberella neuquensis* (Groebner 1924), *Trigonia* sp. 3, *Neuquenitrigonia huenickeni* (Leanza & Garate 1985) and *Neuquenitrigonia plazoensis* sp. nov., Middle Toarcian, Phymatoceras toroense Zone, Quebrada Plaza (loc. 19); *Scaphorella susanae* sp. nov., Late Toarcian, ‘Pleydelia lotharingica’ Zone, La Guardia (loc. 14) and Middle Toarcian, Phymatoceras toroense Zone?, Quebrada Plaza (loc. 19); *Neuquenitrigonia huenickeni* (Leanza & Garate 1985) and *Neuquenitrigonia plazoensis* sp. nov., Middle Toarcian, Phymatoceras toroense Zone, Quebrada Plaza (loc. 19); *Vaugonia* cf. *substriata* (Burmeister & Giebel 1861), Middle Toarcian, Collina chilensis Zone, Quebrada Pinte (loc. 21); *Vaugonia* sp. 1, Middle Toarcian, Phymatoceras toroense Zone?, Quebrada Plaza (loc. 19); *Scaphorella susanae* sp. nov., Late Toarcian, ‘Pleydelia flütians’ Zone, Quebrada El Bolito (loc. 12); *Trigonia* sp. 1, Middle Toarcian, Collina chilensis Zone, Quebrada La Totora/Quebrada El Corral (loc. 17) and Middle Toarcian, Collina chilensis Zone, Quebrada Pinte (loc. 21); *Trigonia* sp. 2, Middle Toarcian, Collina chilensis Zone, Quebrada Pinte (loc. 21).

**Taxonomy**

**Order Trigonoida** Dall 1899

**Suborder Trigoniina** Dall 1899

**Superfamily Trigoniacea Lamarck 1819**

**Family Groeberellidae Pérez, Reyes & Damborenea 1995**

**Genus Groeberella Leanza 1993**

Type species. *Myophoria neaunqsins* Groeber 1924, Early Jurassic (Pliensbachian), Neuquén, Argentina.

**Groeberella neaunqsins** (Groeber 1924)  
Pl. 1, Figs. 1-13, 15, 17-18

1924 *Myophoria neaunqsins* sp. nov. - Groeber: 92-94, pl. 1, figs. a-b.
1931 *Myophoria neaunqsins* Groeber - Windhausen: 179, fig. 71.
1942 *Myophoria neaunqsins* Groeber - Wanish de Carral Tolosa: 59-60, pl. 6, figs. 3a-c.

1942 *Myophoria neaunqsins* sp. nov. were collected at Quebrada San Pedrito/Quebrada Pelado (loc. 13). At Quebrada El Bolito (loc. 12) we recognise the species *N. huenickeni* and *Myophoria bolitoensis* sp. nov., and *N. huenickeni* is also recorded from Hacienda Manflas (loc. 15).

The Early Jurassic trigonioids from Chile presented herein (Text-fig. 2) complete the information provided by Pérez & Reyes (1977, 1979, 1997) and Pérez et al. (1995), which is summarised as follows:

*Groeberella* sp. (Pérez et al. 1995). Early Sinemurian, Quebrada Pan de Azúcar, III Región de Atacama.

*Myophoria catenifera* (Hupé 1854). Pliensbachian, Quebrada Asientos, III Región de Atacama; Toarcian, Cordillera de Doña Ana, IV Región de Coquimbo; Early Jurassic, Quebrada Tres Cruces, IV Región de Coquimbo.

*Trigonia stelzneri* Gottschche 1878. Early Jurassic, south-southeast of Calama, II Región de Antofagasta; Toarcian, Cordillera de Punilla and Cordillera de Doña Ana, IV Región de Coquimbo.

*Vaugonia* cf. *substriata* (Burmeister & Giebel 1861). Toarcian, La Guardia, Quebrada Las Trancas and Juntas, III Región de Atacama.

*Trigonia aff. bella* Lycett 1877. Toarcian, La Guardia, III Región de Atacama.

*Jaworskiella infraclavellata* (Mörice 1894). Middle to late Early Jurassic, Sierra de La Ternera, III Región de Atacama.

*Trigonia flühmanni* Philipp 1899. Early Jurassic, Amolanas, III Región de Atacama.

1967 *Myophorogonia neaunqsins* (Groeber) - Levy: 14-15, pl. on p. 16, figs. 1a-f.
1982 *Myophorogonia aff. neaunqsins* (Groeber) - Pérez: 40, pl. 15, figs. 2-5, appendix 1.
1992 ‘*Myophorogonia* neaunqsins’ (Groeber) - Damborenea & Manceñido: 134, pl. 1, fig. 5a.
1992 *Myophorogonia neaunqsins* (Groeber) - Damborenea et al.: pl. 115, fig. 14.
1993 *Groeberella neaunqsins* (Groeber) - Leanza: 18-19, pl. 1, figs. 2-3.
1995 *Groeberella neaunqsins* (Groeber) - Pérez et al.: 147, pl. 1, figs. 3-5, 13, 15, 16, 18-22.
1997 *Groeberella neaunqsins* (Groeber) - Pérez & Reyes: 573, 576.

Material. 10 specimens from Quebrada Asientos (SNGM 436-437, 439-442, 445, 7368, 8264-8265), 2 from Quebrada Pinte (SNGM 443-444), 1 from Quebrada San Pedrito/Quebrada Pelado (SNGM 435), and 1 from Quebrada Chancoquín (SNGM 438). SNGM 435-436, 439, 441-443, 7368 (articulated specimens, in part incomplete); SNGM 437-438, 440, 444-445, 8264 (incomplete left valves); SNGM 8265 (incomplete right valve).
Localities and age. Quebrada Asientos (locality 9), III Región de Atacama, Late Pliensbachian, Fanninoceras fannini Zone, horizon with *F. fannini* (Hillebrandt 1987: 120; 2006: 14, 261, 262); Quebrada San Pedro/Quebrada Pelado (locality 13), III Región de Atacama, Early Aalenian, Bredyia manflasensis Zone (Hillebrandt & Westermann 1985: 20); Quebrada Chanchequín (locality 18a), III Región de Atacama, Late Sinemurian (Hillebrandt 1973: fig. 2; 2002); Quebrada Pinte (locality 21), III Región de Atacama, Middle Toarcian, Collina chilensis Zone (Hillebrandt 1987: 120). Pérez et al. (1995) assigned a Sinemurian-Pliensbachian age to this species, based on occurrences at Chilean localities (different from those mentioned above) and Argentine localities of this age.

**Remarks.** Because of their incomplete preservation, the studied specimens cannot be identified at species level, and an open nomenclature is preferred. SNGM 446 is the best preserved specimen, and in the style of ornamentation has affinities with *T. stelzneri* Gottsche (1878: 256, pl. 6, fig. 1) as the flank costae undulate toward the anterior end; ornamented with smooth and blunt costae (3 per 5 mm in the median part of the flank), separated by wider interspaces (1.5 mm); umbonal costae concentric; post-umbonal costae subconcentric with a pronounced undulation in the anterior part of the flank and a slight downward inflexion near the marginal carina.
anterior end and bend near the marginal carina. Due to the fragmentary state of this specimen, characteristic features of the species of GOTTSCHE such as size and the curvature of umbo and flank cannot be observed. The downward bending of post-umbonal costae near the marginal carina is not observed in the specimens from Quebrada Pinte.

**Trigonia sp. 2**

Pl. 2, Figs. 1

Material. 6 specimens from Quebrada Pinte (SNGM 454-458, 467). SNGM 454, 456-457, 467 (incomplete right valves); SNGM 455, 458 (incomplete left valves).

Locality and age. Quebrada Pinte (locality 21), III Región de Atacama, Middle Toarcian, Collina chilensis Zone (Hillebrandt 1987: 120).

Measurements (in mm).

<table>
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Description. Shell medium- to large-sized, triangular, with shell length exceeding height. Umbo slightly incurved and opisthogyrous. Shell margins only partly preserved; dorsal margin apparently straight; ventral margin convex. Area covered with radial costae, which carry small tubercles; divided by submedian carina into two parts of unequal size; a narrower one, bordering the marginal carina, with two costae, and a wider one, adjoining to the internal carina, with four finer costae. Marginal carina blunt and with transverse striae. Internal carina poorly preserved and lower. Escutcheon excavated and with widely spaced, transverse costae. Flank moderately convex; ornamented with prominent, blunt, concentric to subconcentric costae with intercostal spaces equal to the width of the costae.

Remarks. Poor preservation of the specimens renders an identification at species level impossible. Distinct observable features of *Trigonia sp. 2* include the strong and widely spaced flank costae, which do not bend at the marginal carina. In these characters it differs from *Trigonia sp. 1* (this study), which was collected at the same stratigraphic level (Collina chilensis Zone) in Quebrada Pinte.

**Trigonia sp. 3**

Pl. 2, Figs. 2-3

Material. 1 incomplete right valve from Quebrada San Pedro/Quebrada Pelado (SNGM 448).

Locality and age. Quebrada San Pedro/Quebrada Pelado (locality 13), III Región de Atacama, Early Aalenian, Bredyia manflasensis Zone (Hillebrandt & Westermann 1985: 20).

Measurements (in mm).

<table>
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Description. Shell medium-sized, triangular. Umbo not preserved. Dorsal, posterior and ventral margins poorly defined; anterior margin convex, forming an angle of 72° with the marginal carina. No ornamentation observed on area except for median carina, which is partly preserved. Marginal carina low, blunt, and with small, transverse crenulations. Internal carina of lesser relief, incomplete. Escutcheon poorly preserved. Flank moderately convex; with smooth, blunt costae separated by slightly wider interspaces; costae concentric to subconcentric, the latter undulating on the anterior flank. With respect to dentition, tooth 3a is preserved (ca. 10.5 mm long, 3 mm thick); anterior adductor scar oval and deep (4 mm).

Remarks. The specimen cannot be assigned to any known species. Strongest affinities exist to *Trigonia sp. 1* (this study) in terms of strength and spacing of the costae and their undulation on the anterior flank. However, the flank is less convex in the anterior part, the marginal carina is less developed, and the costae do not bend when approaching the carina.

**EXPLANATION OF PLATE 1**

Figs. 1-13, 15, 17-18. *Groebarella nequensis* (Groebner 1924). Figs. 1-6, 9-13, 15, 18. Quebrada Asientos, east of Potrerillos, locality 9; Late Pliensbachian, Fanninoceras fannini Zone (*F. fannini* horizon). Figs. 1-2. SNGM 8264 (Hillebrandt 660707/2); left valve. 1: lateral view, x 1; 2: view of umbo and hinge, x 1.5. Figs. 3-5. SNGM 8265 (Hillebrandt 660708/1); right valve, x 1. 3: view of umbo and hinge; 4: lateral view; 5: postero-dorsal view. Figs. 6, 9-11. SNGM 436 (Hillebrandt 660708/1b); articulated specimen, x 1.5. 6: dorsal view; 9: anterior view; 10: right valve view; 11: left valve view. Figs. 12, 18. SNGM 439 (Hillebrandt 660708/1a); articulated specimen, x 1.5. 12: left valve view; 18: right valve view. Figs. 13, 15. SNGM 437 (Hillebrandt 660708/1c); right valve, x 2. 13: lateral view; 15: dorsal view. Figs. 7-8. Quebrada San Pedro/Quebrada Pelado, northeast of Copiapó, locality 13; Early Aalenian, Bredyia manflasensis Zone. SNGM 435 (Hillebrandt 711215/5); articulated specimen, x 1.5. 7: right valve view; 8: left valve view. Fig. 17. Quebrada Chanchequín, southeast of Vallenar, locality 18a; Late Sinemurian, Echioceras raricostum Zone. SNGM 438 (Hillebrandt 671008/2); left valve, lateral view, x 1.5.

Figs. 14, 16, 19. *Trigonia* sp. 1. Figs. 14, 19. Quebrada La Totora/Querbrada El Corral, southeast of Vallenar, locality 17; Middle Toarcian, Collina chilensis Zone. SNGM 446 (Aberhan 1992: appendix I + III, horizon 5-2); right valve, x 1.5. 14: dorsal view; 19: lateral view. Fig. 16. Quebrada Pinte, southeast of Vallenar, locality 21; Middle Toarcian, Collina chilensis Zone. SNGM 449 (Hillebrandt 670912/2); articulated specimen, left valve view, x 1.5.
Subfamily *Neuquenitrigoniinae* LEANZA 1993

Genus *Neuquenitrigonia* LEANZA & GARATE 1987

Type species. *Trigonia huenickeni* LEANZA & GARATE 1985, Bajocian, Neuquén, Argentina.

*Neuquenitrigonia huenickeni* (LEANZA & GARATE 1985)

Pl. 2, Figs. 4-6, 9; Pl. 3, Figs. 4, 8-10, 13

1985 *Trigonia huenickeni* sp. nov. - LEANZA & GARATE: 290, pl. 1, figs. 1-3.

1987 *Neuquenitrigonia huenickeni* (LEANZA & GARATE) - LEANZA & GARATE: 209, pl. 3, figs. 1-3.

1992 *Neuquenitrigonia huenickeni* (LEANZA & GARATE) - DAMBORENEA et al.: pl. 118, fig. 4.

1993 *Neuquenitrigonia huenickeni* (LEANZA & GARATE) - LEANZA: 25, pl. 3, figs. 10, 17.

1997 *Neuquenitrigonia huenickeni* (LEANZA & GARATE) - PEREZ & REYES: 574, 575.

**Material.** 7 specimens from Quebrada El Bolito (SNGM 468-474), 1 from Hacienda Manflas (SNGM 475), 1 from Quebrada San Pedrito/Quebrada Pelado (SNGM 476), and 1 from Quebrada Plaza (SNGM 482). SNGM 469 (articulated specimens); SNGM 468, 470-471, 475 (left valves, some incomplete); SNGM 473-474, 476, 482 (incomplete right valves).

**Localities and age.** Quebrada El Bolito (locality 12), III Región de Atacama, Early Aalenian, Bredyia manflasensis Zone (HILLEBRANDT & WESTERMANN 1985: 8); Quebrada San Pedrito/Quebrada Pelado (locality 13), III Región de Atacama, Early Aalenian, Bredyia manflasensis Zone (HILLEBRANDT & WESTERMANN 1985: 20); Quebrada Plaza (locality 19), III Región de Atacama, Middle Toarcian, Phymatoceras toroense Zone; Hacienda Manflas (locality 15), III Región de Atacama, Early Aalenian, Bredyia manflasensis Zone (HILLEBRANDT & WESTERMANN 1985: HILLEBRANDT 2001: fig. 2). DAMBORENEA et al. (1992) and LEANZA (1993) recorded this species from the Lower Bajocian (Emileia giebeli Zone and Stephanoceras humphriesianum Zone) of Argentina.

**Measurements (in mm).**

<table>
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<th>Specimen</th>
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**Description.** Shell large-sized, trigonal-ovate, inequilateral, longer than high. Umbo incurred, opisthogyrus.

Anterior margin long and weakly convex; dorsal and posterior margins straight; ventral margin short and convex; dorsal and anterior margins forming an acute angle of ca. 75°. Area wide, flat, with reticulate ornamentation; radial costae well developed with a median carina and three to four costae of lesser strength on both sides of carina; transverse costae significantly weaker than radials ones; small tubercles developed at intersections of both types of costae. Marginal carina well developed, wide, blunt, with closely spaced transverse nodes. Internal carina of lower relief and with more widely spaced tubercles. Escutcheon wide, subplanate, elevated and with widely spaced, continuous to irregular, transverse costae, which meet with the tubercles of the internal carina. Flank with high, rounded, widely spaced costae (5 costae per 20 mm, measured in central part of specimen SNGM 469, Pl. 2, Figs. 4-6, 9) of variable strength; intercostal spaces wide (3.5 mm) and excavated; costae slightly curved upward at anterior end, declining in median part of flank and becoming slightly concave close to marginal carina. Antecarinal sulcus of left valve deep and wide; less developed in right valve. Ligamental fossette wide.

**Remarks.** Compared with the specimens figured by LEANZA & GARATE (1987: pl. 3, figs. 1-3) and LEANZA (1993: pl. 3, figs. 10, 17), the flank costae of our specimens are more slender. Where we count an average of three costae every 10 mm, measured on the central part of the flank close to the carina, the Argentine specimens only carry two costae.

*Neuquenitrigonia plazaensis* sp. nov.

Pl. 2, Figs. 7-8, 10-11

1980 *Trigonia n. sp.* - HILLEBRANDT: pl. 2, figs. 6-7.

1997 *Trigonia n. sp.* HILLEBRANDT - PEREZ & REYES: 574.

**Derivation of name.** From Quebrada Plaza, the type locality of the species.

**Material.** 1 right valve (SNGM 477) and 4 mostly incomplete left valves from Quebrada Plaza (SNGM 478-481).

**EXPLANATION OF PLATE 2**

Fig. 1. *Trigonia* sp. 2. Quebrada Pinte, southeast of Vallenar, locality 21; Middle Toarcian, Collina chilensis Zone. SNGM 454 (HILLEBRANDT 670912/2); right valve, lateral view, x 1.5.

Figs. 2-3. *Trigonia* sp. 3. Quebrada San Pedro/Quebrada Pelado, northeast of Copiapó, locality 13; Early Aalenian, Bredyia manflasensis Zone. SNGM 448 (HILLEBRANDT 711215/5); right valve, x 1.5: 2: interior view; 3: lateral view.


Figs. 7-8. 10-11. *Neuquenitrigonia plazaensis* sp. nov. Quebrada Plaza, east of Embalse Lautaro, south of Copiapó, locality 19; Middle Toarcian, probably Phymatoceras toroense Zone. Figs. 7-8. SNGM 477 (holotype) (HILLEBRANDT 671013/2); right valve, x 1.5: 7: lateral view; 8: dorsal view. Figs. 10-11. SNGM 479 (paratype) (HILLEBRANDT 671013/2); left valve, x 1.5: 10: lateral view; 11: dorsal view.
Holotype. SNGM 477 (Pl. 2, Figs. 7-8), right valve with posterior and ventral margins incomplete; hinge partly visible.

Paratypes. SNGM 478; SNGM 479 (Pl. 2, Figs. 10-11); SNGM 480-481.

Locality and age. Quebrada Plaza (locality 19), III Región de Atacama, Middle Toarcian, Phymatoceras toroense Zone? (Hillebrandt 1987).

Measurements (in mm).

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Diagnosis. Shell characterised by dorsal and anterior margins forming an obtuse angle; area occupying about one-fourth of the shell surface; ornamentation of area and flank of moderate strength; escutcheon with fine, transverse costellae.

Description. Shell medium-sized (SNGM 477; Pl. 2, Figs. 7-8), subrectangular, longer than high. Umbo small and opisthogyrous. Dorsal margin straight; anterior margin short and slightly convex, forming an angle of ca. 110° with dorsal margin; ventral margin convex; posterior margin poorly preserved. Area occupying about one-fourth of the shell surface; ornamented with a poorly developed median carina, formed by small tubercles, the size of which increases slightly toward the distal end; also ornamented with seven lines of small tubercles, four on external side of area, three on internal side. Marginal carina of moderate strength and with poorly developed transverse crenulations. Internal carina composed of small nodes. Escutcheon weakly excavated, reaching about one-half the width of the area with which it forms an obtuse angle; ornamented with fine, discontinuous transverse costellae, which widen to form the tubercles of the internal carina; costellae more densely spaced in proximal half of escutcheon. Flank surface moderately convex; ornamented with blunt, widely spaced costae of moderate strength; costae concentric in umbonal part, subconcentric in central and ventral part of shell; post-umbonal costae slightly convex and tightly spaced in anterior third of flank, declining in median part of flank and subhorizontal to weakly concave and widely spaced (3.5 mm) in posterior third of flank; left valve costae terminate at a wide (2 mm in SNGM 479) antecarinal sulcus.

Remarks. *N. plazaensis* sp. nov. can be distinguished from *N. huenickeni* (Leanza & Garate) by an obtuse angle between the dorsal and anterior margins, a less convex flank surface with less prominent costae, a narrower area, a less distinct median carina, and by the costae of the escutcheon being more densely spaced.

Family Prosogyrotrigoniidae Kobayashi 1954

Subfamily Prosogyrotrigoninae Kobayashi 1954

Genus Prosogyrotrigonia Krumbeck 1924

Type species. *Prosogyrotrigonia timorensis* Krumbeck 1924, Late Triassic, Timor.

*Prosogyrotrigonia tenuis* sp. nov.

Material. 12 specimens from Cerros de Cuevitas (SNGM 483-494) and 2 from west of Quillagua (SNGM 495-496). SNGM 484-485, 487, 490(1-4), 492(1), 494(2, 4), 495(1-2, 496 (incomplete left valves); SNGM 483, 486, 488-489, 492(2), 494(1,3), 495(3) (incomplete right valves); SNGM 491, 493 (articulated specimens, in part incomplete); SNGM 492(3-12) (various fragments).

Holotype. SNGM 486 (Pl. 4, Figs. 11-12), right valve with ventral margin partly incomplete; hinge partly visible.

Paratypes. SNGM 484 (Pl. 4, Figs. 14-15); SNGM 485 (Pl. 3, Fig. 7); SNGM 488 (Pl. 4, Figs. 8-9).

Localities and age. West of Quillagua (locality 1), II Región de Antofagasta, Late Hettangian, Badouxia canadensis Zone (Paracaloceras varaense Subzone) and horizon with *Pseudatomoceras arcuatum* (Hillebrandt 2000b: 104); Cerros de Cuevitas (locality 4), II Región de Antofagasta, Late Hettangian, Badouxia canadensis Zone, Schlo-

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EXPLANATION OF PLATE 3

Figs. 1-3, 5-7, 11-12. *Prosogyrotrigonia tenuis* sp. nov. Figs. 1, 3, 5-7. Cerros de Cuevitas, northeast of Antofagasta, locality 4; Late Hettangian, Badouxia canadensis Zone. Figs. 1, 3, 5-6. SNGM 483 (Hillebrandt 841107/4); right valve, x 2. 1: lateral view; 3: interior view; 5: dorsal view; 6: antero-dorsal view. Fig. 7. SNGM 485 (paratype) (Hillebrandt 871105/1); left valve, lateral view, x 1.5. Figs. 2, 11-12. West of Quillagua, locality 1. Late Hettangian; Badouxia canadensis Zone. Figs. 2, 12. SNGM 495-1 (Hillebrandt 940303/6); left valve view, x 1.5. 2: lateral view; 12: interior view. Fig. 11. SNGM 495-2 (Hillebrandt 940303/6); left valve, lateral view, x 2.25.

Figs. 4, 8-10, 13. *Neoquenitrigonia huenickeni* (Leanza & Garate 1985). Hacienda Manflas, southeast of Copiapó, locality 15. Early Aalenian, Bredyia manflasensis Zone. Figs. 4, 8-9. SNGM 475 (Hillebrandt 720104/6a); articulated specimen, x 1.5. 4: dorsal view; 8: left valve view; 9: interior view. Figs. 10, 13. Quebrada El Bolito, northeast of Copiapó, locality 12. Early Aalenian, Bredyia manflasensis Zone. SNGM 468 (Hillebrandt 670222/11); left valve, x 1.5. 10: dorsal view; 13: lateral view.
Prosogyrotrigonia tenuis sp. nov. can be distinguished from the type species of the genus, *P. tenuis* Krumbeck 1924 from the Rhaetian of Timor (Krumbeck 1924; Kobayashi & Mori 1954), by its subrectangular outline, the straight anterior margin, a less convex post-umbonal part of the flank and finer costae on the flank. It differs from *P. inouyei* (Yehara 1921) from the Early Jurassic of Japan (Yehara 1921; Kobayashi & Mori 1954) by its subrectangular outline and finer and more densely spaced costae on the flank. With *Prosogyrotrigonia* (?) cf. *P. inouyei* (Yehara 1921) from northern Yukon, Canada (Frebold & Poulton 1977: pl. 2, fig. 9) it shares the subrectangular outline but differs by finer costae on the flank and by a more obtuse angle between flank and area.

Escobar (1980: 57, pl. 2, fig. 4) reported *Astarte* sp. from the Sinemurian southeast of El Guindo, VII Región del Maule, central Chile. Judging from the features of flank and area, this specimen may also belong to *P. tenuis* sp. nov., but hinge characters are not preserved and therefore this assignment remains uncertain.

**Prosogyrotrigonia** sp. 1

**Material.** 1 incomplete right valve from west of Quillagua (SNGM 497).

**Locality and age.** West of Quillagua (locality 1), II Región de Antofagasta, earliest? Sinemurian, horizon with *Coroniceras* aff. *conybeari* (Hillebrandt 2000a).

**Measurements (in mm).**

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**Description.** Specimen medium-sized. Umbo small, slightly incurved and prosogyrous, situated anteriorly.
Preserved parts of anterior and dorsal margins straight, forming an angle of ca. 113°; posterior and ventral margins not preserved. Area occupying one-fourth of the shell surface and forming an angle of ca. 100° with the flank; ornamented with fine, transverse to progressively oblique costellae (less than 1 mm in width), separated by slightly wider (1 mm) interspaces; costellae continuing from the costae of the flank, some of which dichotomizing on the area. Marginal carina lacking; separation of area and flank marked by a marginal angulation, which, in the median and distal part, exhibits small tubercles at the contact of the costae of flank and area. Internal carina demarcated by small nodes of the costellae of the area. Escutcheon partly preserved, excavated and narrow. Flank moderately convex and ornamented with concentric to subconcentric, smooth costae in umbalonal part, which develop into rows of elongated tubercles in median and distal part of valve; costae narrow (less than 1 mm in width) and progressively more oblique toward anterior margin, separated by somewhat wider interspaces (1 mm). Parts of teeth 3a and 3b preserved.

Remarks. The available incomplete specimen differs from *P. tenuis* sp. nov. by the presence of costae, which in the median and distal parts of the flank are composed of rows of elongated tubercles. This feature is also lacking in *P. timorensis* Krumbeck 1924 and *P. inouyei* (Yehara 1921).

**Prosogyrotrigonia** sp. 2

Pl. 5, Fig. 14

Material. 3 specimens from Limón Verde (SNGM 498-499, 508). SNGM 498 (incomplete right valve); SNGM 499, 508 (incomplete left valves).

Locality and age. Sierra Limón Verde (locality 3), II Región de Antofagasta, earliest Late Sinemurian, Asteroceras obtusum Zone (Hillebrandt 2002: 42).

**Prosogyrotrigonia** sp. 3

Pl. 5, Fig. 15

Material. 1 incomplete right valve from Quebrada Doña Inés Chica (SNGM 500).

Locality and age. Quebrada Doña Inés Chica (locality 6), III Región de Atacama, Late Hettangian or earliest Sinemurian (Hillebrandt, this study).

**EXPLANATION OF PLATE 5**

Figs. 1, 3-4, 9-13. *Freneguellia tapiai* (Lambert 1944). Portezuelo Pedraules, northeast of Potrerillos, locality 8. Late Pliensbachian, Faminoceras disciforme Zone. Figs. 1, 11, 13. SNGM 501 (Hillebrandt 660710/4); articulated specimen, x 1.5. 1: right valve view; 11: dorsal view; 13: left valve view. Figs. 3, 12. SNGM 504 (Hillebrandt 660710/4); left valve, x 2. 3: lateral view; 12: interior view. Fig. 4. SNGM 502 (Hillebrandt 660710/4); left valve, lateral view, x 2. Figs. 9-10. SNGM 503 (Hillebrandt 660710/4); right valve, x 2, 9: interior view; 10: lateral view. Figs. 2, 5. *Prosogyrotrigonia tenuis* sp. nov. Cerros de Cuevitas, northeast of Antofagasta, locality 4; Late Hettangian, Badouxia canadensis Zone (Schlotheimia cuevitensis Subzone). SNGM 487 (Hillebrandt 871105/1); left valve, x 2. 2: lateral view; 5: interior view.

Figs. 6-8. *Freneguellia poultoni* leanza 1993. Quebrada Pan de Azúcar, ca. 10 km southwest of Las Bombas, locality 7; Sinemurian. Fig. 6. SNGM 540 (Pérez & Escobar Afós 7; 3063-13); left valve, left valve, x 1.5. Fig. 7. SNGM 527 (Pérez & Escobar Afós 7; 3063); left valve, lateral view, x 1.5. Fig. 8. SNGM 536 (Pérez & Escobar Afós 7; 3063-33); right valve, lateral view, x 1.5.

Fig. 14. *Prosogyrotrigonia* sp. 2. Sierra Limón Verde, eastern hill, 17.5 km south of Calama, locality 3; Late Sinemurian, Asteroceras obtusum Zone. SNGM 498 (Hillebrandt 751211/1); right valve, lateral view, x 1.5.

Fig. 15. *Prosogyrotrigonia* sp. 3. Quebrada Doña Inés Chica, northeast of El Salvador, locality 6; Late Hettangian or earliest Sinemurian. SNGM 500 (Hillebrandt 841114/4b); right valve, lateral view, x 1.5.
Description. Specimen large-sized, subrectangular in outline, longer than high. Umbo and anterior margin not preserved; dorsal margin straight; posterior margin moderately convex; ventral margin convex. Area representing less than one-fourth of the shell surface and forming an angle of ca. 115° with the flank; ornamented with transverse, widely spaced costellae of increasing density toward posterior margin; ornamentation continuing from the costae of the flank, occasionally dichotomizing on the area. Area separated from flank by marginal angulation. Escutcheon not preserved. Flank convex and ornamented with thick (1 mm), subconcentric costae, becoming more oblique toward anterior margin and separated by equally spaced interspaces. Hinge not preserved.

Remarks. Prosogyrotrigonia sp. 3 differs from P. tenuis sp. nov. by its larger size, a less obtuse angle between flank and area, and a stronger ornamentation on both flank and area. It can be distinguished from Prosogyrotrigonia sp. 1 by its larger size and by stronger and more widely spaced costae on the flank, which bend less markedly at the anterior end and lack tubercles. Compared with Prosogyrotrigonia sp. 2, the angle between flank and area is less obtuse and the costae of the flank do not carry tubercles.

In the arrangement of the costae of area and flank, the specimen assigned to Prosogyrotrigonia sp. 3 exhibits some affinities with species of the genus Frenguelliella Leanza (1942), but lacks a marginal carina.

Suborder Myophorellina Cooper 1991

Superfamily Myophorellaceae Kobayashi 1954

Family Frenguelliellidae Nakano 1960

Subfamily Frenguelliellinae Nakano 1960

Genus Frenguelliella Leanza 1942

Type species. Trigonia inexspectata Jaworski 1916, Early Jurassic, Neuquén, Argentina.

Frenguelliella tapiai (Lambert 1944)

Pl. 5, Figs. 1, 3-4, 9-13

1944 Trigonia tapiai sp. nov. - Lambert: 358-359, pl. 13, fig. 1.
1977 Trigonia (Frenguelliella) tapiai Lambert - Perez & Reyes: 12, pl. 1, fig. 2.
1980 Frenguelliella tapiai (Lambert) - Hillebrandt: pl. 2, figs. 8a, b.
1987 Frenguelliella tapiai (Lambert) - Leanza & Garate: 210, pl. 1, fig. 5.
1987 Frenguelliella tapiai (Lambert) - Leanza & Garate: 210, pl. 1, fig. 5.
1992 Frenguelliella tapiai (Lambert) - Damborenea et al.: pl. 116, fig. 18.
1993 Frenguelliella tapiai (Lambert) - Leanza: 26, pl. 1, fig. 8.
1997 Frenguelliella tapiai (Lambert) - Perez & Reyes: 574, 576.

Material. 7 specimens from Portezuelo Pedernales (SNGM 501-507). SNGM 502, 504-505 (partly incomplete left valves); SNGM 503, 506-507 (incomplete right valves); SNGM 501 (articulated specimens with partly deteriorated flanks).

Locality and age. Portezuelo Pedernales (locality 8), III Región de Atacama, Late Pliensbachian, Fanninoceras disciforme Zone, horizon with Reynsoceras americanum (Hillebrandt 1987: 116; 2002: 12). Damborenea et al. (1992) and Leanza (1993) reported this species from the Pliensbachian of Argentina, the former author from the Radulonectites sosnadoensis Zone (comprising the European Amaltheus marginatus and Pleuroceras spinatum standard zones), and the latter author from the Fanninoceras fannini Zone, which comprises part of these zones (Hillebrandt 1987: 120).

Measurements (in mm).

<table>
<thead>
<tr>
<th>Specimen</th>
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<th>H/L</th>
<th>W/L</th>
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<td>8</td>
<td>0.79 0.30</td>
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<tr>
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<td>lv</td>
<td>22 27</td>
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<td>lv</td>
<td>25 [29]</td>
<td>9</td>
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</table>

Description. Shell small- to medium-sized, oval to subquadrate, inequilateral. Umbo opisthogyrous, situated anteriorly. Dorsal margin straight, with a gentle, concave inflexion at distal end; posterior margin straight in dorsal half and convex in ventral half; both margins forming an
obtuse angle of ca. 115°; anterior margin weakly convex; ventral margin convex; dorsal and anterior margins forming a slightly obtuse angle of ca. 100°. Area wide, occupying about one-third of the shell surface, asymmetrically divided by a subtle groove; ornamented with transverse costellae (6 per 5 mm), which are more numerous than flank costae, separated by somewhat wider interspaces; area and flank forming an angle of ca. 125°. Marginal carina low, rounded, slightly curved and with small nodes, which correspond to the costae of the area. Internal carina less developed, but also with small nodes. Escutcheon excavated, its length occupying almost all of the dorsal margin; surface covered with four to five diagonal striae. Flank moderately convex, with narrow antecarinal sulcus; ornamented with low costae (4 per 5 mm in central part of flank), separated by slightly wider interspaces. Course of costae variable (Pl. 5, Fig. 4); concentric in umbonal part; rising at anterior end in median part to form a convex undulation; subconcentric in distal part of flank. Costae interrupted at antecarinal sulcus in central part, but only attenuated in distal part.

Remarks. LAMBERT (1944: 359) described the escutcheon as apparently smooth. In contrast, the studied specimens agree with the descriptions of LEANZA & GARATE (1987: 210) and LEANZA (1993: 26), who reported the presence of fine, albeit more numerous, oblique costellae. With respect to the ornamentation of the flank, the specimen figured by LEANZA (1993: 26, pl. 1, fig. 8) carries a larger number of costae than the specimens studied herein and those figured by LAMBERT (1944: 358, pl. 13, fig. 1), LEANZA & GARATE (1987: 210, pl. 1, fig. 5) and DAMBORENEA et al. (1992: pl. 116, fig. 18). F. chubutensis (FERUGLIO 1934: 34, pl. 4, figs. 9, 11) from the Pliensbachian (DAMBORENEA et al. 1992: pl. 116, fig. 17) of Valle del Río Genua in Patagonia, has affinities with F. tapiai, but differs by a dorsal margin, which is curved at the distal end, an area with a poorly developed submedian groove, and more densely spaced costae on the flank. LAMBERT (1944: 359) also mentioned that the species of FERUGLIO is smaller sized.

F. tapiai can be separated from F. poultoni LEANZA (1993: 26, pl. 2, figs. 3-6) by its larger size, flank costae which are more strongly subconcentric, and narrower intercostal spaces toward the anterior margin. F. tapiai differs from F. perezreyesi LEANZA (1993: 27, pl. 2, figs. 1-2, 7-8) by its larger size and by a more obtuse angle between the surfaces of flank and area.

Frenguelliella poultoni LEANZA 1993

Pl. 5, Figs. 6-8

1979 Frenguelliella sp. B - POUTHON: 18, pl. 1, fig. 10.
1993 Frenguelliella poultoni sp. nov. - LEANZA: 26, pl. 2, figs. 3-6.

Material. 47 specimens from Quebrada Pan de Azúcar (SNGM 515-561, 690) and 6 from Quebrada Pinte (SNGM 509-514). SNGM 510-511, 513-514, 518, 520(1), 522, 535(2), 536(1), 536(2), 537, 539(1), 544, 545(2), 551(3), 552(2), 558(2), 560 (right valves, some partly incomplete); SNGM 509, 512, 517, 519, 520(2), 520(3), 523(1), 525, 526(1), 526(2), 527, 528, 530, 532, 539(2), 540, 545(1), 547, 549(1), 551(2), 558(1), 559, 561, 690 (left valves, some partly incomplete); SNGM 515, 516(1), 516(2), 517(2), 518(2), 523(2), 524, 534, 535(1), 538, 541, 543, 548, 550, 551(1), 553(2), 554(1), 555(1), 556(1), 557 (external molds of left valves, some incomplete); SNGM 516(3), 521, 529, 531, 533, 542, 546(1), 546(2), 549(2), 553(1), 553(3), 554(2), 555(2) (external molds of right valves, some incomplete); SNGM 552(1), 556(2) (external molds of articulated specimens).

Localities and age. Quebrada Pan de Azúcar (locality 7), III Región de Atacama, Sinemurian (based on the co-occurrence with Ariettes sp. and Arnioceras sp.), probably Obtusum Zone, Stellare Subzone, horizon with Asteroceras cf. stellare (HILLEBRANDT 2002: 46); Quebrada Pinte (locality 21), III Región de Atacama, Late Sinemurian (ABERHAN 1992: 139, appendix I). POUTHON (1979) identified specimen GSC 9635 from the Early Sinemurian Laberge Group as Frenguelliella sp. B. LEANZA (1993: 26-27) considered this specimen to be synonymous with F. poultoni from the Late Pliensbachian (Fanninoceras fannini Zone) of Catán Ll, Argentina.

Measurements (in mm).

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Valve</th>
<th>H</th>
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<th>W</th>
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<td>12</td>
<td>16</td>
<td>-</td>
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Description. Shell small-sized and thin-shelled, subrectangular, highly inequilateral. Umbo orthogyrous. Dorsal margin moderately concave; posterior margin straight and shorter than dorsal margin, both forming an obtuse angle of ca. 105°; anterior margin weakly convex; ventral margin convex, changing to slightly concave close to marginal carina; dorsal and anterior margin forming an angle of ca. 100°. Area wide, occupying about one-third of shell; asymmetrically divided by shallow groove with
Early Jurassic Bivalvia of northern Chile. Part III. Order Trigonioida
dorsal part narrower than ventral part; ornamented with transverse costellae. Marginal carina distinct relative to size of shell; with small nodes where it meets the ornamentation of the area. Internal carina less developed; also with small nodes. Escutcheon lanceolate and excavated. Flank moderately convex, occupying two-thirds of the shell surface; ornamented with low, blunt concentric costae (5-6 per 5 mm), separated by intercostal spaces which are somewhat wider in dorsal part of flank and of equal width on ventral part. Costae bending upward at anterior end of flank, forming a slightly convex undulation before reaching the marginal carina; weakening distally; narrow antecarinal sulcus present in dorsal and central part of flank.

Remarks. This species exhibits a fair amount of intra-specific variability with respect to ornamentation. In specimens of equal size the costellae of the area can vary in strength and spacing, and the antecarinal sulcus is lacking in some specimens (see also POULTON 1979: 18; LEANZA 1993: 26). The small tubercles on the marginal and internal carinae, visible in specimen SNGM 538, are not present in the remaining specimens from Quebrada Pan de Azúcar, probably due to preservational reasons. LEANZA (1993: 26) did not mention tubercles on the carinae, whereas POULTON (1979: 18) reported their presence on the internal carina.

Most specimens of this species are very small (13-18 mm in length, 9-15 mm in height), such as those studied by POULTON (1979: GSC 9635) from Yukon, Canada, by LEANZA (1993: holotype MOZP 5315, paratype MOZP 5317-1), from Arroyo Ñireco, Neuquén, Argentina, and the material from Pan de Azúcar, Chile, studied herein. LEANZA (1993: paratypes MOZP 5316 and 5317-2) also documented larger specimens (23-33 mm in length, 17-25 mm in height) from Argentina. Small specimens from Argentina have a height/length ratio (H/L) of 0.83, whereas larger specimens have a ratio of 0.74-0.75. In this respect the Chilean specimens (H/L = 0.61-0.69) have stronger affinity with the specimen from Canada (H/L = 0.66).

**Frenguellia inexspectata** (Jaworski 1916)

*Pl. 6, Figs. 1, 3-4, 7*

1916 *Trigonia inexspectata* sp. nov. - Jaworski: 377-380, pl. 5, figs. 2a, b.
1942 *Trigonia (Frenguellia) inexspectata* Jaworski - Leanza: 165-166, pl. 7, fig. 1.
1992 *Frenguellia inexspectata* (Jaworski) - Damborenea et al.: pl. 116, fig. 16.
1997 *Frenguellia inexspectata* Jaworski - Leanza: 26, pl. 2, fig. 9.
1997 *Frenguellia inexspectata* (Jaworski) - Perez & Reyes: 574, 576.

Material. 1 complete right valve (SNGM 562) and 1 complete left valve with partly preserved hinge (SNGM 563) from Quebrada Asientos.

Locality and age. Quebrada Asientos (locality 9), III Región de Atacama, Early/Late Pliensbachian, Fanninoceras fannini Zone, horizon with *Fanninoceras leptodiscus* (Hillebrandt 1987: 120; 2002: 14). In Argentina, this species was reported from the Pliensbachian Radulonectites sosneadoensis Zone (corresponding to the Amaltheus margari-tatus and Pleuroceras spinatum European standard zones) (Damborenea et al., 1992), the Otaria neuquensis Zone (corresponding to the Uptonia jamesoni and Predactyloceras davoei standard zones) and the Radulonectites sosneadoensis Zone (Leanza 1993).

**Description.** Shell medium-sized to large, subrectangular, inequilateral. Umbo small, opisthogyrous. Dorsal margin straight, curved upward at the distal end; posterior margin weakly convex, much shorter than dorsal margin; both margins forming an angle of ca. 125°; anterior and ventral margins convex. Area narrow, occupying about one-fifth of shell surface; subdivided by shallow groove in two parts of subequal size; ornamented with transverse costae of moderate strength, more numerous than flank costae, separated by interspaces twice as wide than the costae. Carinae blunt; marginal carina stronger than internal carina; both with small nodes at contact with ornamentation of area. Escutcheon excavated, with diagonal, discontinuous striae. Flank convex, with antecarinal depression widening toward ventral margin; ornamented with blunt variable costae (3 per 5 mm), separated by slightly wider interspaces; umbonal costae concentric, post-umbonal costae slightly bending at the anterior end; costae increasing in strength at border between flank and antecarinal depression, forming a small bulb, continuing across depression as much finer and markedly convex costellae until meeting marginal carina.

Remarks. Compared with specimens figured by Jaworski (1916: pl. 5, fig. 2a), Leanza (1942: pl. 7, fig. 1), Damborenea et al. (1992: pl. 116, fig. 16), and Leanza (1993: pl. 2, fig. 9) the costae of the flank of the studied material from Chile are more densely spaced.

**Genus Jaworskiella** Leanza 1942

Type species. *Trigonia burckhardti* Jaworski 1916, Early Jurassic (Pliensbachian), Neuquén, Argentina.

*Jaworskiella gryphitica* (Moricke 1894)

*Pl. 6, Figs. 5-6, 10-11*

1894 *Trigonia gryphitica* sp. nov. - Moricke: 45-46, pl. 3, fig. 5.
1997 *Jaworskiella gryphitica* (MÖRICKE) - PÉREZ & REYES: 15, pl. 3, fig. 4.

1997 *Jaworskiella gryphitica* (MÖRICKE) - PÉREZ & REYES: 574.

Material. 1 specimen from Río Manflas (SNGM 564) and 3 specimens from Quebrada del Pobre (SNGM 565-566(1-2)); SNGM 564, 566-1 (right valves); SNGM 566-2 (left valve); SNGM 565 (incomplete articulated specimen).

Localities and age. Río Manflas (locality 16), III Región de Atacama, Late Sinemurian (HILLEBRANDT & SCHMIDT-EFFING 1981: 24); Quebrada del Pobre (locality 23), V Región de Valparaiso, Late Sinemurian? (HILLEBRANDT 2002: 51; 2006: 27). The specimens of *J. gryphitica* from Quebrada Las Vizcachas and Sierra de La Ternera, south of Copiapó, III Región de Atacama, were assigned to the Early Jurassic by MÖRICKE (1894).

Measurements (in mm).

<table>
<thead>
<tr>
<th>Specimen</th>
<th>valve</th>
<th>H</th>
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<th>W</th>
<th>H/L</th>
<th>W/L</th>
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<td>[23]</td>
<td>6</td>
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<td>0.26</td>
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<td>[15]</td>
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<td>0.38</td>
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Description. Shell small- to medium-sized, subrectangular to oval, longer than high. Umbo small, incurved, slightly opisthogyrous. Anterior margin weakly convex; dorsal and posterior margins straight; ventral margin convex. Area occupying about one-fourth of the shell surface; asymmetrically divided by shallow submedian groove, with the region bordering the marginal carina being the larger one; ornamented with fine, transverse costellae, separated by somewhat wider interspaces. Marginal and internal carinae blunt; with small tubercles, which are stronger in marginal carina, located at intersection with costae of area. Escutcheon relatively wide compared to area, slightly excavated, with oblique growth striae. Flank convex, with wide antecarinal sulcus; costae blunt, with small tubercles; umbonal costae concentric, post-umbonal costae subconcentric, about 1 mm in strength, separated by larger interspaces (ca. 2 mm); ornamentation interrupted at antecarinal sulcus.

Remarks. *J. gryphitica* differs from *J. infraclavellata* (MÖRICKE 1898) by more widely spaced flank costae. It can be distinguished from *J. burckhardtii* (JAWSWSKI 1916) by its smaller size and a moderately convex flank with costae which are tuberculated throughout. *Jaworskiella* sp. (this study) is larger and the costae of the flank are not tuberculated. POULTON (1979: 19-20, pl. 7, figs. 1-8) analysed the genus *Jaworskiella* and described two species from North America: *J. siemonmulleri* POULTON (1979) and *J. supleiensis* POULTON (1979). Compared with these species, *J. gryphitica* is smaller, ornamented with wider spaced costae, and exhibits a marked antecarinal sulcus.

1997 *Jaworskiella burckhardti* (JAWSWSKI 1916)

Pl. 6, Figs. 2, 8-9; Pl. 7, Figs. 1-3, 6-7; Pl. 8, Fig. 3

1901 *Trigonia gryphitica* BURCKHARDT non STEINMANN - BURCKHARDT: 21-22, pl. 4, fig. 4.

1916 *Trigonia burckhardtii* sp. nov. - JAWSWSKI: 380, pl. 5, fig. 3.

1942 *Trigonia* (*Jaworskiella*) *burckhardtii* JAWSWSKI - LEANZA: 166-168, pl. 6, figs. 2-3.

1977 *Jaworskiella burckhardtii* (JAWSWSKI) - PÉREZ & REYES: 14, pl. 2, figs. 1, 3, 6.

1980 *Jaworskiella burckhardtii* (JAWSWSKI) - HILLEBRANDT: pl. 2, figs. 5a, b.

1987 *Jaworskiella burckhardtii* (JAWSWSKI) - LEANZA & GARATE: 210, pl. 1, figs. 1-2.

1993 *Jaworskiella burckhardtii* (JAWSWSKI) - LEANZA: 28, pl. 1, figs. 1, 6, 7, 10.


Material. 4 specimens from Quebrada Asientos (SNGM 568-569, 571-572) and 1 from eastern Punilla (eastern flank) (SNGM 570). SNGM 568, 570-572 (partly incomplete right valves); SNGM 569 (partly incomplete left valve).

Localities and age. Quebrada Asientos (locality 9), III Región de Atacama, Late Pliensbachian, Fanninoceras fannini Zone, horizon with *F. fannini* (HILLEBRANDT 1987: 120; 2006: 14); eastern Punilla (eastern flank) (locality 22), IV Región de Coquimbo, Toarcian (THIELE 1964), Late? Pliensbachian (HILLEBRANDT, this study). In Argentina, LEANZA (1993) recorded this species from the Pliensbachian Otapiria neuquensis Zone (corresponding to the Uptonia jamesoni and Prodactylioceras davoei zones) and the Radulonectites sosnoeadensis Zone (corresponding to the Amaltheus margaritatus and Pteroceras spinatum zones).

Measurements (in mm).

<table>
<thead>
<tr>
<th>Specimen</th>
<th>valve</th>
<th>H</th>
<th>L</th>
<th>W</th>
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<td>25</td>
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Description. Shell medium-sized to large, trigonal-ovate. Umbo strongly incurred, opisthogyrous, situated submesially. Dorsal margin straight; anterior margin moderately convex; ventral margin convex; posterior margin short and straight. Area occupying about one-fifth of shell surface; with median groove and ornamented with fine, transverse costellae, separated by somewhat wider interspaces. Marginal carina with small tubercles, which meet with costellae of area. Internal carina formed by small tubercles, corresponding to swellings of costellae of area. Escutcheon excavated, elongated, smooth. Flank convex, ornamented with narrow (1.5 mm), prominent costae, separated by larger (2 mm) interspaces; umbonal costae concentric; post-umbonal costae subconcentric, becoming subhorizontal toward anterior margin, slightly concave in median part of flank and moderately inclined toward antecarinal sulcus; post-umbonal costae often more or less sinuous, bifurcating at the anterior end in some cases, and with tubercles in median and precardinal parts of flank; antecarinal sulcus wider in left valve than in...
right valve, interrupting or attenuating the contact between ornamentation of flank and marginal carina. SNGM 568 (Pl. 6, Fig. 9) with tooth 3a (14 mm long, 5 mm thick) and tooth 3b (14 mm long, 2 mm thick in median part); anterior adductor scar lenticular (11 mm in height, 6 mm in length); posterior pedal retractor scar ca. 2 mm in diameter. Tooth 2 (19 mm long at base, 12 mm high) preserved in SNGM 569 (Pl. 7, Fig. 6).

Remarks. Specimens of *J. burckhardti* vary with respect to the ornamentation of the flank and the area. The type specimen (Jaworski 1916: 380, pl. 5, fig. 3) lacks tubercles on the costae of the flank. However, tubercles are well developed in the precarinal part of the flank in the specimens figured by Leanza (1942: 166, pl. 6, figs. 2-3), Leanza & Garate (1987: 210, pl. 1, figs. 1-2), and Leanza (1993: pl. 1, fig. 1). In specimens SNGM 568 and 569 (this study), in contrast, the tubercles are small. Concerning the costellae of the area, these are strong and widely spaced in the specimens figured by Jaworski (1916), Leanza (1942), Leanza & Garate (1987), and Leanza (1993). They are of lesser strength and more densely arranged in the Chilean specimen SNGM 568 (Pl. 6, Figs. 2, 8), but not in specimens SNGM 569 (Pl. 7, Fig. 7) and SNGM 570 (Pl. 7, Fig. 3). Finally, costae dichotomizing near the anterior margin of the flank are present in the type specimen and were described by Leanza (1942), Leanza & Garate (1987), and Leanza (1993). This feature is present in some of the specimens studied herein (SNGM 569, Pl. 7, Fig. 2), but not in others (SNGM 568, Pl. 6, Fig. 2; SNGM 570, Pl. 7, Fig. 1). Poultón (1979: 20) compared *J. burckhardti* with *J. siemonmulleri* Poultón (1979) and pointed out that the latter is smaller and more regularly ornamented.

**Jaworskiella** sp.

Pl. 7, Figs. 4-5

Material. 1 incomplete left valve (SNGM 567) from Sierra Limón Verde.

Locality and age. Sierra Limón Verde (locality 3), western flank east of eastern hill, II Región de Antofagasta, earliest Late Sinemurian, Asteroceras obtusum Zone (Hillebrandt 2002: 42).

**Genus Quadratojaworskiella REYES & PÉREZ 1980**

Type species. *Jaworskiella (Quadratojaworskiella) pustulata* REYES & PÉREZ 1980, Early Pliensbachian, northern Chile.

**Quadratojaworskiella pustulata REYES & PÉREZ 1980**

Pl. 8, Figs. 1, 4-6, 8; Pl. 9, Figs. 1, 5; Pl. 10, Figs. 1-4; Pl. 12, Fig. 10

**EXPLANATION OF PLATE 8**

Figs. 1, 4-6, 8. Quadratojaworskiella pustulata REYES & PÉREZ 1980. Quebrada Asientos, east of Potrerillos, locality 9; Early/Late Pliensbachian, Fanninoceras fannini Zone. Figs. 1, 8. SNGM 575 (Hillebrandt 660708/8); left valve, x 1.5: 1: interior view; 8: lateral view. Figs. 4-5. SNGM 576 (Hillebrandt 660708/8); right valve, x 1.5: 4: interior view; 5: lateral view. Fig. 6. SNGM 573 (Hillebrandt 660708/8); left valve, lateral view, x 1.5.

Figs. 2, 7, 8. ?Trigonoioida indet. Quebrada Pinte, southeast of Vallenar, locality 21; Late Sinemurian. Fig. 2. SNGM 682 (Aberhan 1992: appendix I + III, horizon 1-26); right valve, lateral view, x 1.5. Fig. 7. SNGM 679 (Aberhan 1992: appendix I + III, horizon 4-30 B3); left valve, lateral view, x 1.5.

Fig. 3. Jaworskiella burckhardti (Jaworski 1916). Quebrada Asientos, east of Potrerillos, locality 9; Early/Late Pliensbachian, Fanninoceras fannini Zone. SNGM 572 (Hillebrandt 660708/8); right valve, lateral view, x 1.5.

### Measurements (in mm).

<table>
<thead>
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<td>[63]</td>
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Description. Specimen large, longer than high. Umbo incurved, weakly opisthogyrous. Dorsal margin straight; anterior and ventral margins only partly preserved; posterior margin slightly convex. Area occupying one-fourth of flank surface; with median groove and ornamented with strong, transverse costae, separated by wider interspaces. Marginal carina slightly curved in umbonal part; straight, wide and blunt in central and distal part, with tubercles at contact with costae of area. Internal carina slightly concave; formed by tubercles which correspond to swellings of the costae of the area. Escutcheon shallow, very elongated, running along large part of dorsal margin; relatively wide, approximately one-half the size of the area; mostly smooth, but with diagonal costellae at distal end, which are prolongations of the costae of the area. Flank moderately convex; upper third ornamented with concentric to subconcentric, blunt, smooth, densely spaced (3 in 5 mm) costae; costae stronger and more widely spaced (2 in 5 mm) in central and distal part of flank. Antecarinal depression shallow, widening distally, not interrupting ornamentation of flank.

Remarks. *Jaworskiella* sp. is of about the same size as *J. burckhardti* (Jaworski 1916), but differs by a less incurved umbo, a straight marginal carina, stronger and more widely spaced costae of the area, and more regular flank costae; the antecarinal depression is weakly developed and widening distally.
Early Jurassic Bivalvia of northern Chile. Part III. Order Trigonioida
1980 Jaworskiella (Quadratojaworskiella) pustulata sp. nov. - REYES & PÉREZ: 89-93, pl. 1, figs. 1-4; pl. 2, figs. 1-4.
1980 Quadratojaworskiella pustulata (REYES & PÉREZ) - HILLEBRANDT: pl. 2, fig. 9.
1982 Jaworskiella (Quadratojaworskiella) pustulata REYES & PÉREZ - PL. 15, figs. 7-10, appendix 1.
1997 Quadratojaworskiella pustulata REYES & PÉREZ & REYES: 574.

Material. 13 specimens from Quebrada Asientos (SNGM 573-584, 586). SNGM 576-580, 584, 586 (incomplete right valves; 5 with parts of the hinge preserved); SNGM 573-575, 581-583 (incomplete left valves; 3 with parts of the hinge preserved).

Locality and age. Quebrada Asientos (locality 9), III Región de Atacama, Early/Late Pliensbachian, Fanninoceras fannini Zone, horizon with Fanninoceras leptodiscus (HILLEBRANDT 1987: 120; 2006: 14).

Measurements (in mm).

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Description. Shell large-sized, subquadrate. Umbo small, moderately incurved, slightly opisthogyrous. Dorsal margin straight; anterior margin weakly convex in umbonal part, otherwise straight; both margins meet at an approximately right angle; posterior margin straight, forming a slightly obtuse angle of ca. 100-110° with dorsal margin; ventral margin moderately convex. Area occupying one-fourth of the valve surface; ornamented with thin, oblique, partly sinuous and discontinuous costae, forming an acute angle with the marginal carina; asymmetrically divided by a submedian groove. Marginal carina blunt, with nodes becoming more distinct toward ventral margin. Internal carina represented by well spaced nodes of greater strength than those of marginal carina. Escutcheon narrow, elongated, smooth. Flank weakly convex, ornamentation pattern varying in dorsal-ventral direction; dorsal quarter of flank with smooth, concentric to subconcentric costae; anterior part of remainder of flank with smooth, declining, sinuous costae, which are replaced by rows of triangular or irregular tubercles on the median and precardinal part of the flank, and which are subconcentric (SNGM 578; Pl. 9, Figs. 1, 5) or have a tendency toward a Vaugonia-like ornamentation (SNGM 573; Pl. 8, Fig. 6). Ornamentation of flank terminates at a narrow antecarinal sulcus. Hinge characters preserved in several specimens (see figures).

Remarks. The type specimens together with the specimens studied herein exhibit a fair amount of variation in the ornamentation of the flank. The course of the smooth anterior costae can vary from regular and continuous to irregular and discontinuous; tubercles occur in the anterior third of the flank in some specimens and more mesially in others; and the smooth costae and their continuation as rows of tubercles may have a subconcentric or a Vaugonia-like arrangement.

Quadratojaworskiella acarinata sp. nov.

Pl. 11, Figs. 2-3, 6-7

1980 Quadratojaworskiella n. sp. - HILLEBRANDT: pl. 2, fig. 10.
1997 Quadratojaworskiella n. sp. HILLEBRANDT - PÉREZ & REYES: 574.

Derivation of name. From the Latin a (without) and carina (keel), referring to the absence of a marginal carina.

Material. 2 right valves from Quebrada Yerbas Buenas (SNGM 585, 587) and 1 incomplete left valve from Quebrada Cachina (SNGM 588).

Holotype. SNGM 587 (Pl. 11, Fig. 2), right valve with dorsal part of left valve; anterior and ventral margins are partly preserved.

Paratypes. SNGM 585 (Pl. 11, Figs. 6-7); SNGM 588 (Pl. 11, Fig. 3).

Localities and age. Quebrada Cachina (locality 5), II Región de Antofagasta, Middle/Late Hettangian, Sunrisites peruvianus Zone (HILLEBRANDT 2000b: 126); Quebrada Yerbas Buenas (locality 10), III Región de Atacama, earliest Late Sinemurian, Asteroceras obtusum Subzone, horizon with Asteroceras cf. confusum and Arnioceras cf. rejectum (HILLEBRANDT 2002).

Measurements (in mm).

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EXPLANATION OF PLATE 9

Figs. 1, 5. Quadratojaworskiella pustulata REYES & PÉREZ 1980. Quebrada Asientos, east of Potrerillos, locality 9; Early/Late Pliensbachian, Fanninoceras fannini Zone. SNGM 578 (HILLEBRANDT 660708/8); right valve, x 1.5. 1: lateral view; 5: interior view.

Figs. 2, 4. Psilotrigonia vegaeensis sp. nov. Vega Redonda, northeast of Copiapó, locality 11; Late Sinemurian or Early Pliensbachian. Fig. 2. SNGM 590 (HILLEBRANDT 720131/1); left valve, lateral view, x 1.5. Fig. 4. SNGM 591 (holotype) (HILLEBRANDT 720131/1); left valve, lateral view, x 1.5.

Fig. 3. ?Trigonoida indet. Quebrada Pinte, southeast of Vallenar, locality 21; Late Sinemurian. SNGM 677 (ABERHAN 1992: appendix I + III, horizon 4-30 B3); right valve, lateral view, x 2.25.
Diagnosis. Shell without marginal carina and antecarinal sulcus; costae with triangular nodes occupying all of postumbonal flank surface.

Description. Shell large-sized, subquadrate in outline. Umbo small, incurved, slightly opisthogyrous. Anterior, dorsal and posterior margins straight, the former two forming an almost right angle, the latter two forming an obtuse angle of ca. 125°; ventral margin convex near anterior end and weakly convex toward posterior margin. Area wide, occupying about one-fourth of the valve surface; a shallow groove divides area into two asymmetrical parts; area of holotype ornamented with fine, oblique, continuous costellae; area of paratype SNGM 588 with well developed, widely spaced costellae. Area and flank meet at an obtuse angle of ca. 130°. Area not separated from flank by carina or marginal angulation. Low, rounded internal carina with small, widely spaced tubercles. Escutcheon wide, extending along all of dorsal margin; only with growth lines. Flank ornamented with smooth, concentric to subconcentric costae in umbonal part, which are replaced by rows of small, triangular nodes at early post-umbonal stages, running parallel to the growth lines; tubercles more prominent in the remaining three quarters of flank and occupying all of the flank surface.

Remarks. *Q. acarinata* sp. nov. differs from *Q. pustulata* by the absence of both a marginal carina and an antecarinal sulcus, and by the extension of the tubercles of the flank to the anterior margin.

Subfamily *Psilotrigoniinae* Fleming 1987

Genus *Psilotrigonia* Cox 1952


*Psilotrigonia vegaensis* sp. nov.

Pl. 9, Figs. 2, 4; Pl. 10, Figs. 5-6; Pl. 12, Fig. 1

1997 *Psilotrigonia* sp. - Pérez & Reyes: 574.

Derivation of name. From Vega Redonda, the type locality of the species.

Material. 4 incomplete right valves (SNGM 592-595) and 3 incomplete left valves (SNGM 589-595) from Vega Redonda.

Holotype. SNGM 591 (Pl. 9, Fig. 4), left valve, partially deteriorated at the ventral and posterior margins.

Paratypes. SNGM 592 (Pl. 10, Fig. 6); SNGM 593 (Pl. 10, Fig. 5).

Locality and age. Vega Redonda (locality 11), III Región de Atacama, Late Sinemurian or Early Pliensbachian (Hillebrandt, this study).

Measurements (in mm).

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Diagnosis. Shell medium-sized; area slightly concave, ornamented with fine, dense costellae, which are strongly curved toward the marginal angulation; surfaces of area and flank form a slightly obtuse angle; anterior half of flank ornamented with fine, sinuous costae.

Description. Shell medium-sized, oval. Umbo small, weakly incurved, located in anterior third of valve. Anterior and ventral margins convex; dorsal margin straight; posterior margin moderately convex. Area wide, slightly concave, occupying between one-third and one-fourth of the valve surface; ornamented with fine, densely spaced (3 per 2 mm), subconcentric and strongly curved costellae; area and flank forming a slightly obtuse angle of ca. 103°. Marginal carina poorly developed, replaced in large parts of valve by marginal angulation. Escutcheon poorly preserved. Flank moderately convex; ornamentation of fine (1 mm thick), sinuous costae, restricted to anterior half of flank; costae separated by equally wide interspaces; remainder of shell smooth. Hinge characters not preserved.

Remarks. POULTON (1976) separated *Psilotrigonia beesleyana* (Lycett 1874; 91, pl. 17, figs. 2-4) and *P. canadensis* Poulton (1976: 45, pl. 8, fig. 1) from the group of species assigned to *Psilotrigonia (P.) sanchuensis* Nakano (1957), *T. excentrica* Parkinson (Lycett 1874), *T. semiculta* Forbes in Stoliczka (1871), and *T. beyrichi* Krumbeek (1906) by the presence of a smooth posterior part of the flank and diagonal costellae in the distal part of the area. *Psilotrigonia vegaensis* sp. nov. presents the features typical of the group *beesleyana-canadensis*, but...
differed from *P. beesleyana* by the anteriorly placed umbo, a more planate surface of the area, and a more obtuse angle between area and flank. It can be distinguished from *P. canadensis* by the anteriorly situated umbo, a less obtuse angle between area and flank, and a more pronounced marginal angulation. Furthermore, the costellae on the area are finer, more densely arranged, and curved toward the marginal angulation.

**Family Myophorellidae** KOYAYASHI 1954

**Subfamily Myophorellinae** KOYAYASHI 1954

**Genus Myophorella** BAYLE 1878

Type species. *Myophorella nodulosa* BAYLE 1878, Late Jurassic (Oxfordian), France.

*Myophorella* (Myophorella) *araucana* (LEANZA 1942)

Pl. 11, Figs. 1, 4-5, 8; Pl. 12, Figs. 2-7, 9, 11-12; Pl. 13, Figs. 1, 7

1901 *Trigonia aff. angulata* Sowerby - BURCKHARDT: 22, pl. 4, figs. 5-6.

1942 *Trigonia (Clavitrigonia) araucana* sp. nov. - LEANZA: 162, pl. 6, figs. 4-6.

1966 *Myophorella (Promyophorella) araucana* (LEANZA) - LEVY: 240.

1977 *Myophorella (Promyophorella) araucana* (LEANZA) - PÉREZ & REYES: 13, 14, pl. 1, figs. 1-3.

1980 *Myophorella catenifera* (HUPÉ) - HILLEBRANDT: pl. 2, fig. 4.

1982 *Myophorella (Promyophorella) araucana* (LEANZA) - PÉREZ: pl. 14, fig. 9.

1987 *Myophorella (Promyophorella) araucana* (LEANZA) - LEANZA & GARAPE: pl. 1, figs. 6-8.


1993 *Myophorella (Promyophorella) araucana* (LEANZA) - LEANZA: 29, pl. 1, figs. 4-5.

1997 *Myophorella (Promyophorella) araucana* (LEANZA) - PÉREZ & REYES: 574, 575.

Material. 21 specimens from Quebrada Asientos (SNGM 596-616). SNGM 596, 598-603, 606, 609-610, 615 (right valves, mostly complete; 2 with partly preserved hinge); SNGM 597, 605, 607, 611, 614, 616 (left valves, partly incomplete; 3 with partly preserved hinge); SNGM 604, 608, 612-613 (articulated specimens).

**Measurements (in mm).**

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</table>

**Description.** Shell medium-sized, longer than high, ovaly oblong in outline. Anterior margin moderately convex; posterior margin short and truncated; dorsal margin concave; ventral margin strongly convex in anterior half. Umbo opisthogyrous, located in anterior fifth of shell. Area narrow, occupying about one-fourth of the shell surface; ornamented with transverse costellae, which are distinct, widely spaced and weakly convex in the dorsal third of the area; remainder of area with finer, transverse costellae and interspaces with very fine striae. Marginal carina high, rounded, and with small tubercles where meeting with the costellae of the area, which become more distinct toward posterior margin of area. Internal carina less prominent than marginal carina, but with equally strongly developed tubercles. Escutcheon wide, lanceolate, excavated, smooth, extending along all of dorsal margin. Flank weakly convex; ornamented with subconcentric, fine costae with small tubercles in umbonal part; costae in median part of flank moderately curved toward anterior margin, with well developed tubercles and with wider intercostal spaces (3 mm in median part of flank, 6 mm at anterior margin); costae stronger and less curved in posterior third of shell, and intercostal spaces narrower (2 mm). Antecarinal sulcus widening posteriorly, preventing the direct contact between costae and marginal carina.

**Remarks.** With respect to the ornamentation of the area, some specimens bear relatively strong and widely spaced costellae in the anterior and median parts (e.g. SNGM...
Description. Shell large-sized, subrectangular-ovate, longer than high, strongly inequilateral. Umbo small, incurved, opisthogyrous. Anterior margin moderately convex; dorsal margin straight, changing to slightly concave at distal end; ventral margin convex; posterior margin weakly convex. Area becoming much wider toward posterior end, due to the curvature of dorsal margin and internal carina; area with subtle submedian groove; ornamented with fine, dense, transverse striae. Marginal carina blunt, narrow (2 mm), with small tubercles from post-umbonal part onwards; in distal part more strongly curved and developing into a marginal angulation. Internal carina blunt, with tubercles becoming more pronounced toward posterior margin. Escutcheon elongated, slightly excavated, relatively wide; with fine growth lines. Flank moderately convex; ornamented with thick (2.5 mm) costae of well developed nodes typical of Myophorella, separated by larger interspaces (4 mm); umbonal costae subconcentric; first post-umbonal costae moderately curved toward marginal carina in precarinal part, forming an obtuse inflection with the anterior branch of the costae, which reach the anterior margin at an approximately right angle; costae of distal half of flank curved in an anterior direction, running subparallel to the ventral margin; ontogenetically latest costae weakly curved and running toward ventral margin. Wide antecarinal sulcus present, which prevents the direct contact of the costae with the marginal area.


EXPLANATION OF PLATE 12

Fig. 1. Psilotrigonia vegaensis sp. nov. Vega Redonda, northeast of Copiapó, locality 11; Late Sinemurian or Early Pliensbachian. SNGM 589 (Hillebrandt 720131/1); left valve, lateral view, x 1.5. Figs. 2-7, 9, 11-12. Myophorella (Myophorella) araucana (Leanza 1942). Quebrada Asientos, east of Potrerillos, locality 9; Figs. 2-4, 6, 9; Early/Late Pliensbachian, Fanninoceras fannini Zone; Figs. 5, 7, 11-12; Late Pliensbachian, Fanninoceras fannini Zone (F. fannini horizon). Figs. 2, 6. SNGM 604 (Hillebrandt 660708/8); articulated specimen, x 2. 2: dorsal view; 6: left valve view. Fig. 3. SNGM 606 (Hillebrandt 660708/8); right valve, lateral view, x 2. Fig. 4. SNGM 609 (Aberhan 1992: appendix I + III, horizon 2-81); right valve, lateral view, x 1.5. Fig. 5. SNGM 603 (Hillebrandt 660708/1); right valve, lateral view, x 1.5. Fig. 7. SNGM 598 (Hillebrandt 660708/1); right valve, lateral view, x 2. Fig. 9. SNGM 599 (Hillebrandt 660708/8); right valve, lateral view, x 2. Fig. 11. SNGM 596 (Hillebrandt 660708/1); right valve, lateral view, x 1.5. Fig. 12. SNGM 601 (Hillebrandt 660708/1); right valve, lateral view, x 1.5. Fig. 8. Myophorella (Myophorella) reginae sp. nov. La Guardia, 2.5 km west of Río Jorquera, south of Copiapó, locality 14; Late Toarcian. Pleydelia lotharingica Zone. SNGM 650 (paratype) (Hillebrandt 720108/8); left valve, lateral view, x 1.5. Fig. 10. Quadratojaworskiiella postulatae Reyes & Perez 1980. Quebrada Asientos, east of Potrerillos, locality 9; Early/Late Pliensbachian, Fanninoceras fannini Zone. SNGM 573 (Hillebrandt 660708/8); left valve, interior view, x 1.5.
Early Jurassic Bivalvia of northern Chile. Part III. Order Trigonioida
(Haidaia) volkheimeri LÉANZA & GARATE (1987), and M. (H.) elguetai LÉANZA (1993), with the exception of Myophorella (M.) signata of AGASSIZ (1840: 18-19, pl. 3, fig. 8, pl. 9, fig. 5) but not of GOTTSCHE (1878: 26, pl. 6, figs. 14a-b). In particular, the specimen figured by AGASSIZ (1840: pl. 9, fig. 5) corresponds well with M. bolitoensis in size and shape and the arrangement of the last costae in the median part of the flank, which bend in an anterior direction near the ventral margin. In contrast to M. signata (AGASSIZ 1840), the first post-umbonal costae of M. bolitoensis are irregular anteriorly, and, in the precarinal part, are less curved, more widely spaced, and terminate at an antecarinal sulcus. In paratype SNGM 645 (Pl. 13, Fig. 2) the costae are more regular.

Myophorella (Myophorella) reginae sp. nov.

Pl. 12, Fig. 8; Pl. 14, Figs. 1, 3-6, 8

1980 Myophorella n. sp. - HILLEBRANDT: 130, pl. 2, fig. 2.
1997 Myophorella n. sp. HILLEBRANDT - PÉREZ & REYES: 574.

Derivation of name. Dedicated to the Argentine palaeontologist Regina Levi, in honour of her contributions to the systematics of South American species of the bivalve order Trigonioida.

Material. 2 specimens from La Guardia (SNGM 649-650) and 3 from Quebrada Plaza (SNGM 653-655). SNGM 649-650, 653-654 (left valves, in part incomplete); SNGM 655 (fragment of right valve).

Holotype. SNGM 649 (Pl. 14, Figs. 1, 8), left valve with parts of the escutcheon poorly preserved (=HILLEBRANDT 1980: pl. 2, fig. 2).

Paratype. SNGM 650 (Pl. 12, Fig. 8).

Localities and age. La Guardia (Locality 14), III Región de Atacama, Late Toarcian, Pleydellia lotharingica Zone (HILLEBRANDT 1987); Quebrada Plaza (Locality 19), III Región de Atacama, Middle Toarcian, Phymatoceras toroense Zone? (HILLEBRANDT 1987).

Measurements (in mm).

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Diagnosis. Medium-sized Myophorella with moderately strong ornamentation; convex curvature of subumbonal costae near anterior margin becomes more pronounced in costae of the median and lower part of the flank.

Description. Shell medium-sized, ovate, inequilateral. Umbo small, moderately incurred, opisthogyrous, located anteriorly. Dorsal margin straight; anterior margin weakly convex; posterior margin straight; ventral margin convex. Area with narrow submedian groove, dividing area in a dorsal part and a ventral part, the latter being narrower; ornamentation composed of fine, dense, transverse costellae. Marginal carina low, blunt, curved, with small swellings. Internal carina with same characters as marginal carina. Escutcheon wide (4 mm), elongated, without ornamentation. Flank convex; costae with small tubercles, separated by somewhat wider interspaces; umbonal and first post-umbonal costae subconcentric, 1.5 mm in thickness, strongly curved toward anterior margin and marginal carina; anterior branch of median and lower post-umbonal costae progressively more convex near anterior margin of flank; precarinal branch of these costae straight, forming an acute angle with the marginal carina; distal costae of flank straight, divergent, intersecting the ventral margin; most distal costae convex. Narrow antecarinal sulcus becoming better defined in middle and distal parts.

Remarks. Myophorella reginae sp. nov. differs from M. catenifera (HUPE 1854: pl. 5, fig. 8; PHILIPPI 1899: pl. 36, fig. 5) by its more elongated shape, a less convex ventral margin, a less strongly curved marginal carina, median and lower post-umbonal costae that are convex near the anterior margin, and by the absence of bifurcating costae. It can be distinguished from M. araucana (LEANZA 1942: pl. 6, figs. 4-6) by a narrower antecarinal sulcus, finer and denser ornamentation of the area, more closely spaced flank costae with smaller tubercles, and by median and lower post-umbonal costae, which are more convex near the anterior margin. Compared with M. cf. tuberculata (AGASSIZ 1840) (in LEANZA 1993: pl. 1, fig. 9), the area is more finely ornamented, and the post-umbonal costae of the flank are not concentric.

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EXPLANATION OF PLATE 13

Figs. 1, 7. *Myophorella* (Myophorella) araucana (LEANZA 1942). Quebrada Asientos, east of Potrerillos, locality 9; Late Pliensbachian, Fanninoceras fannini Zone (F. fannini horizon). SNGM 597 (HILLEBRANDT 660708/1); left valve, x 2. 1: lateral view; 7: interior view.

Figs. 2-3, 5-6. *Myophorella* (Myophorella) bolitoensis sp. nov. Quebrada El Bolito, northeast of Copiapó, locality 12; Early Aalenian, Bredyia manflasensis Zone. Figs. 2, 5-6. SNGM 645 (paratype) (HILLEBRANDT 670222/11); left valve, x 1.5. 2: lateral view; 5: dorsal view; 6: interior view. Fig. 3. SNGM 646 (holotype) (HILLEBRANDT 670222/11); left valve, lateral view, x 1.5.

Figs. 4, 8, 10. *Scaphorella susanae* sp. nov. Quebrada El Bolito, northeast of Copiapó, locality 12; Late Toarcian. ‘Pleydellia fluitans’ Zone. SNGM 627 (HILLEBRANDT 670222/11); left valve, x 1.5. 4: dorsal view; 8: lateral view; 10: interior view.

Fig. 9. *Vaugonia hectorlearnzai* sp. nov. Sierra Limón Verde, south of Calama, locality 3; Late Sinemurian. SNGM 673 (HILLEBRANDT 751211/1a); left valve, interior view, x 1.5.
Differences between *M. reginae* and *Myophorella* (*M.*) sp. 2 (this study) are pointed out below. *M. reginae* differs from the specimen assigned to *Trigonia signata* *Agassiz* (1840) by *Gottschel* (1925: 258, pl. 6, figs. 14a-b) by a less convex anterior and a more strongly curved ventral margin, more densely arranged flank costae, narrower intercostal spaces near the marginal carina, and a convex undulation of the median and lower post-umbonal costae of the flank near the anterior margin.

*Myophorella* (*Myophorella*) *sp. 1*

Pl. 14, Figs. 2, 7

Material. 1 incomplete articulated specimen from Quebrada San Pedroito/Quebrada Pelado (SNGM 663).


Measurements (in mm).

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<td>22</td>
<td>7</td>
<td>0.64</td>
<td>0.32</td>
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Description. Specimen small-sized, trigonal-ovate, longer than high, inequilateral. Umbo small, weakly incurved, slightly opisthogyrous. Dorsal margin weakly concave; anterior margin weakly convex; posterior and ventral margins not preserved. Area narrow (2.5 mm) in median part and 5 mm in distal part; ornamented with thin, transverse costellae, two of which are each connected to a tubercle of the carinae. Marginal carina low, blunt, with small tubercles. Internal carina with widely spaced tubercles. Escutcheon elongated, excavated, smooth, 2 mm wide in median part. Anterior half of flank high and strongly convex; flank ornamented with thick (1.5 mm) costae, which bear small tubercles and which are separated by interspaces of about equal width; umbonal costae subconcentric, with radial striae typical of *Haidaia*; post-umbonal costae diverging from the marginal carina, curved in median part of flank and slightly undulating before meeting the anterior margin at an approximately right angle; distal costae diverge slightly and reach the ventral margin.

Remarks. The shape of the shell and the ornamentation of the flank of the studied specimen exhibit some similarity with *Myophorella* (*M.*) *tuberculata* (*Agassiz* 1840), in particular with the specimen figured on his plate 9, figs. 6-7, but differs by more densely spaced costae of the flank and a narrower area. The same differences exist to *Myophorella* (*M.*) *cf. tuberculata* in *Leanza* (1993: 29, pl. 1, fig. 9).

*Myophorella* (*Myophorella*) *sp. 2*

Pl. 14, Fig. 9

Material. 1 left valve from Quebrada Asientos (SNGM 665).


Measurements (in mm).

<table>
<thead>
<tr>
<th>Specimen</th>
<th>valve</th>
<th>H</th>
<th>L</th>
<th>W</th>
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Description. Specimen medium-sized, trigonal-ovate, longer than high, strongly inequilateral. Umbo not preserved. Dorsal margin concave; anterior and posterior margins moderately convex; ventral margin convex. Area occupying one-fourth of valve; ornamented with fine (5 per 3 mm), transverse costellae, which thicken toward posterior end (3 per 3 mm); intercostal spaces somewhat wider than costae. Marginal carina with medium-sized tubercles at the contact with the costellae of the area.

---

**EXPLANATION OF PLATE 14**

Figs. 1, 3-6, 8. *Myophorella* (*Myophorella*) *reginae* sp. nov. Figs. 1, 4, 5, 8. La Guardia, 2.5 km to the west, Río Jorquera, south of Copiapó, locality 14; Late Toarcian, Pleydellia lotharingica Zone. Figs. 1, 8. SNGM 649 (holotype) (*Hillebrandt* 720108/8); left valve, x 1.5: 1 lateral view, 8 dorsal view. Figs. 4-5. SNGM 653 (*Hillebrandt* 671013/2); left valve, x 2. 4: interior view; 5: lateral view. Figs. 3, 6. Quebrada Plaza, east of Embalse Lautaro, south of Copiapó, locality 19; Middle Toarcian, probably Phymatoceras toroense Zone. SNGM 654 (*Hillebrandt* 671013/2); left valve, x 2. 3: lateral view; 6: hinge.

Figs. 2, 7. *Myophorella* (*Myophorella*) *sp. 1*. Quebrada San Pedroito/Quebrada Pelado, northeast of Copiapó, locality 13; Early Aalenian, Bredyia manflasensis Zone. SNGM 663 (*Hillebrandt* 711215/5); articulated specimen, x 2. 2: left valve view; 7: right valve view.

Fig. 9. *Myophorella* (*Myophorella*) *sp. 2*. Quebrada Asientos, east of Potrerillos, locality 9; Late Pliensbachian, Fanninoceras fannini Zone (*F. fannini* horizon). SNGM 665 (*Hillebrandt* 660708/1); left valve, lateral view, x 1.5.

Figs. 10-14. *Scaphorella susanae* sp. nov. Quebrada San Pedroito/Quebrada Pelado, northeast of Copiapó, locality 13; Early Aalenian, Bredyia manflasensis Zone. Fig. 10. SNGM 621 (*Hillebrandt* 712115/5); left valve, lateral view, x 1.5. Fig. 11. SNGM 619 (*Hillebrandt* 712115/5); right valve, lateral view, x 2. Figs. 12, 14. SNGM 618 (paratype) (*Hillebrandt* 712115/5); right valve, x 1.5. 12: interior view; 14: lateral view. Fig. 13. SNGM 617 (holotype) (*Hillebrandt* 712115/5); right valve, lateral view, x 1.5.
Only distal part of internal carina preserved; tubercles developed at the contact with the costellae of the area. Escutcheon not observable. Anterior part of flank more convex than posterior part; ornamented with strong (1.5 mm) costae with tubercles; costae of anterior half of flank subconcentric and progressively wider spaced (4 mm) toward anterior end; costae of posterior half straight, divergent toward ventral margin, and with intercostal spaces equalling the width of costae.

Remarks. This specimen has affinities with *Myophorella (M.) reginae* sp. nov. However, the area lacks a submedian groove and the costellae are stronger and more widely spaced; the tubercles of the marginal carina are better developed; and the costae of the flank are more widely spaced, do not become convex at the anterior margin, and bear more prominent tubercles. *Myophorella (M.) sp. 2* differs from *Myophorella (M.) araucana* by the lack of an antecarinal sulcus, and by costae which are more subconcentric on the anterior part of the flank and straight posteriorly. Compared with *Myophorella* sp. 1, the area is wider, and the costae of the flank are stronger, more widely spaced, and bear more prominent tubercles.

**Genus Scaphorella LEANZA, PÉREZ & REYES 1987**

*Type species. Trigonia leanzai LAMBERT 1944, Middle Jurassic (Bajocian-Bathonian), Neuquén, Argentina.*

*Scaphorella susanae* sp. nov.

Pl. 13, Figs. 4, 8, 10; Pl. 14, Figs. 10-14; Pl. 15, Figs. 1-2, 4

**Derivation of name.** Dedicated to the Argentine palaeontologist Susana Damborenea, in honour of her valuable contributions to the knowledge of fossil bivalves in South America.

**Material.** 9 specimens from Quebrada San Pedrito/Quebrada Pelado (SNGM 617-624, 626) and 3 specimens from Quebrada El Bolito (SNGM 627-629). SNGM 617-620, 622, 624 (right valves, partly incomplete, 3 with hinge preserved); SNGM 621, 623, 626-629 (left valves, partly incomplete, 3 with hinge preserved).

**Holotype.** SNGM 617 (Pl. 14, Fig. 13; Pl. 15, Fig. 1), well preserved right valve with hinge.

**Paratypes.** SNGM 618 (Pl. 14, Figs. 12, 14); SNGM 620 (Pl. 15, Figs. 2, 4).

**Localities and age.** Quebrada El Bolito (locality 12), III Región de Atacama, Late Toarcian, ‘Pleydellia fluitans’ Zone (HILLEBRANDT & WESTERMANN 1985: 8; HILLEBRANDT & WESTERMANN 1987: 122); Quebrada San Pedrito/Quebrada Pelado (locality 13), III Región de Atacama, Early Aalenian, Bredyia manflasensis Zone (HILLEBRANDT & WESTERMANN 1985: 20).

**Measurements (in mm).**

<table>
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<th>Specimen</th>
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<th>H</th>
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<td>14</td>
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</table>

**Diagnosis.** Outline oval-elongated; anterior margin moderately convex; distal part of area with dense ornamentation; marginal carina curved; flank costae bearing small tubercles; antecarinal sulcus wide; smooth band between anterior and posterior costae lacking.

**Description.** Shell medium-sized, oval-elongated, longer than high. Umbo small, weakly incurved, opisthogyrous, situated anteriorly. Dorsal margin straight; anterior margin moderately convex; ventral margin convex; posterior margin slightly convex. Area occupying about one-fourth of the valve surface; ornamented with very fine transverse costellae, which become stronger in the distal half and are separated by interspaces of the same width as the costellae; submedian groove divides area into two asymmetrical parts: dorsal one narrower than ventral one, occupying only one-third of the area. Marginal carina narrow, markedly curved towards umbo; bearing small tubercles, which are progressively better defined toward posterior end, and which correspond to swellings of the costellae of the area. Internal carina of lesser relief, bearing widely spaced tubercles in anterior third, which change into obliquely arranged, clove-shaped swellings medially and posteriorly. Escutcheon elongated, excavated, smooth. Flank convex; distinctly demarcated from area by wide and subplanar antecarinal sulcus; ornamented with two sets of tuberculated costae. Umbonal costae of anterior fourth of valve subconcentric; post-umbonal costae extending from antecarinal sulcus to anterior margin, sinuous, occasionally dichotomizing. Posterior three-fourth of flank ornamented with moderately retroverse costae, extending from antecarinal sulcus to ventral margin. The holotype (SNGM 617; Pl. 15, Fig. 1) preserves tooth 3a (11 mm long, 1.5 mm thick) and tooth 3b (10 mm long, 1 mm thick).

**Remarks.** *Scaphorella susanae* sp. nov. differs from *Scaphorella leanzai* (LAMBERT 1944; pl. 1, figs. 5-6), the type species of the genus, by its ovaly elongated outline, a less convex shell surface, a more strongly curved anterior margin, finer and denser ornamentation of the distal part of the area, a curved marginal carina, and presence of a wide antecarinal sulcus. The anterior costae of the flank are more densely spaced and sinuous, and the costae of the mesial and posterior parts of the flank are more widely spaced near the marginal carina. *Myophorella cf. argo* (POULTON 1979, non CRICKMAY 1930), was considered to be conspecific with *Scaphorella leanzai* (LAMBERT 1944) by LEANZA et al. (1987). *Scaphorella susanae* sp. nov. can be distinguished from *Scaphorella kruusei* (LEANZA & GARATE 1987; pl. 4, fig. 1) by a moderately convex anterior margin, a finer and denser ornamentation of the area, a curved marginal carina, the presence of an antecarinal sulcus, and absence of a smooth band between...
the anterior and posterior costae of the flank. It differs from Scaphorella camachoii (Leanza 1993: pl. 3, figs. 12-13) by its larger size, a more strongly convex anterior margin, a more densely ribbed flank both anteriorly and posteriorly, and less strongly developed tubercles.

The studied specimens of S. susanae exhibit variations in the anterior ornamentation of the flank. In paratype SNGM 618 (Pl. 14, Fig. 14), the costae of the anterior fourth of the flank are more widely spaced, and the separation between anterior and posterior costae is less well defined than in the holotype (Pl. 14, Fig. 13).

### Family Vaugoniidae Kobayashi 1954

#### Subfamily Vaugoniinae Kobayashi 1954

Genus Vaugonia Crickmay 1930

Type species. Vaugonia veronica Crickmay 1930, Middle Jurassic, British Columbia, Canada.

Vaugonia hectorleanzai sp. nov.

Pl. 13, Fig. 9; Pl. 15, Figs. 3, 5-11;
Pl. 16, Figs. 1, 3, 8-9, 11-12, 14-15

1980 Vaugonia n. sp. - Hillebrandt: 130, pl. 2, fig. 1.
1981 Vaugonia n. sp. (cf. V. oregonensis Poulton) - Hillebrandt: 30.

Derivation of name. In honour of the Argentine palaeontologist Héctor A. Leanza for his valuable contributions to the knowledge of the bivalve order Trigonioida in South America.

Material. 11 specimens from Quebrada Chancoquín/Paitepén (SNGM 630-640), 3 from Moctezuma (SNGM 641-643), and 2 from Sierra Limón Verde (SNGM 644, 673). SNGM 634-635, 637, 642-644 (right valves, partly incomplete, 1 with part of the hinge preserved); SNGM 630, 632-633, 636, 638-639, 641, 673 (left valves, some partly incomplete, 1 with hinge preserved); SNGM 631, 640 (articulated specimens).

Holotype. SNGM 631 (Pl. 15, Figs. 5-7), articulated specimen with incomplete posterior margin (= Hillebrandt 1980: pl. 2, fig. 1).

Paratypes. SNGM 632 (Pl. 15, Figs. 3, 10-11); SNGM 644 (Pl. 16, Figs. 8, 14-15).

Localities and age. Quebrada Chancoquín/Paitepén (locality 18b), III Región de Atacama, Early Toarcian, Dactylioceras hoelderi Zone (Hillebrandt & Schmidt-Effing 1981: 30, fig. 11); Moctezuma (locality 2), II Región de Antofagasta, Early Toarcian, between limestones with Late Pliensbachian ammonites (upper part of Fanninoceras disciforme Zone, horizon with Protogrammoceras (Argutarpites) cf. meneghinii) and limestones with Early Toarcian ammonites (Dactylioceras hoelderi Zone?) (Perez & Lev 1961; Hillebrandt 2002: 9 and this study); Sierra Limón Verde (locality 3), II Región de Antofagasta, Late Sinemurian, lower part of Asteroeroceras obtusum Zone (Hillebrandt 2002: 42).

Measurements (in mm).

<table>
<thead>
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<th>Specimen valve</th>
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<th>W</th>
<th>H/L</th>
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<td>9</td>
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Diagnosis. Shell medium-sized; carinae poorly developed; costae smooth and narrow in anterior and median parts of flank, stronger and tuberculated in posterior part. First post-umbonal costae V-shaped; following costae broadly curved, bending before reaching the anterior margin, a feature which becomes less pronounced ventrally.

Description. Shell medium-sized, longer than high, subrectangular, inequilateral. Umbro small, opisthogyrous, weakly incurved. Anterior margin slightly convex; dorsal margin long and weakly concave; posterior margin short and straight; ventral margin moderately convex. Area representing about one-fourth of the valve surface; ornamented with dense, transverse costellae, becoming more irregular and sinuous toward distal end; costellae separated by interspaces of equal width; submedian sulcus subtle, dividing area into two asymmetrical parts, the dorsal one smaller than ventral one. Marginal carina weakly developed and with transverse swellings coinciding with the ornamentation of the area. Internal carina defined by enlargements of the costae of the area. Escutcheon wide, excavated, elongated, with diagonal striae forming an acute angle with dorsal margin. Flank moderately convex; umbral costae concentric; first post-umbonal costae V-shaped, forming an acute angle. Anterior branch of subsequent costae meeting anterior margin at a right angle, undulating and declining toward central part of flank to meet with the ascending posterior branch of costae; posterior costae stronger, tuberculated, meeting marginal carina at an acute angle. Anterior set of ventral costae narrow, undulating or dichotomized, running parallel to ventral margin and curving into posterior set of costae, which are stronger, tuberculated and almost straight, before meeting the marginal carina at an acute angle. Paratype SNGM 632 (Pl. 15, Fig. 11) preserves tooth 2 (3.5 mm high, 7 mm long at base), tooth 4a (7 mm long, 1.5 mm thick) and tooth 4b (5 mm long, ca. 1 mm thick). Paratype SNGM 644 (Pl. 16, Fig. 8) exhibits tooth 3a (ca. 11 mm long, 3 mm thick).

Remarks. V. hectorleanzai sp. nov. has affinities with Vaugonia lycetti (Gottschie 1878) regarding the elongated outline and the poorly developed carinae. It differs by less accentuated V-shaped inflections of the flank costae. Only the earliest costae form an acute angle, whereas the remaining costae form a wide curvature with an obtuse angle of divergence between anterior and posterior sets of costae. Furthermore, the anterior flank costae lack tubercles and present a distinct trajectory, being perpendicular to the anterior margin and undulating posteriorly before descending toward the median of the flank. The posterior costae are simpler, run parallel to the ventral
margin and exhibit a weak curvature when approaching the marginal carina. In his description of *Trigonia lyctetti*, Gottschke (1878: 26, pl. 6, fig. 3a) mentioned the presence of intercalated anterior costae which give rise to an irregular bifurcation pattern. The studied specimens of *V. hectorleanzai* sp. nov. do not exhibit free secondary costae, but the holotype (SNGM 631, Pl. 15, Figs. 6, 7) displays bifurcating anterior costae.

In shape and style of ornamentation *V. hectorleanzai* sp. nov. resembles *V. oregonensis* Poulton (1979) from the Upper Pliensbachian of Oregon (Poulton 1979: 23, pl. 10, figs. 14-19). *V. hectorleanzai* differs from this species by the presence of transverse tubercles on the internal carina which correspond to expansions of the costae of the area. In contrast, the internal carina of *V. oregonensis*, known from a single specimen only, forms a sharp but simple edge between the area and the escutcheon (Poulton 1979: 23). *V. hectorleanzai* also differs by more strongly V-shaped costae and by the posterior set of costae bearing small tubercles, which are neither observed on the specimens figured by Poulton nor are mentioned in the text.

**Vaugonia cf. gottschei** (Morikke 1894)

Pl. 16, Figs. 2, 4-6, 13

cf. 1894 *Trigonia gottschei* sp. nov. - Morikke: 49-50, pl. 6, figs. 7-8.

cf. 1977 *Vaugonia (Vaugonia) gottschei* (Morikke) - Perez & Reyes: 16-17, pl. 3, fig. 15.

Material. 42 specimens from Quebrada Las Pircas (SNGM 651-1-42) and 1 from Quebrada La Totoro/Quebrada El Corral (SNGM 652). SNGM 651-11, 651(41) (incomplete right valves); SNGM 651-1 (fragment of the flank); SNGM 651(10), (12-17), (19-40), (42) (articulated specimens); SNGM 652 (articulated specimen).

Localities and age. Quebrada La Totoro/Quebrada El Corral (locality 17), III Región de Atacama, Late Toarcian (Hillebrandt, this study); Quebrada Las Pircas (locality 20), III Región de Atacama, Pliensbachian? (Hillebrandt, this study).

Measurements (in mm).

<table>
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<th>Specimen valve</th>
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<td>6.0</td>
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Description. Shell (SNGM 652; Pl. 16, Figs. 2, 4) small-sized, longer than high, subrectangular. Umbro opisthogyrous, incurved. Anterior margin moderately convex; ventral margin convex; dorsal margin weakly concave; posterior margin straight. Area (SNGM 651-33; Pl. 16, Figs. 5, 13) 5 mm wide in median part; ornamented with transverse, widely separated costellae, which become fine striae in median and distal parts of area. Marginal carina (SNGM 651-40) formed by row of small tubercles. Internal carina with transverse swellings, which are more widely spaced than tubercles of marginal carina. Esclutcheon (SNGM 652; Pl. 16, Fig. 4) elongated, excavated, 3.0 mm wide in median part; ornamented with fine radial striae (SNGM 651-29). Flank (SNGM 651-33; Pl. 16, Fig. 5) moderately convex; with fine, tuberculated costae; umbonal costae varying from subconcentric to angular; remaining costae V-shaped, forming a variably acute angle; trajectory of anterior set of costae subhorizontal, somewhat curved near the anterior margin; posterior set of costae forming an acute angle with the marginal carina. Latest posterior costae diverge and reach the ventral margin. Antecarinal sulcus developed in distal part of flank.

Remarks. *Vaugonia cf. gottschei* differs from *V. gottschei* (Morike 1894: pl. 6, figs. 7-8) by a lower number of V-shaped costae which also are more widely spaced. The latter is also true of the divergent distal costae. The studied specimens are similar to *Vaugonia exotica* (Morikke 1894: pl. 1, fig. 9, pl. 6, fig. 9) regarding the subconcentric umbonal costae of the flank, the intercostal spaces being wider than the costae, and the presence of an antecarinal sulcus in the distal part of the flank. They differ, however, by the presence of markedly angular costae.

**Vaugonia cf. substriata** (Burmeister & Giebel 1861)

Pl. 16, Fig. 7

cf. 1861 *Trigonia substriata* sp. nov. - Burmeister & Giebel: 24, pl. 2, fig. 4.

cf. 1899 *Trigonia substriata* Burmeister & Giebel - Philipp: 87, pl. 36, fig. 10.

cf. 1977 *Vaugonia (Vaugonia) substriata* (Burmeister & Giebel) - Perez & Reyes: 19, pl. 3, fig. 7.

**EXPLANATION OF PLATE 15**

Figs. 1-2. *Scaphorella susanae* sp. nov. Quebrada San Pedrito/Quebrada Pelado, northeast of Copiapó, locality 13; Early Aalenian, Bredyia manflasensis Zone. Fig. 1. SNGM 617 (holotype) (Hillebrandt 71215/5); right valve, interior view, x 1.5. Figs. 2, 4. SNGM 620 (paratype) (Hillebrandt 711215/5); right valve, x 1.5. 2: interior view; 4: lateral view.

Figs. 3, 5-11. *Vaugonia hectorleanzai* sp. nov. Figs. 3, 5-7, 9-11. Quebrada Chanchoquin-Paitepen, southeast of Vallenar, locality 18b; Early Toarcian, Dactylioceras hoelderi Zone. Figs. 3, 10-11. SNGM 632 (paratype) (Hillebrandt 671012/5b); left valve, x 2. 3: dorsal view; 10: lateral view; 11: interior view. Figs. 5-7. SNGM 631 (holotype) (Hillebrandt 671012/5b); articulated specimen, x 1.5; 5: dorsal view; 6: right valve, lateral view; 7: left valve, lateral view. Fig. 9. SNGM 633 (Hillebrandt 671012/5b); left valve, lateral view, x 2. 8. Moctezuma, south of Calama, locality 2; Early Toarcian. SNGM 641 (Hillebrandt 860311/14); left valve, lateral view, x 1.5.
Material. 4 variously incomplete right valves (SNGM 656-657, 659, 661) and 3 incomplete left valves (SNGM 658, 660, 662) from Quebrada Pinte.

Localities and age. Quebrada Pinte (locality 21), Región de Atacama, Middle Toarcian, Collina chilensis Zone (Hillebrandt 1987: 120).

Measurements (in mm).

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Description. Shell (SNGM 657; Pl. 16, Fig. 7) medium-sized, longer than high, subrectangular, inequilateral. Umbo small, opisthogyrous, incurved. Anterior and ventral margins moderately convex; dorsal and posterior margins not preserved. Area occupying about one-fourth of shell surface; ornamented with transverse striae. Marginal carina narrow, moderately developed, blunt, with small nodes. Interior carina less developed, with somewhat more prominent and widely spaced nodes. Escutcheon excavated, elongated, smooth; width in median part almost one-half the width of area. Flank moderately convex; ornamented with tuberculated costae (1.5-2.0 mm thick, interspaces 3.0 mm wide); umbonal costae subconcentric; post-umbonal costae weakly sinusous near anterior end; distal costae curved, moderately divergent, reaching the ventral margin.

Remarks. Due to the poor preservation of the specimens, the majority of which are fragmented and do not preserve features of the area, the studied material can only be referred to *V. substriata* with reservation. Morphological characters which agree with *V. substriata* include the elongated shell outline, arrangement of the flank costae and their undulation near the anterior margin, and the presence of small tubercles. The specimens can also be compared to *Vaugonia exotica* (Mörcke 1894) regarding the style of ribbing and the development of the tubercles.

In this species, however, the costae are not sinusous near the anterior margin.

**Vaugonia** sp. 1

Pl. 16, Fig. 10

Material. 1 incomplete right valve from Quebrada Plaza (SNGM 664).

Localities and age. Quebrada Plaza (locality 19), III Región de Atacama, Middle Toarcian, Phymatoceras toroense Zone? (Hillebrandt 1987).

Measurements (in mm).

<table>
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<th>Specimen</th>
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Description. Specimen medium-sized. Umbo small, opisthogyrous. Dorsal margin moderately concave; anterior margin weakly convex; ventral and posterior margins not preserved. Area occupying about one-fourth of the shell surface; ornamentation partly preserved with a few weak costellae in anterior third of area. Marginal and internal carinae poorly preserved; the former is better developed, narrow and blunt. Escutcheon narrow, excavated. Flank with high, 1.5 mm wide, tuberculated costae, separated by slightly wider (2 mm) interspaces. Umbonal costae concentric to subconcentric; subsequent costae becoming more and more L-shaped with a better developed set of posterior costae diverging from the carina, and a less developed anterior set of costae, which bend to meet the anterior margin at a sub-perpendicular angle. Distal part of flank not preserved.

Remarks. The single available fragment of a right valve does not preserve sufficient diagnostic characters to allow an identification at species level. The style of ornamentation of the flank resembles that of the juvenile specimen of *Vaugonia lycetti* figured by Gottsche (1878):
pl. 6, fig. 4). It differs by more widely spaced and less angular costae.

**Vaugonia sp. 2**

Pl. 16, Fig. 16

Material. 1 incomplete left valve from Quebrada Asientos (SNGM 666).

Locality and age. Quebrada Asientos (locality 9), III Región de Atacama, Late Pliensbachian, Fanninoceras fannini Zone, horizon with *F. fannini* (Hillebrandt 1987: 120; 2006).

Measurements (in mm).

<table>
<thead>
<tr>
<th>Specimen</th>
<th>valve</th>
<th>H</th>
<th>L</th>
<th>W</th>
<th>H/L</th>
<th>W/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNGM 666</td>
<td>lv</td>
<td>28</td>
<td>49</td>
<td>[11]</td>
<td>0.57</td>
<td>0.22</td>
</tr>
</tbody>
</table>

Description. Specimen medium-sized, subrectangular, inequilateral. Umbo opisthogyrous. Anterior margin moderately convex; ventral margin convex; posterior margin straight; dorsal margin not preserved. Area occupying about one-fourth of the shell surface. Marginal carina blunt and apparently without tubercles. Internal carina less developed, with small tubercles. Escutcheon not observable. Flank moderately convex; post-umbonal part ornamented with strong costae, diverging from the carina to form a V-shaped to L-shaped inflection in the anterior half of the flank; toward the anterior margin costae continue in a zigzag pattern, which becomes sinuous near the ventral margin; diverging costae reaching the ventral margin in the posterior half of the flank; intercostal spaces equivalent to the width of the costae near the marginal carina, increasing in anterior and ventral directions.

Remarks. The zigzag pattern of the anterior costae of *Vaugonia* sp. 2 is an outstanding feature, which has not been observed in any other known species of this genus in South America. It is only known from some specimens of *Andivaugonia fuenzalidai* (Reyes & Pérez 1984; SNGM 7436). *Andivaugonia* is closely related to *Vaugonia*, but so far is confined to the Lower Bajocian to Lower Callovian of Chile and Argentina (Leanza 1993).

?Trigonioida indet.

Pl. 8, Figs. 2, 7; Pl. 9, Fig. 3

1992 Trigonidae gen. et sp. nov. - Aberhan: 143, 147.

Material. 2 incomplete right valves (SNGM 677, 682) and 4 incomplete left valves (SNGM 678-681) from Quebrada Pinte.

Locality and age. Quebrada Pinte (locality 21), III Región de Atacama, Late Sinemurian (Hillebrandt, this study).

Measurements (in mm).

<table>
<thead>
<tr>
<th>Specimen</th>
<th>valve</th>
<th>H</th>
<th>L</th>
<th>W</th>
<th>H/L</th>
<th>W/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNGM 679</td>
<td>lv</td>
<td>[11]</td>
<td>32</td>
<td>[7]</td>
<td>0.34</td>
<td>0.21</td>
</tr>
<tr>
<td>SNGM 677</td>
<td>rv</td>
<td>[13]</td>
<td>20</td>
<td>[6]</td>
<td>0.65</td>
<td>0.30</td>
</tr>
</tbody>
</table>

Description. Shell medium-sized, subrectangular, oblong, inequilateral. Umbo small, elevated, incurved, weakly opisthogyrous. Anterior and ventral margins moderately convex; posterior margin straight; dorsal margin poorly preserved. Area occupying about one-third of shell surface, forming an obtuse angle with flank; smooth except for fine growth lines. Marginal carina high, blunt, smooth, curved toward umbo. Internal carina less developed. Escutcheon moderately excavated. Flank subplanate anteriorly and inclined in antecarinal part. Anterior part of flank ornamented with concentric, blunt costae of about 1 mm thickness; intercostal spaces becoming progressively wider than costae ventrally; ornamentation weakening toward marginal carina, developing into a wide and smooth precarinal zone.

Remarks. The preserved morphological features suggest an assignment to the Trigonoida, although this cannot be confirmed at present, due to the incomplete preservation and lack of information on hinge characters. Presence of a smooth area, a well developed marginal carina, concentric costae on the anterior half of the flank, and a wide precarinal zone without ornamentation tentatively suggest the existence of a new taxon within the subfamily Laevitrigoniinae Saveliev 1958.

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We would like to thank F. T. Fürsich (Würzburg), H. A. Leanza (Buenos Aires), and T. P. Poulton (Calgary) for reviewing the manuscript. We also wish to thank the Servicio Nacional de Geología y Minería (Sernageomin, Chile) for the offered facilities. F. Morales and N. Espinoza (Sernageomin), and E. Siebert (Berlin) produced the text-figures; W. Harre (Berlin) and F. Guerra (Sernageomin) carried out the photographic work.

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Appendix. Localities yielding the trigonioid bivalves described in this study, with information on associated faunas and stratigraphic position. See also text-fig. 1.

Location 1. West of Quillagua (21°39'S; 69°32'W), II Región de Antofagasta, northern Chile (Hillebrandt 2000a, b).

- Prosogyrotrigonia tenuis sp. nov. associated with Phylloceras chilense, Badouxiella canadensis, Badouxi cf. canadensis?, Paracaloceras sp., Pseudatemoceras? sp., Schreinbachites? sp. B, and serpulids (Hillebrandt 2000a, b). Grey limestone. Late Hettangian, Badouxiella canadensis Zone (Paracaloceras varaneza Subzone) and horizon with Pseudatemoceras arcuatum (Hillebrandt 2000a, b).


- Vaugonia hectorleanzai sp. nov. No associated fauna. Limestone with silicified fauna. Late Sinemurian, Asteroceras obtusum Zone (Hillebrandt 2002).

- Jaworskiella sp. No associated fauna. Sandstone. Late Sinemurian, Asteroceras obtusum Zone (Hillebrandt 2002).

Location 4. Cerros de Cuevitas (23°34’S; 69°55’W), northeast of Antofagasta, II Región de Antofagasta, northern Chile (Hillebrandt 2000a, b).

- Prosogyrotrigonia tenuis sp. nov. associated with Coroniceras? sp. A and Angulatifera cf. ventricosum (Hillebrandt 2000b). Late Hettangian, Badouxiella canadensis Zone, Schlotheimia cuevitensis Subzone (Hillebrandt 2000b) and earliest Sinemurian, horizon with Coroniceras aff. conybeari (Hillebrandt 2000a: fig. 2, section 1).

Location 5. Quebrada Cachina (25°54’S; 70°35’W), south of Taltal, II Región de Antofagasta, northern Chile (Hillebrandt 2000b).

- Quadratojaworskiiella acarinata sp. nov. associated with Psiloceras perezi, Schlotheimia? cachinensis, Psilocerites sp., and gastropods. Limestone with ammonites, bivalves, and gastropods (Hillebrandt 2000b: 129). Middle/Late Hettangian, Sunrisites peruianus Zone (Hillebrandt 2000b).

Location 6. Quebrada Doña Inés Chica (26°00’S; 69°10’W), northeast of El Salvador, III Región de Atacama (Hillebrandt 1990: 40; 2002: 46).

- Prosogyrotrigonia sp. 3. No associated fauna. Sandstone. Late Hettangian or earliest Sinemurian (Hillebrandt 2002;
this study).

**Locality 7.** Quebrada Pan de Azúcar (26°02'S; 70°28.5'W), ca. 10 km southwest of Las Bombas, III Región de Atacama.


**Locality 8.** Portezuelo Pedernales (26°20'S; 69°16'W), northeast of Potrerillos, III Región de Atacama, northern Chile (HILLEBRANDT & SCHMIDT-EFFING 1981: fig. 2, section 16).


**Locality 9.** Quebrada Asientos (26°27’S; 69°20’W), east of Potrerillos, III Región de Atacama, northern Chile (HILLEBRANDT & SCHMIDT-EFFING 1981).


**Locality 10.** Quebrada Yerbas Buenas (27°03’42’S; 69°37’12’W), north of Vallenar, III Región de Atacama, northern Chile (HILLEBRANDT & SCHMIDT-EFFING 1981: fig. 1, section 9).


**Locality 11.** Vega Redonda (27°08’S; 69°00’W), northeast of Copiapó, III Región de Atacama, northern Chile (HILLEBRANDT 1973: 184, fig. 3).

- *Psilotrigonia vegaensis* sp. nov. associated with ‘Terebratula’ sp. and *Lisothrochus* sp. Limestone. Late Sinemurian or Early Pliensbachian (HILLEBRANDT this study).

**Locality 12.** Quebrada El Bolitó (27°09’S; 69°33’W), northeast of Copiapó, III Región de Atacama, northern Chile (HILLEBRANDT & SCHMIDT-EFFING 1981: fig. 5).


**Locality 13.** Quebrada San Pedrito/Quebrada Pelado (27°15’S; 69°40’W), III Región de Atacama, northern Chile (HILLEBRANDT & WESTERMANN 1985: 9).


**Locality 14.** La Guardia (27°42’S; 69°37’W), 2.5 km to the west, Río Jorquera, south of Copiapó, III Región de Atacama, northern Chile (HILLEBRANDT & SCHMIDT-EFFING 1981: 23, fig. 1, section 14c).

(Hillebrandt 1987).

**Locality 15.** Hacienda Manflas (28°08’S; 69°58’W), northeast of Vallenar, III Región de Atacama, northern Chile (Hillebrandt & Westermann 1985: 12, locality 4).

- *Neuquenitrigonia huenickeni* (Leanza & Garate 1985) associated with *Mesomiltha* sp., *Protocardia* sp., *Neocrassina anium* (Gottsch), *Trigonastarte’* steinmanni (Morice), *Sphaerocoeloceras brochiiformis* Jaworski, Bredya manflasensis Hillebrandt & Westermann, and *B. delicata* Hillebrandt & Westermann (Hillebrandt this study). Early Aalenian, Bredya manflasensis Zone (Hillebrandt & Westermann 1985; Hillebrandt 2001).

**Locality 16.** Río Manflas (28°12’S; 70°01’W), northeast of Vallenar, III Región de Atacama, northern Chile (Hillebrandt & Schmid-Effing 1981: 24, fig. 1, section 16).


**Locality 17.** Quebrada La Totora/Quebrada El Corral (28°44’S; 70°15’W), southeast of Vallenar, III Región de Atacama, northern Chile (Abernian 1992: section 4).


**Locality 18a.** Quebrada Chancoquiñ/Paitepén (28°47’S; 70°15’W), southeast of Vallenar, III Región de Atacama, northern Chile (Hillebrandt & Schmid-Effing 1981: fig. 2, section to the left, about 140 m above the base; Hillebrandt 2002: fig. 2b, loc. 21; 2006: fig. 8).

- Groebarella nequensis (Groebre 1924) associated with *Gryphaea tricarinata* Philippi, Actinostreon costatum (J. de C. Sowerby), *Pseudolimea duplicata* (J. de C. Sowerby), *Pseu-

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Weyla alata (von Buch), and Lucina chubutensis Wanish. Late Sinemurian (Hillebrandt this study).

**Locality 22.** Eastern Punilla (eastern flank) (29°40’S; 70°16’W), northeast of La Serena, IV Región de Coquimbo, northern Chile (Thiele 1964).


**Locality 23.** Quebrada del Pobre (32°25.5’S; 71°12’W), northeast of La Ligua, V Región de Valparaíso, central Chile.

- Jaworskiella gryphitica (Moricke 1894) associated with Paltechioceras sp. Quebrada del Pobre Formation (Thomas 1958). Late Sinemurian, Echioceras raricostatum Zone (Hillebrandt 2002: 52).