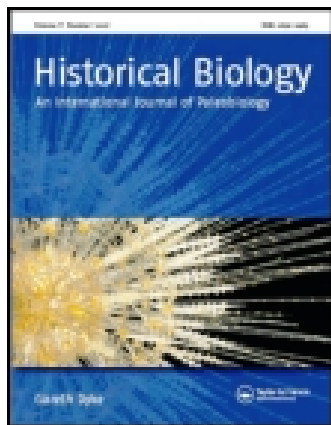


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Patellogastropoda and Vetigastropoda (Mollusca, Gastropoda) from the marine Jurassic of Patagonia, Argentina

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Patellogastropoda and Vetigastropoda (Mollusca, Gastropoda) from the marine Jurassic of Patagonia, Argentina

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Gastropod faunas from the Early Jurassic (Late Pliensbachian–Early Toarcian) marine deposits of Chubut Province, Argentina, are described from Lomas Occidentales, Cerro La Trampa and Puesto Currumil localities, representing eight species, three of them new. These are *Scurriopsis?* sp., *Chartronella gradata* sp. nov., *Calliotropis?* sp., *Pleurotomaria* sp., *Leptomaria* sp., *Hamusina? wahnishae* sp. nov., *Colpomphalus musachioi* sp. nov. and *Jurassiphorus? cf. triadicus* Haas. The gastropod assemblage reported here testifies paleobiogeographical connections with other coeval gastropod associations from the western Tethys. However, *Chartronella*, *Hamusina* and *Jurassiphorus* may represent survivors of Triassic associations, considering the ancient seaway from Peru as the most plausible hypothesis for biotic exchange of these faunas during the Late Triassic–Early Jurassic boundary. An abundant and diverse invertebrate fauna such as corals, echinoderms, cephalopods, brachiopods, bivalves and other gastropods found in association with the gastropods described here characterises a shallow marine environment for the gastropod-bearing rocks.

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Keywords: Gastropoda; paleobiogeography; paleoecology; Jurassic; Patagonia

1. Introduction

Early Jurassic gastropod faunas from South America were studied by Bayle and Coquand (1851), Gottsche (1878, 1925), Behrendsen (1891, 1922), Möricke (1894), Burckhardt (1900, 1902), Jaworski (1925, 1926a, 1926b), Weaver (1931), Feruglio (1934), Piatnitzky (1936, 1946), Wahnish (1942), Gründel (2001), Damborenea and Ferrari (2008) and Ferrari (2009, 2011a, 2011b, 2012, 2013). Ferrari (2009, 2011a, 2011b, 2012, 2013) pointed out that some new genera were cosmopolitan being known from the southern hemisphere and Europe, but represented by local species in west-central Patagonia and other localities of Argentina and Chile.

This paper describes a new and fairly diverse gastropod fauna from the Lower Jurassic marine deposits of Osta Arena and Mulanguíñeu formations that crop out over wide areas of Chubut Province, Argentina (Figure 1). Members of Patellogastropoda and Vetigastropoda are recovered from Lomas Occidentales, Cerro La Trampa and Puesto Currumil (named 'El Córdoba' by Ferrari 2009; Pagani et al. 2011) localities (Figure 1), comprising eight species; three of them are new. Most of the species reported here have not been known from Argentina, being *Scurriopsis*, *Calliotropis*, *Leptomaria*, *Hamusina* and *Jurassiphorus* the first mention of these genera for the South American Jurassic. The gastropod assemblage had a distribution extending over the Andean region from northern Peru to Argentinean

Patagonia and also testifies paleobiogeographical connections with other coeval gastropod associations from the western Tethys, Peru, Antarctica, New Zealand, western India and eastern Africa. The new species *Chartronella gradata*, *Hamusina? wahnishae* and *Colpomphalus musachioi* are only known, until now, from Chubut Province and lived from the Late Pliensbachian to the Early Toarcian. The genera *Chartronella*, *Hamusina* and *Colpomphalus* may represent survivors of Peruvian Triassic associations, considering the ancient seaway from Peru as the most plausible hypothesis for biotic exchange of these faunas during the Late Triassic–Early Jurassic boundary. An abundant and diverse invertebrate fauna composed by corals, echinoderms, cephalopods, brachiopods, bivalves and other gastropods is found in association with the gastropods. The whole mollusc taxa characterise a marine sedimentary environment dominated by shallow, agitated and oxygenated waters.

In general, the gastropod species described here are represented by fragmentary and recrystallised specimens in which its shells lack external morphology details such as surface ornamentation of whorls and other diagnostic features. The taphonomic events during the deposition of marine sediments had an important role in the conservation of the shells, and are shown in their poorly preserved conditions. The material 'in situ' is preserved in fine- to medium-grained sandstone beds where shallow and

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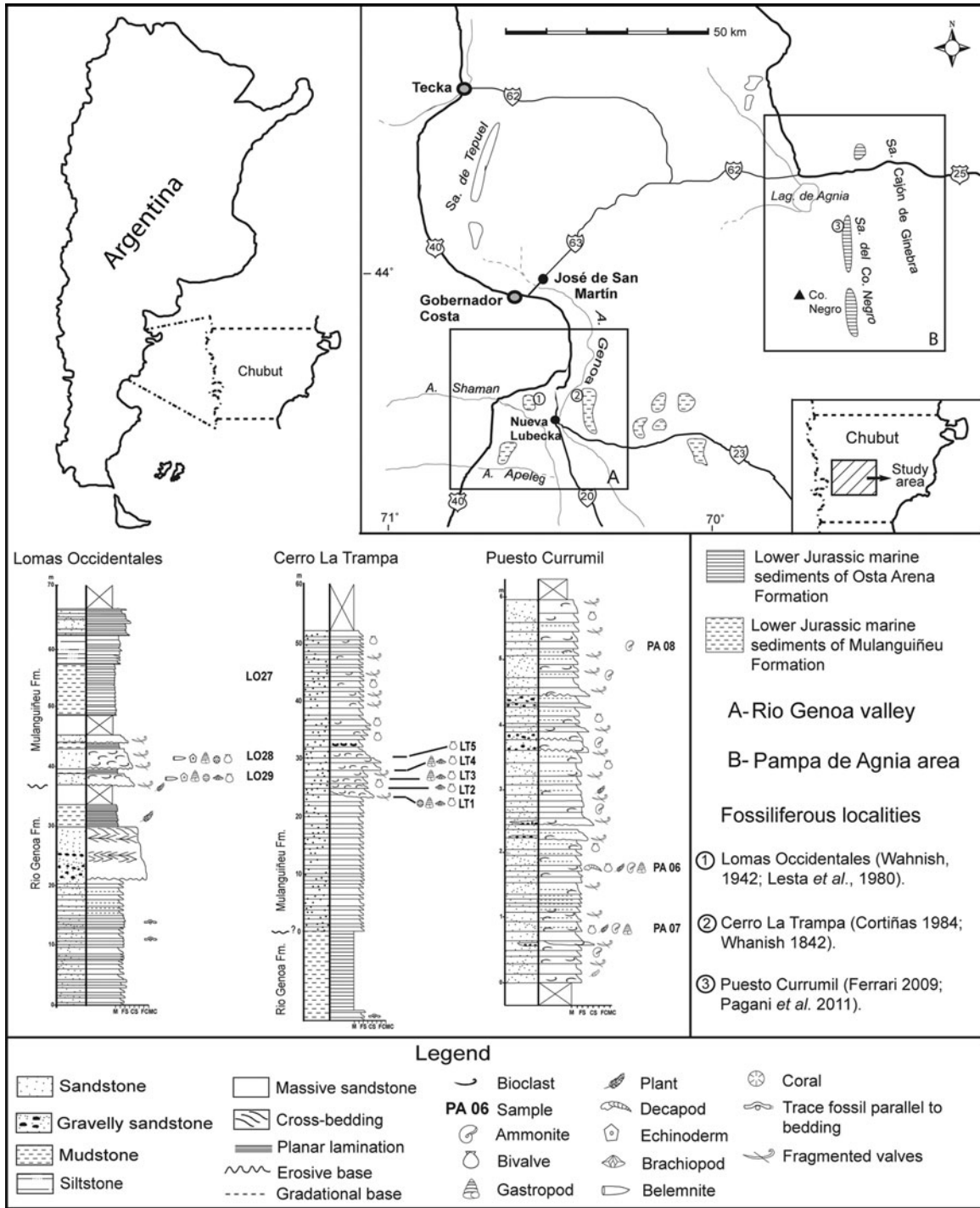


Figure 1. Map of southwestern Chubut Province showing the localities of the new gastropod fauna in Patagonia. General views and stratigraphical sections of each locality are shown. Stratigraphical sections are modified from Pagani *et al.* (2011) and Ferrari 2013.

high-energy marine environments were predominant. The most fragmentary specimens were not preserved ‘*in situ*’ and are represented by broken shells, pointing to the presence of post-mortem transport and revealing also transport prior to burial. Even though the material is fragmentary, it is mostly determinable.

2. Geological and stratigraphical setting

Early Jurassic sediments in the Chubut Province are distributed along a NW–SE belt of outcrops between 42°30’ and 44°30’S and between 69°30’ and 71°W (Riccardi 1983; Giacosa and Márquez 1999). The sediments rest unconformably on upper Paleozoic rocks

of the Tepuel Group. In the southwestern region of Chubut Province, the lower Jurassic marine deposits crop out in the Ferraroti and Nueva Lubecka areas and are referred to the Mulanguiñeu Formation (Fernández Garrasino 1977), originally described as ‘Seria marina con *Vola* y *Cardinia*’ by Suero (1952, 1953, 1958). The most extensive outcrops of this unit are on the western slope of Salar de Ferraroti and Lomas Occidentales near Río Genoa valley (Figure 1), where the unit lies unconformably on upper Paleozoic marine sediments of the Río Genoa Formation (Figure 2). The associated marine invertebrate fauna includes corals (e.g. *Montlivaltia* sp.), bivalve species (*Cardinia* cf. *andium* (Giebel), *Frenguelliella* cf. *tapiai* (Lambert), *Kolymonectes coloradoensis* (Weaver), *Neocrassina aurelia* (Feruglio), *Entolium* sp., *Chlamys* sp., *Gryphaea* sp., *Pholadomya* sp., *Weyla* sp., few gastropod species including *Globularia catanlilensis* (Weaver) and ammonites of the Hildoceratidae group (i.e. *Dactylioceras* sp.). The occurrence of all these taxa suggests that the Mulanguiñeu Formation is Lower Jurassic (Pliensbachian–Toarcian).

In Río Genoa area (Figure 1(A)), Lomas Occidentales locality (Wahnish 1942; Lesta et al. 1980) is located west

of the old telegraphic station of Nueva Lubecka (Figure 1(1); Ferrari 2011a), and Cerro La Trampa locality (Figure 1(2)) is situated east from the old telegraphic station (Wahnish 1942; Cortiñas 1984) (Figure 1). In the Pampa de Agnia area (Figure 1(B)), the Jurassic succession begins with ignimbrites and tuffites of the Puntado Alto Formation (Herbst 1966, 1968) which are of continental origin and yield plants of Early Jurassic age (Riccardi 1983). The Puntado Alto Formation is overlain by the El Córdoba Formation (Figure 2), described by Robbiano (1971). The Lower Jurassic marine deposits of the Osta Arena Formation (Herbst 1966; Nullo 1983) are overlain by the El Córdoba Formation which reaches a thickness of 190–340 m (Figure 2). The most extensive outcrops of this unit are on the western slope of sierras de Lonco Trapial, Cajón de Ginebra and Cerro Negro (Figure 1). Puesto Currumil locality (Pagani et al. 2011; Figure 1(3)) is located west of the Sierra del Cerro Negro at the access to Quebrada El Córdoba, where a stratigraphical section was measured by Robbiano (1971) and subsequently revised by Nullo (1983). The Osta Arena Formation consists of marine sandstone, tuffite and conglomerate. The formation is Toarcian (Lower Jurassic) based on dactylioceratid and hildoceratid ammonoids (Musacchio and Riccardi 1971; Blasco et al. 1978). Puesto Currumil locality yielded a single specimen of *Dactylioceras* (*Orthodactylites*) *hoelderi* Hillebrandt and Schmidt-Effing that indicates an Early Toarcian age for this association (Ferrari 2009; Pagani et al. 2011), according to the current biostratigraphical zonation in Argentina (Riccardi 2008).

3. Material

Teleoconchs were prepared by technical staff (Sr Leandro Canessa) at the MPEF laboratory. The photographs were taken with a digital camera Sony at MPEF and by scanning electronic microscopy (SEM) at ALUAR (Pto. Madryn, Argentina).

Repository. The material was collected in 2008 and 2009 and belongs to the MPEF collection.

Abbreviations. The institutional abbreviations cited in the systematic part section are as follows: ALUAR, Aluminio Argentino, Pto. Madryn, Chubut, Argentina; MPEF, Museo Paleontológico Egidio Feruglio, Trelew, Chubut, Argentina; SEGEMAR, Servicio Geológico y Minero Argentino, Buenos Aires.

4. Systematic paleontology

The systematic classification follows Hickman and McLean (1990), Ponder and Lindberg (1997) and Bouchet and Rocroi (2005). The morphological terminology is based on Knight et al. (1960) and Camacho and Longobucco (2007).

Area		Río Genoa valley	Pampa de Agnia
Stage			
Lower Jurassic	Upper Pliensbachian-Lower Toarcian	Mulanguiñeu Formation	Osta Arena Formation
			El Córdoba Formation
			Puntado Alto Formation
Triassic		?	
Upper Palaeozoic	Tepuel Group	Río Genoa Formation	

Figure 2. Possible relationships between the stratigraphical units mentioned in the text.

Subclass **Eogastropoda** Ponder and Lindberg, 1997

Order **Patellogastropoda** Lindberg, 1986

Superfamily **Lottioidae** Gray, 1840

Family **Acmaeidae** Forbes, 1850

Remarks. Lindberg and McLean (1981) and Lindberg (1988) emphasised the consistency between the classification based on soft anatomy and shell structure in patellogastropods, and recognised that the Lottiidae Gray, 1840 (= Acmaeidae Forbes, 1850) are characterised by the possession of a fibrous prismatic layer dorsal to the outer crossed-lamellar layer (Kase and Shigeta 1996). The present research follows the classification based on general shell morphology and shell microstructure.

Genus *Scurriopsis* Gemmellaro, 1879

Type species. *Scurriopsis neumayri* Gemmellaro, 1879, from the Early Jurassic of Sicily.

Scurriopsis? sp.

Figure 3(a)–(h)

Material examined. MPEF-PI 3580 and 4109 (Figure 3); three fragmentary replaced teleoconchs.

Description. Patelliform, conical, elevated and medium-sized shell. The height of the shell ranges from 22.4 to 54.2 mm, and the width ranges from 36.6 to 63 mm. The apex is slightly eccentric; the slopes of the shell in lateral view are almost straight and imperforated, lacking an exhalant hole. The ornament pattern consists of radial ribs that are well developed towards the largest slope of the shell. Fine growth lines intercept the radial ribs. The microstructure of the shell is recrystallised, preserving traces of a crossed-lamellar outer layer (Figure 3(f)). The aperture is fragmentary and oval.

Distribution. Bed LO 29, Lomas Occidentales, Chubut, Argentina, Early Jurassic (Late Pliensbachian–Early Toarcian), Mulanguñeu Formation.

Remarks. This material shows the characters that are typical of *Scurriopsis*, such as a conical and elevated shell, apex in a median or eccentric position, and ornament pattern with collabral and radial elements. Moreover, the preserved traces of a crossed-lamellar outer layer suggest an assignment to Acmaeidae. However, due to the poor preservation of the available specimens, the material is left in open nomenclature.

Scurriopsis? sp. is the first – although doubtful – occurrence of the genus in the Early Jurassic of Argentina and South America. *Scurriopsis? arahetexta* Edwards (1980, p. 44, fig. 3(c)) from the Early Jurassic (Sinemurian, according to Thompson and Turner 1986) of Lully Foothills (Antarctica) differs from the species described here by having more developed radial and collabral ornament, the apex in a median position and a

conical and depressed shell. The type species of the genus, *Scurriopsis neumayri* Gemmellaro is similar to *Scurriopsis?* sp.; Gemmellaro's species, however, has an ornament made of radial and concentric threads developed on the shell surface. In the Patagonian species, radial threads are preserved only on the largest slope of the shell. *Hennocquia* sp. Gründel (2000, p. 233, pl. 7, figs 10, 11), from the Middle Jurassic of Europe, resembles *Scurriopsis?* sp.; the European species, however, is smaller than the species described here, has regular concentric threads and lacks radial threads. *Scurriopsis (Dietrichiella) kindopensis* (Dietrich) (Cox 1965, p. 141, pl. 22, fig. 4), from the Upper Jurassic (Kimmeridgian) of Tanzania, is smaller than the Patagonian species, with a height of 11.3 mm and a width of 7.2 mm, and has a stronger concentric ornament.

Pseudorhytidopilus? detonii (Haber) (Gatto and Monari 2010, p. 776, fig. 4(A)–(G)) from the Early Jurassic of Italy differs from *Scurriopsis?* sp. by having concentric folds that subdivide the shell surface in roughly regular commarginal bands. *Scurriopsis (Scurriopsis) schmidtii* (Dunker), from the Early Jurassic of Germany, is very similar to the species described here; the European species, however, has stronger primary radial ribs intercalated with secondary ribs (Monari et al. 2011, p. 352, fig. 5(A)–(C)).

The genus *Scurriopsis* is found in the marine Jurassic from all over the world. The doubtful *Scurriopsis* species reported here may actually represent a new member of the genus, and also certainly testifies the first occurrence of Acmaeidae from the marine Jurassic of South America. The comparison of this species with other coeval *Scurriopsis* members is based on the similarities regarding the general shell morphology and ornament pattern, which are considered as the most diagnostic features for the genus.

Subclass **Orthogastropoda** Ponder and Lindberg, 1997

Order **Vetigastropoda** Salvini-Pläwen, 1980

Superfamily **Trochoidea** Rafinesque, 1815

Family **Ataphridae** Cossmann, 1915

Subfamily **Ataphrinae** Cossmann, 1915

Remarks. Ferrari (2011a) has recently discussed the systematic classification of the family Ataphridae and considered the general shell morphology of the aperture and the peristoma as the most diagnostic shell characters of this group (see Gründel 2008). In this paper, the Ataphridae classifications of Gründel (2008), Kaim et al. (2009) and Ferrari (2011a) are followed.

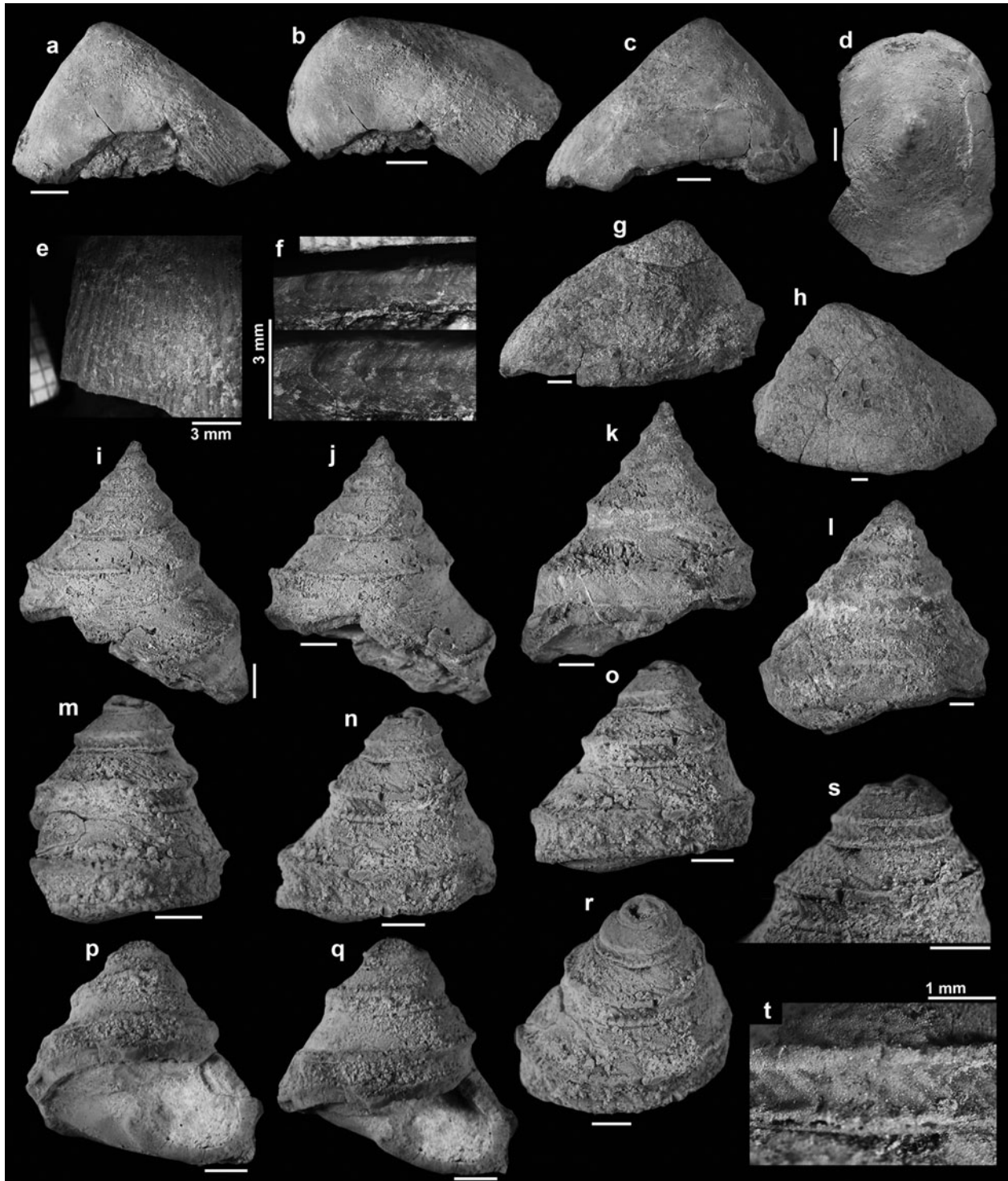


Figure 3. (a–f) *Scurriopsis?* sp. (a–d) MPEF-PI 3580, teleoconch in lateral (a–c) and apical (d) view. (e) Ornament detail. (f) Shell microstructure detail. (g, h) MPEF-PI 4109-2, teleoconchs in lateral view. Scale bars represent 5 mm, except (e)–(j), 3 mm. (i–s) *Chartronella gradata* sp. nov. (i–k) Holotype, MPEF-PI 3583, teleoconch in lateral view. (l) Paratype, MPEF-PI 3585, teleoconch in lateral view. (m–t) Paratype, MPEF-PI 3582, teleoconch in lateral (m–o), basal (p), apertural (q), apical (r) view. (s) Juvenile teleoconch in lateral view. (t) Ornament detail. Scale bars represent 3 mm, except (t), 1 mm.

Tribe **Colloniini** Cosmann, 1916

Genus *Chartronella* Cossmann, 1902

Type species. *Chartronella digoniata* Cossmann in Chartron and Cossmann (1902), from the Early Jurassic of France.

Remarks. The diagnostic features of the genus *Chartronella* proposed by Gründel (2008) are used.

Chartronella gradata sp. nov.

Figure 3(i)–(s)

Holotype. MPEF-PI 3583 (Figure 3); fragmentary and replaced teleoconch.

Paratypes. MPEF-PI 3585, MPEF-PI 3582; fragmentary and replaced teleoconchs.

Material examined. MPEF-PI 3584, MPEF-PI 4083; fragmentary and replaced teleoconchs.

Diagnosis. Dextral, gradate to pagodiform shell with peripheral keel; cyrtocoenoidal juvenile shell combined with coeloconoidal later whorls; teleoconch with four/five angular whorls; outer face of the whorls concave with prosocline growth lines and bordered by two strong spiral keels; base flat bordered by a strong spiral keel; holostomatous and circular aperture with a crescent-shaped columellar lip; outer lip concave.

Description. Dextral, gradate to pagodiform, anomphalous, cyrtocoenoidal juvenile shell combined with coeloconoidal later whorls. The early teleoconch consists of two convex whorls with a height of about 0.8 mm and a width of 1 mm. The protoconch is not preserved. The teleoconch comprises four/five whorls with a height of 15–25 mm and a width of 15–28.7 mm; the upper portion of the whorls forms a straight sutural ramp which gives to the periphery of the shell an angular outline. The periphery of the shell bears a strong and well-developed keel. The outer face of the whorls is flat to concave and wide, and is bordered by two strong spiral keels. Suture is weakly impressed. Spiral ornament is made of two strong spiral keels edging the outer face of whorls; one of the spiral keels is peripheral and the other one is located in an abapical position bordering the suture. The two spiral keels are stronger on the outer face of the last whorl. The outer face is ornamented by well-developed, regularly spaced and prosocline collabral ribs (Figure 3(t)). The base is flat and the aperture is holostomatous and circular with the outer lip concave and a crescent-shaped columellar lip.

Etymology. Refers to the strongly gradate and pagodiform general shell morphology.

Distribution. Bed LO 29, Lomas Occidentales fossiliferous locality, Mulanguíneu Formation, Chubut, Argentina; Bed LT (s), Cerro La Trampa fossiliferous locality, Mulanguíneu Formation, Chubut, Argentina, Early Jurassic (Late Pliensbachian–Early Toarcian).

Remarks. An angular shell shape, two strong peripheral keels and a crescent-shaped columellar

lip suggest an assignment to *Chartronella* (see Gründel 2008).

Some members of the genus were previously recorded from the Early Jurassic of Argentina (see Ferrari 2011a). *Chartronella paganiae* Ferrari (2011a, p. 69, figs 7.1–10) from the Early Jurassic of Chubut Province differs from the new *Chartronella* species in having a lower spired shell, being smaller and lacking ornament on the shell surface. *Chartronella spiralis* Ferrari (2011a, p. 71, figs 9.1–6) from the Early Jurassic of Chubut Province is also similar to *Chartronella gradata* sp. nov.; however, *C. spiralis* has a more developed spiral and collabral ornament.

Chartronella noszkyi Szabó (1982, p. 22, pl. 2, figs 7, 8) from the Jurassic of Hungary resembles *C. gradata* sp. nov. in general shell morphology; however, Szabó's species has a more developed ornament, with spiral elements and prosocline growth lines; moreover, the convex surface of the whorls is divided into three longitudinal parts. Haas (1953) described some species from the late Triassic of Peru very similar to *C. gradata* sp. nov. These are *Chartronella pacifica* (Jaworski, 1923) (Haas 1953, p. 81, pl. 5, figs 31–41, 45–47, 54), which differs from the Chubutean species in having tubercles on adapical and peripheral keels, and *Chartronella wortheniaeformis* (Cox, 1949) (Haas 1953, p. 83, pl. 5, figs 42–44, 48, 55), having the spiral elements crossed by growth threads that are straight and have a pronounced forward inclination both on the upper portion of the whorls and in the periphery. *Chartronella mitoleensis* Cox (1965, p. 145, pl. 24, fig. 3(a),(b)) from the Kimmeridgian (Late Jurassic) of Africa differs from the Patagonian species in having a more gradate outline of the shell and narrow spiral cords with transverse threads near the carina. *Chartronella (Tubertronella) tuberosa* Gründel (2000, p. 230, pl. 7, figs 5–8; 2008, p. 186, figs 2, 13, 14) from the Bathonian (Middle Jurassic) of Germany is also similar to *C. gradata* sp. nov.; the European species, however, has a conspicuous knob on the lower portion of the inner lip.

Superfamily **Seguenzioidae** Verrill, 1884

Family **Eucyclidae** Koken, 1896

Genus *Calliotropis* Seguenza, 1902

Type species. *Trochus otto* Philippi 1844, from the Pleistocene of Sicily, Italy.

Remarks. Ancient species of *Calliotropis* are abundant in the fossil record and well known from the Triassic of Europe, Asia and South America as family Eucyclidae. These fossil representatives of the group are very similar to their extant counterparts, and Kaim (2004) has observed that the only difference between extant calliotropids and the Jurassic forms is the absence of umbilicus among the latter. Though several Jurassic calliotropid species have been united in genus *Riselloidea* Cossmann, Kaim (2004) suggested that actually there are no serious taxonomic

reasons to keep these Jurassic gastropods separately from recent members of *Calliotropis* and subsequently synonymised both genera with the Jurassic *Riselloidea* being a junior synonym of the extant *Calliotropis*. Nevertheless, he pointed out that it is difficult to prove their biological relationship and suggested keeping them together pending a more exhaustive work on the fossil and living trochoids.

The systematical position of *Calliotropis* is currently under debate. Some authors include the genus in Calliotropinae (Chilodontidae) (Bouchet and Rocroi 2005; Poppe et al. 2006; Vilvens 2006, 2007; Vilvens and Swinnen 2008; Williams et al. 2008; Vilvens and Sellanes 2010); others assign *Calliotropis* to Calliotropini (Eucyclinae, Trochidae) (Hickman and McLean 1990; Kiel and Bandel 2001; Kaim 2004; Vilvens 2004; Stilwell 2005; Kano 2008). Gründel (2000, 2007) and Gründel and Koppka (2007) retained the family Eucyclidae to include related members of *Calliotropis*, and Bandel (2010), based on the anatomical features of living species, considered *Calliotropis* to be a member of the family Calliotropidae (concept derived from Hickman and McLean, 1990). Recent phylogenetical analysis based on molecular data (Kano 2008; Kano et al. 2009) suggested that Calliotropidae is a monophyletic group included in Seguenzioidea (see e.g. Bouchet and Rocroi 2005). In this paper, the classifications of Kano et al. (2009), Gründel (2000, 2007), and Gründel and Koppka (2007) are followed.

Calliotropis? sp.

Figure 4(a)–(e)

Material examined. MPEF-PI 3591 (Figure 4); fragmentary and replaced teleoconch.

Description. Dextral, gradate, small-sized and low-spired shell. The height of the shell is 11.5 mm and the width is 14 mm. The protoconch is not preserved. The teleoconch comprises two fragmentary and angulated whorls, with a narrow ramp and a concave outer face. Sutures are weakly impressed. The ornament consists of three nodose spiral cords on teleoconch whorls. One is strongly developed and borders the periphery of the shell; and two weaker spiral cords are located on the flank of whorls, above the peripheral one (Figure 4(e)). Collabral ornament is weakly developed on the shell surface. The base is convex and ornamented with four spiral cords bearing small nodes. The aperture is fragmentary, holostomatous and quadrangular.

Distribution. Bed LO 29, Lomas Occidentales fossiliferous locality, Chubut, Argentina, Early Jurassic (Late Pliensbachian–Early Toarcian), Mulanguñeu Formation.

Remarks. Although the single specimen described is poorly preserved, it shows the typical characters of the Eucyclinae *Calliotropis*, such as the presence of a conical and gradate shell, axial and collabral elements with nodes at

the intersection points, convex base with four to five spiral cords with or without nodose rows, and aperture holostomatous, oblique and subcircular (see Kaim, 2004). However, these are also common characters of other eucyclinid genera, such as *Biarmatoidella* Gründel and *Riselloidea* Cossmann. The doubtful inclusion of this specimen into the genus *Calliotropis* is based on the strongest morphological resemblance with the extant representatives of *Calliotropis* rather than with other genera. However, the systematic relationships within the Eucyclinae genera are indeed problematic, and a more available and better-preserved material is clearly required to assess a correct taxonomic assignment for this calliotropinid species.

Calliotropis? sp. is the first –although doubtful– mention of the genus in the Jurassic of Argentina and South America. Regarding the similar eucyclinid species described from the Jurassic of Patagonia, *Calliotropis* sp. is similar to *Amberleya? espinosa* Ferrari (2009, p. 450, fig. 2(A)) from the Early Toarcian (Early Jurassic) of Chubut Province; the former species, however, has a higher spire, a strongly spinose ornament in the periphery of the shell and poorly developed spiral and axial elements.

Calliotropis biarmata (Münster, 1844) (Kaim 2004, p. 22, fig. 9(B)–(E)), from the Middle and Upper Jurassic of Europe, resembles the species described here in general shell morphology and ornament pattern. However, the European species has a slightly convex base with strongly nodose spiral rows, and less and more developed nodes per whorl. *Riselloidea pileiformis* Jaitly et al. (2000, p. 56, pl. 5, figs 15, 16, pl. 6, figs 1–3) from the Bathonian (Middle Jurassic) of India is similar to *Calliotropis?* sp.; however, the Indian species has a more trochiform shell shape and a wide callus along the inner lip. *Calliotropis noszkyi* Szabó (1995, p. 71, pl. 7, fig. 13; 2009, p. 83, fig. 78), from the Sinemurian (Early Jurassic) of Hungary, has more convex whorls than *Calliotropis?* sp., sutures more deeply impressed and a more developed collabral ornament. The Chubutean species is also very similar to Eucyclidae gen. et sp. indet. Gründel et al. (2011, p. 487, text-figure 6(J)), from the Early Jurassic (Toarcian) of England; but the European species lacks three cords of developed nodes on the outer face.

Superfamily **Pleurotomarioidea** Swainson, 1840

Family **Pleurotomariidae** Swainson, 1840

Genus ***Pleurotomaria*** DeFrance, 1826

Type species. *Trochus anglicus* Sowerby, 1812–1822 from the Early Jurassic of France.

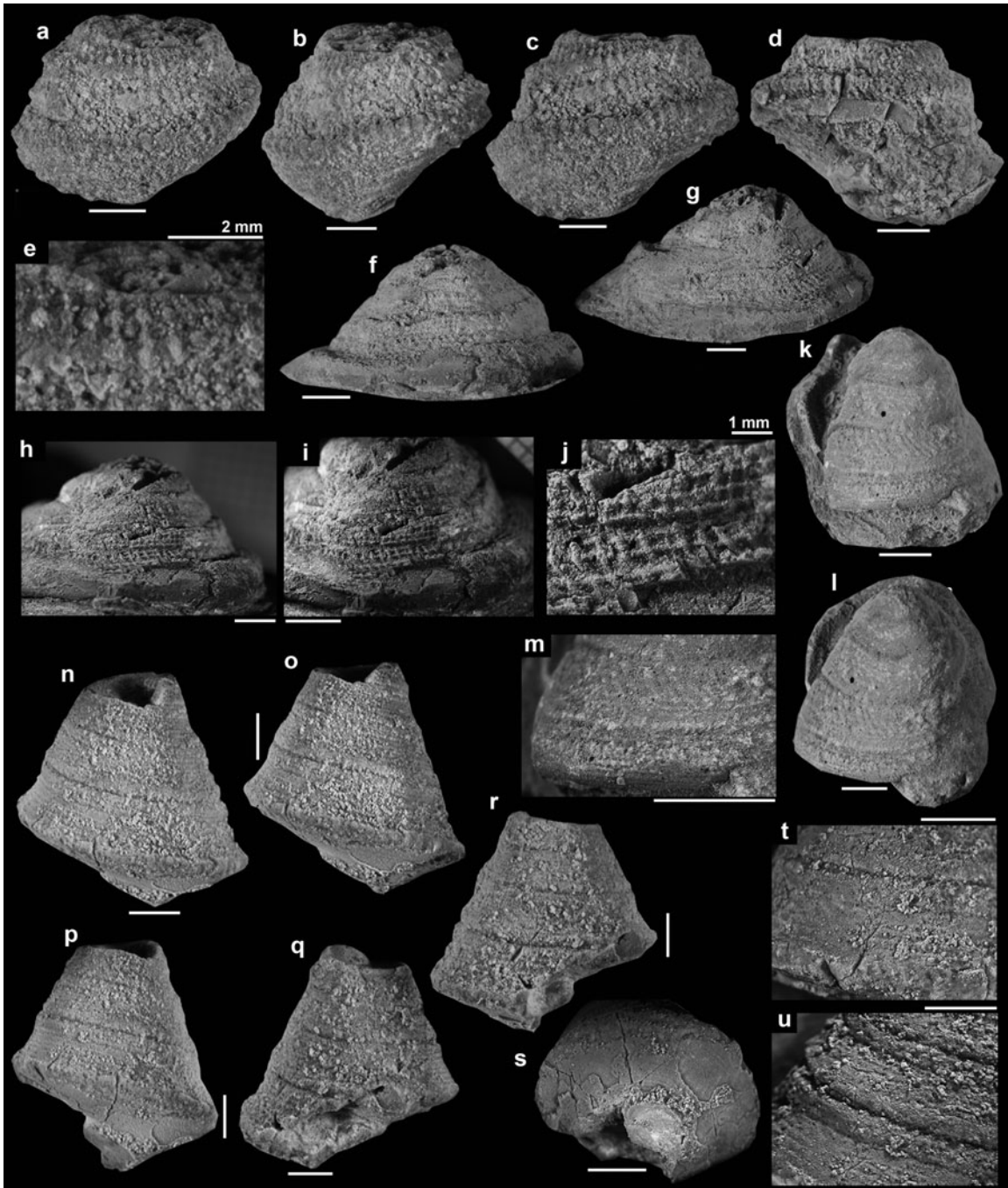


Figure 4. (a–e) *Calliotropis?* sp., MPEF-PI 3591, teleoconch in lateral (a–c) and apertural (d) view. (e) Ornament detail. (f–j) *Pleurotomaria* sp., MPEF-PI 4084, teleoconch in lateral (f–i) view. (j) Ornament detail. (k–m) *Leptomaria* sp., MPEF-PI 4085 (SEGEMAR 25007), teleoconch in lateral (k) and apical (l) view. (m) Ornament detail. (n–u) *Hamusina? wahnishae* sp. nov., holotype, MPEF-PI 3592, teleoconch in lateral (n–p), apertural (q, r) and basal (s) view. (t–u) Ornament detail. All scale bars represent 3 mm, except (e), 2 mm and (j), 1 mm.

Pleurotomaria sp.

Figure 4(f)–(j)

Material examined. MPEF-PI 4084 (Figure 4); fragmentary and replaced teleoconch.

Description. Fragmentary, trochiform, slightly gradate, low-spired and medium-sized shell. The height of the shell

is 11.3 mm, and the width is 18.2 mm. The protoconch is not preserved. The teleoconch comprises three whorls; the ramp of the whorls is flat and the outer face is slightly concave. Sutures are weakly impressed. The ornament is reticulate consisting of spiral threads and collabral riblets. The regularly spaced spiral threads intercept the collabral

elements forming a network with granules. The ornament is better preserved on the outer face of last whorl where well-developed and prosocline collabral threads become slightly opisthocline (Figure 4(j)). The selenizone seems to have an abapical position on the outer face of the whorls, where the collabral threads change their direction. The selenizone is represented by a narrow furrow running in the middle of the outer face. Basal and apertural features are not preserved.

Distribution. Bed LT 3, Cerro La Trampa fossiliferous locality, Chubut, Argentina, Early Jurassic (Late Pliensbachian–Early Toarcian), Mulanguíneu Formation.

Remarks. The present material shows some characters typical of *Pleurotomaria*, such as a trochiform, angular and low-spined shell, selenizone in the middle of the outer face and spiral and nodular elements on the periphery of the shell. However, the single available specimen is very poorly preserved, thus it is left in open nomenclature.

Pleurotomaria sp. resembles *Pleurotomaria* cf. *multicincta* Zieten (Jaworski, 1926a, p. 195), from the Early Jurassic of Mendoza, Argentina, but this species is bigger than the Chubutean species, with a height of about 65 mm and a width of 105 mm, and has a stronger spiral ornament. *Pleurotomaria leufuensis* Weaver (1931, p. 364, pl. 41, fig. 274), from the Callovian (Middle Jurassic) of Argentina, is related to the species described here; however, Weaver's form has more convex whorls and has no nodular elements at the crossing points of the collabral riblets with the spiral threads. The species described here is also similar to *Pleurotomaria* cf. *subfasciata* d'Orbigny, from the Bajocian (Middle Jurassic) of Peru (Jaworski 1925, p. 112); d'Orbigny's species, however, is bigger than the Patagonian form, with a height of about 76–80 mm and a width of 72 mm. Moreover, it has the ramp of the whorls slightly more convex than *Pleurotomaria* sp., and it has a spiral ornament without nodular elements. *Pleurotomaria anglica* (Sowerby) from the Sinemurian–Pliensbachian (Early Jurassic) of Chile differs from *Pleurotomaria* sp. in having stronger nodular elements, outer face of the whorls more concave (Gründel 2001, p. 44, pl. 1, figs 1, 2). *Pleurotomaria debuchii* Eudes-Deslongchamps (1849) from the Sinemurian–Pliensbachian (Early Jurassic) of France and Germany is comparable to the species here described in general shell morphology and ornament pattern, but this European species has more convex whorls and it has more developed collabral and spiral elements (Schubert et al. 2008, p. 18, fig. 2(I)–(N); Szabó 2009, p. 43, figs 37, 38). *Pleurotomaria suessii* Hörnes (1853), from the Sinemurian (Early Jurassic) of Austria, differs from *Pleurotomaria* sp. in having the outline of the shell cyrtoconical to conical and a stronger collabral ornament, with strong and regular ribs and fine growth lines crossing spiral elements (Szabó 2009, p. 42, fig. 36).

Genus *Leptomaria* E. Eudes-Deslongchamps, 1863–1869
Type species. *Pleurotomaria amoena* J.A. Eudes-Deslongchamps, 1849, from the Middle Jurassic (Bajocian) of France.

Leptomaria sp.

Figure 4(k)–(m)

Material examined. SEGEMAR 25007 (cast MPEF-PI 4085) (Figure 4), replaced fragmentary teleoconch collected by E. Wahnish.

Description. Dextral, cyrtoconical and small-sized shell, with a height of 12 mm and a width of 13.2 mm. The protoconch is not preserved. The teleoconch comprises four/five slightly convex, not angular whorls. Sutures are weakly impressed. The ornament is weakly developed on the shell surface; it consists of collabral and spiral elements. On the ramp of each whorl, the collabral elements are prosocline becoming opisthocline towards the outer face. The selenizone is narrow and runs slightly below the middle of the whorl surface (Figure 4(m)). The base is fragmentary and ornamented by weak cords. Apertural features are not preserved.

Distribution. Lomas Occidentales fossiliferous locality, Chubut, Argentina, Early Jurassic (Late Pliensbachian–Early Toarcian), Mulanguíneu Formation.

Remarks. Features such as a conical shell with convex whorls, selenizone in a median position and ornament with collabral and spiral elements suggest an assignment to *Leptomaria*. However, this single specimen is poorly preserved; thus, it is left in open nomenclature until a new more material is available.

Leptomaria sp. represents the first record of the genus in the Early Jurassic of Argentina and South America.

Trochotomaria somhegyensis (Szabó 1980, p. 59, pl. 3, figs 1–3), from the Bajocian (Middle Jurassic) of Hungary, resembles the species described here; however, Szabó's form has more developed collabral and spiral elements. *Leptomaria* cf. *tardita* (Sieberer), from the Bajocian (Middle Jurassic) of Hungary, differs from the species described here in having a wide and flat selenizone near the midwhorl, and stronger spiral ornament (Szabó 1980, p. 60, pl. 3, fig. 4). The Patagonian species resembles *Leavitomaria dani* Szabó (2009, p. 49, fig. 43), from the Sinemurian–Pliensbachian (Early Jurassic) of Hungary, but the Hungarian species has a wider selenizone in a median position of the whorls, and small nodes appear at the intersections of collabral and spiral elements behind the sutures. The Indian Callovian (Middle Jurassic) material referred to *Leptomaria fraga* (J.A. Eudes-Deslongchamps) is slightly smaller than the species described here, has less convex whorls and stronger collabral elements (Jaitly et al. 2000, p. 40, pl. 2, figs 3, 4). *Leptomaria pseudoumbilicata* Jaitly et al. (2000; p. 40, pl.

2, figs 5, 6), from the Callovian (Middle Jurassic) of India, differs from *Leptomaria* sp. in having a slightly more depressed apex and a convex selenizone. *Leptomaria simplex* Jaitly et al. (2000, p. 42, pl. 2, fig. 7) and *Leptomaria* sp. Jaitly et al. (2000, p. 43, pl. 2, fig. 9), both from the Bathonian (Middle Jurassic) of India, differ from the Chubutean species by having a more cyrtocoid apex and slightly more impressed sutures, respectively. *Leptomaria* sp. resembles *Leptomaria striata* (Hörnes), from the Sinemurian–Pliensbachian (Early Jurassic) of Europe, but the European species is bigger, has more convex whorls and a stronger spiral ornament (Szabó 2009, p. 50, fig. 44).

Superfamily **Cirroidea** Cossmann, 1916

Family **Cirridae** Cossmann, 1916

Subfamily **Hesperocirrinae** Haas 1953

Remarks. Bandel (1993) subdivided the family Cirridae into three subfamilies: Hesperocirrinae Haas including the most diversified forms of the group, while members of Cirrinae Cossmann and Cassianocirrinae Bandel have smaller shells with rounded and planispiral whorls. According to Bandel (1993), the Hesperocirrinae have a conical shell with flat to slightly convex whorls; base slightly convex to flat, anomphalous or phaneromphalous, connected to the flank by variably pronounced peripheral edge; periphery of the shell above the suture may have nodes; ornament consists of spiral lirae and spiral cords crossed by oblique growth lines, often forming tubercles at interception points; the aperture is quadrangular. Haas (1953) proposed Hesperocirrinae to include the genera *Hesperocirrus* Haas and *Sororcula* Haas, both from the Upper Triassic of Peru. Although many Jurassic and Cretaceous hamusini-like genera resemble *Hesperocirrus* and *Sororcula*, they differ by having a bigger shell and lack of umbilicus. Regarding the last two characters, Bandel (1993) emended the diagnosis of Hesperocirrinae and included the genera *Hesperocirrus*, *Sororcula*, *Hamusina* Gemmellaro and *Sensuitrochus* Quintero and Revilla. This author extended the stratigraphical distribution of the subfamily to the Late Cretaceous. Here, the systematic classification of Bandel (1993) is followed.

Genus *Hamusina* Gemmellaro, 1878

Type species. *Turbo berthelothi* d'Orbigny, 1850, from the Early Jurassic of France.

Remarks. *Hamusina* differs from *Scaevola* Gemmellaro in having the outer face of the whorls flat to not strongly convex. *Hesperocirrus* Haas and *Sororcula* Haas have an open umbilicus and are smaller than *Hamusina*. The morphological differences of *Hamusina* with *Aristarella* Dubar and *Shikamacirrus* Kase consist of the presence

of a narrow umbilicus in the latter genera. *Sensuitrochus* Quintero and Revilla differs from *Hamusina* by having spiral ornament with nodose rows and the outer face of the whorls flat, while *Auseria* Fucini lacks ornament (Bandel 1993). Kiel (2001) considered *Sensuitrochus* and *Sikamacirrus* as junior synonyms of *Hamusina*, according to the diagnoses of *Sensuitrochus ferreri* Quintero and Revilla and *Shikamacirrus nipponicus* Kase, the type species of both genera, which are the same as that of *Hamusina*. Hickman and McLean (1990) included *Hamusina* in Eucyclini (Trochidae), which is closely related to Chilodontini Wenz and Calliotropini Hickman and McLean. Bandel (1993) pointed out that Hickman and McLean (1990) did not mention the change in mode of coiling that distinguishes members of the Cirridae from those of modern and fossil Trochidae. However, the general trochiform shell and the ornament pattern suggest a resemblance between fossil members of Cirridae (*Hamusina*, *Cirrus*) to the extant Trochidae.

Hamusina? wahnishae sp. nov.

Figure 4(n)–(u)

Holotype. MPEF-PI 3592 (Figure 4), only one fragmentary specimen with a replaced teleoconch.

Diagnosis. Sinistral and anomphalous shell; whorls of the teleoconch flat to slightly concave; sutures well impressed and bordered by two feebly swollen belts; five weak spiral threads on the shell surface; base flat; aperture quadrangular and oblique.

Description. Sinistral, anomphalous, conical, small- to medium-sized and acute shell. The height and width of the shell are of about 14.7 mm. The protoconch is not preserved. The fragmentary teleoconch comprises four whorls; the early whorls are flat becoming slightly concave on the mature shell. Sutures are feebly impressed. The ornament is clearly developed on the mature whorls of the teleoconch and it is predominantly spiral. Suture is accompanied in both sides by feebly swollen belts; five weak and regularly spaced spiral threads appear between the belts (Figure 4(t)–(u)). Axial and collabral ornament is absent. The base is flat to slightly convex, and the periphery angular marked by a spiral cord. Fine spiral threads ornament the base. The aperture is fragmentary and quadrangular.

Etymology. Dedicated to Dr Esther Wahnish who made previous most important contribution to the paleontological knowledge of the marine gastropod faunas from the Early Jurassic of Chubut Province.

Occurrence. Bed LO 29, Lomas Occidentales fossiliferous locality, Chubut, Argentina, Early Jurassic (Late Pliensbachian–Early Toarcian), Mulanguíñeu Formation.

Remarks. According to the interpretations of the Cirridae made by Bandel (1993) and Bandel et al. (2000),

the Patagonian species shows the typical characters of *Hamusina*, such as a conical and high-spired shell with the outer face of the whorls flat, an angular and peripheral keel on base, base flat to slightly convex, an ornament pattern consisting of spiral ribs and aperture quadrangular. However, some diagnostic features of *Hamusina*, such as the presence of nodes and spiral threads connected to oblique growth lines, are absent in the specimen described here. Probably, the material represents a new genus into the family Cirridae, but for the moment it is left in open nomenclature.

Hamusina? wahnishae sp. nov. is the first doubtful record of the genus for the Early Jurassic of Argentina. The species described here resembles *Hesperocirrus triasicus* (Cox 1949; as *Hamusina triasica*) from the Late Triassic of Peru, but the latter has more convex whorls, nodular and axial ornament and a convex base with spiral cords (Haas 1953, p. 44, pl. 3, figs 1–15, 19–22, 25–27). *Hesperocirrus robusteornatus*, *Hesperocirrus striatus*, *Sororcula gracilis* and *Sororcula costata* (Haas 1953, pp. 48, 49, 52, 54, pls 2, 3) have an axial and nodular ornament and a more conspicuous spiral thread than the Patagonian species. Most of Haas's species are widely or narrowly phanerocephalous, whereas *Hamusina? wahnishae* sp. nov. is anomphalous. *Hamusina* cf. *damesi* Gemmellaro (in Möricke 1894, p. 29, pl. 5, fig. 3), from the Middle Jurassic of Chile, is closely related to the species described here; however, the Patagonian species has more overlapping whorls and a more developed sutural keel. *Hamusina maxwelli* Bandel (1993, p. 58, pl. 4, figs 9, 10; pls 5, 1–5; Bandel et al. 2000, p. 77; pl. 2, figs 1–6), from the Jurassic of New Zealand, differs from the species described here in having a stronger axial ornament, whereas in *Hamusina? wahnishae* the axial ornament is absent. The species described by Hudleston (1887–1896, p. 304, pl. 24, fig. 12) as *Hamusina* Gemmellaro, from the Jurassic of England, differs from the Patagonian species by having more developed nodes, wavy spiral ribs increasing in number towards the mature whorls of the teleoconch, collabral lirae, circular aperture and spiral ornament on the base. *Hamusina oppelensis* Lycett, from the Early Jurassic of England (Hudleston 1887–1896, p. 305, pl. 24, figs 13, 14), is more elongated than the species described here, has more convex whorls and the aperture is subcircular rather than quadrangular.

Family **Discohelicidae** Schröder, 1995

Remarks. Members of Discohelicidae have been included into Euomphaloidea, Cirroidea and Patelloidea (Knight et al. 1960; Gründel 2000, 2001; Bouchet and Rocroi 2005), and considered as closely related to the Trochoidea (Conti and Monari 2001). Gründel (2005) suggested that Discohelicidae is a heterogenic and probably polyphyletic unit. The author considered *Discohelix* Dunker, *Pentago-*

nodiscus Wendt, *Colpomphalus* Cossmann and *Asterohelix* Szabó as the most representative members of the group for which the diagnostic characters are the presence of growth lines running opisthocytic on the outer face of the whorls, prosocline on the adapical and opisthocline on the basal side. Here, the classification of Gründel (2005) is followed.

Genus *Colpomphalus* Cossmann, 1916

Type species. *Straparollus altus* d'Orbigny, 1853, from the Middle Jurassic (Bathonian) of France.

Colpomphalus musacchioi sp. nov.

Figure 5(a)–(j)

2009 *Colpomphalus?* sp. Ferrari, p. 452, fig. 2(B)

Holotype. MPEF-PI 4041 (Figure 5); fragmentary teleoconch preserved as external mould.

Paratype. MPEF-PI 4018; fragmentary teleoconch preserved as external mould.

Lectotypes. MPEF-PI 1863 and 4024; two fragmentary teleoconchs preserved as external moulds.

Diagnosis. Small and phanerocephalous shell; smooth and planispiral protoconch; three teleoconch whorls; last teleoconch whorl expanded; ornament with nodular, collabral and spiral elements; peripheral keel with more conspicuous and fewer nodes than the adapical keel; outer face of last whorl oblique with six to seven threads and prosocline to feebly sigmoidal growth lines; flat base bordered by a row of 24 nodes; wide and open umbilicus bordered by a small nodose keel; peristome quadrangular and oblique; aperture holostomatous.

Description. Dextral, phanerocephalous, discoidal, auriform, small-sized and low-spired shell. The height of the shell ranges from 2 to 3 mm, and the width ranges from 3.5 to 9.3 mm. The protoconch is fragmentary and consists of one smooth and planispiral whorl. The teleoconch consists of three whorls; last teleoconch whorl expanded. The ramp of each whorl is concave, becoming slightly convex to the outer face. Sutures are well impressed forming a deep spiral furrow. The ornament consists of nodular, spiral and collabral elements. On the ramp of the whorls, fine and regularly spaced spiral threads appear; weak prosocline collabral growth lines intersect the spiral elements. Two strong spiral keels appear above and below the sutures; the adapical is peripheral with fewer and more developed nodes than the abapical. The outer face of the last whorl is ornamented by six or seven fine and regularly spaced threads; fine and prosocline to feebly sigmoidal growth lines cross the spiral elements (Figure 5(c),(d)). The base is flat with a sharply angulated outer rim bearing a row of 24 strong and conspicuous nodes. The umbilicus is open, wide and deep, and is bordered by a small nodose

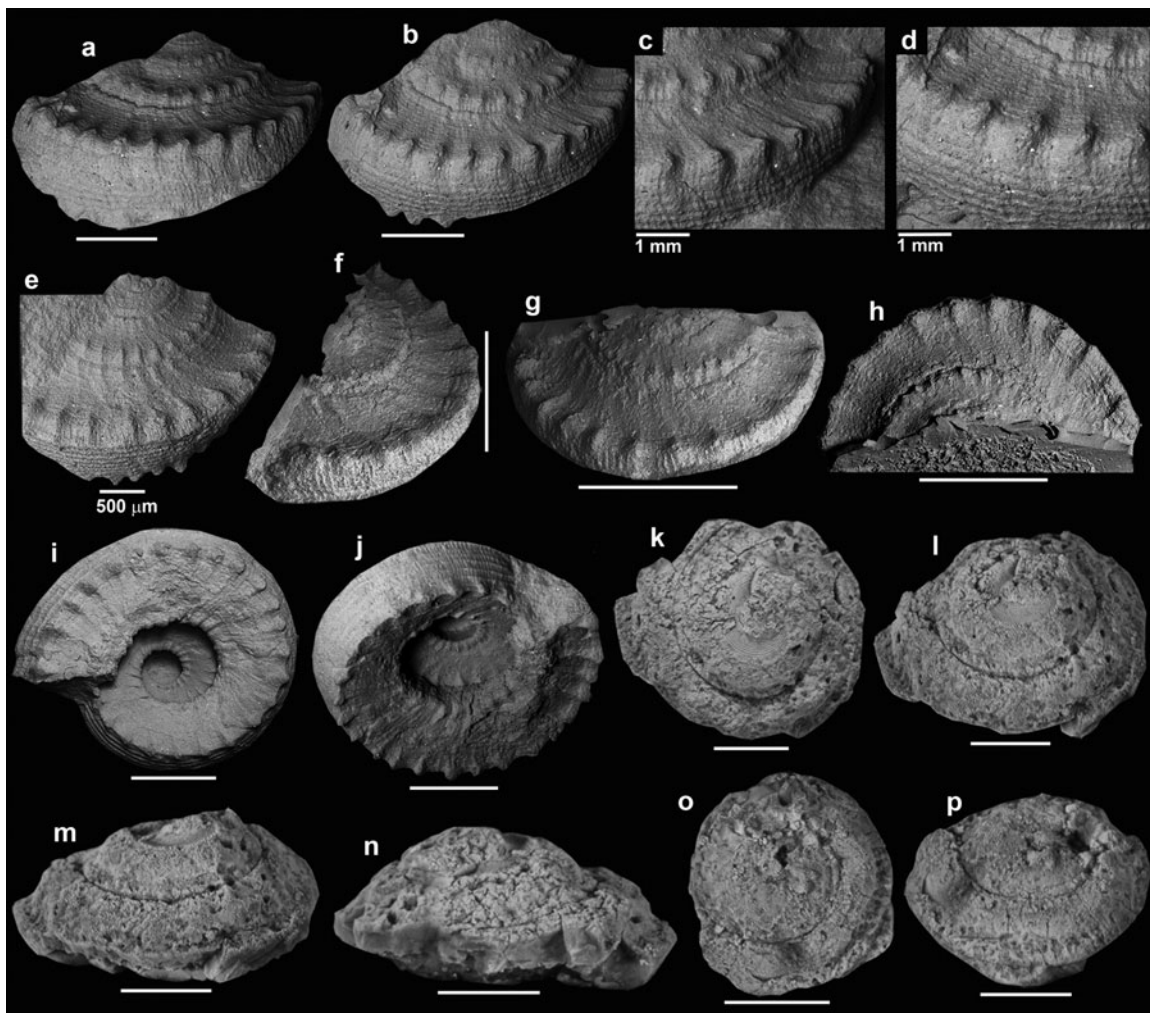


Figure 5. (a–j) *Colpomphalus musacchioi* sp. nov. (a–d) Holotype, MPEF-PI 4041, teleoconch in lateral (a) and apical (b) view. (c, d) Ornament detail. (e) Lectotype, MPEF-PI 4024, teleoconch in lateral view. (f–h) Lectotype, MPEF-PI 1863 (Ferrari 2009), teleoconch in lateral (f) and apical (g, h) view. (i, j) Paratype, MPEF-PI 4018, teleoconch in basal (i) and basal, umbilical and apertural (j) view. (k–p) *Jurassiphorus?* cf. *triadicus* Haas. (k–n) MPEF-PI 4023-1, teleoconch in apical (k, l) and lateral (m, n) view. (o, p) MPEF-PI 4023-2, teleoconch in apical and lateral views. All scale bars represent 3 mm, except (c, d), 1 mm and (e), 500 μm .

row (Figure 5(i,j)). Weak growth lines appear between the outer nodose row of the base and the periumbilical edge. The aperture is holostomatous, and the peristome is oblique with a quadrangular shape.

Etymology. In memory of Dr Eduardo Aldo Musacchio (1940–2011), renowned Argentinean geologist and paleontologist, recognised by his career and important contributions to the Paleozoic and Mesozoic biostratigraphical knowledge of Central and northern Patagonia.

Distribution. Beds PA 06 and PA07, Puesto Currumil fossiliferous locality, Chubut, Argentina, Early Jurassic (Early Toarcian), Osta Arena Formation.

Remarks. A discoidal shell shape with the last whorl expanded, a low spire, an abapical keel, fine and prosocline to feebly sigmoidal growth lines crossed by spiral elements on the outer face of last whorl and an open

umbilicus suggest that the material described here should be included into *Colpomphalus*.

Colpomphalus musacchioi sp. nov. is the first certain record of the genus in the Early Jurassic of Argentina.

Colpomphalus toarciensis Gründel (2001, p. 46, pl. 1, figs 9–13), from the Toarcian (Early Jurassic) of Chile, resembles the species described here in general shell morphology and ornament pattern, with spiral threads and two spiral keels on each whorl; however, Gründel's species has a bigger shell than *Colpomphalus musacchioi* sp. nov., has a narrower umbilicus and has no collabral ornament. Another species very similar to *Colpomphalus musacchioi* sp. nov. is *Colpomphalus angulati* Quenstedt (1856, in Gründel 2003, p. 6, pl. 1, figs 9, 10), from the Hettangian (Early Jurassic) of Germany. The Patagonian species, however, differs from *Colpomphalus angulati* by having

the last whorls more expanded, and fewer and more conspicuous nodes.

Family uncertain

Genus *Jurassiphorus* Cossman, 1915

Type species. *Solarium cailliaudanus* d'Orbigny, 1853, Middle Jurassic (Callovian), France.

Remarks. Following Nützel and Erwin (2004) classification, in this paper the genus *Jurassiphorus* is included into the Vetigastropoda and the family assignment is kept uncertain. This genus was recorded by Haas (1953) from the Upper Triassic of Peru, and subsequently mentioned by Bandel (1994). Gründel (1997) described the protoconch of the type species *Jurassiphorus cailliaudans* (d'Orbigny), and included the genus into the trochomorph vetigastropods.

Jurassiphorus? cf. *triadicus* Haas 1953

Figure 5(k)–(p)

Material examined. MPEF-PI 4023 (Figure 5); two fragmentary and replaced teleoconchs.

Description. Dextral, discoidal, small-sized and low-spired shell. The height of the shell ranges from 4.1 to 5 mm, and the width ranged from 7 to 9.7 mm. The protoconch is not preserved. The teleoconch comprises two or three low trochospiral whorls, with last whorl expanded. Sutures are weakly impressed. The ornament consists of strong nodes or tubercles on the rump of the whorls, more developed on the last whorl. Collabral ornament is not developed. The base is flat, ornamented by weak spiral ribs. The aperture is fragmentary and quadrangular. Umbilical characters are not observed.

Distribution. Bed LO 29, Lomas Occidentales fossiliferous locality, Chubut, Argentina, Early Jurassic (Late Pliensbachian–Early Toarcian), Mulanguñeu Formation.

Remarks. The present material seems to be conspecific with *Jurassiphorus triadicus* proposed by Haas (1953, p. 101, pl. 16, figs 30, 40, 47) from the Upper Triassic of the Pucará Group in Central Peru. Both are similar in general shell morphology and ornament pattern, with similar-sized shell, a slightly elevated-spired shell, the outer face convex, nodes on the sutural ramp near the adapical suture and the aperture quadrangular in transverse section. However, the typical prominent crest is not clearly developed in the Chubutean form. The species described here also resembles the type species *Jurassiphorus cailliaudanus* (d'Orbigny) from the Callovian of France, but the former has stronger nodes and a well-developed crest. The absence of a well-developed crest in *Jurassiphorus?* cf. *triadicus*, which is a typical character of the genus, retains the Patagonian species in open nomenclature.

Jurassiphorus? cf. *triadicus* represents the first – although doubtful – mention of the genus in the Jurassic of South America.

5. Paleocological considerations

The patelliform general shell morphology appears convergently in many gastropod lineages. The wide foot that adheres to the substrate by suction and is completely covered by a protective shell is an anatomical character that evolved independently in different groups of mollusks. The extant Patellogastropoda are distributed worldwide and generally live in the intertidal zone; most of the herbivore forms live in depths where the light penetration allows algae to grow; the bathyal species are probably detritivorous. The fossil members of *Scurriopsis* are closely related to the extant Acmaeidae, which are defined according to shell microstructure and radula characters and have one gill or ctenidium in the mantle cavity above the head.

Members of Ataphridae are very closely related to the extant Turbinidae (see classification proposed by Kaim et al. 2009). These forms are distributed worldwide and found at all latitudes and at depths ranging from intertidal to subtidal, with a few in the bathyal zone, but with a strong preference for carbonatic substrates; they are abundant and diverse in warm tropical and subtropical water (Hickman and McLean, 1990). The genus *Chartronella* is very similar to the extant *Cantrainea* Jeffreys; these forms are epifaunal, herbivorous or suspensivorous feeders, mobile over consolidated substrates and living at different depths, from shallow water to bathyal environments (see Ferrari 2011a).

Recent calliotropids are abundant, diverse and worldwide distributed gastropods. They are particularly common in Indonesia, at the Atlantic coast of Europe, Africa, Madagascar and Brazil reaching up to the Antarctica. This distribution shows a wide range of climatic conditions to which these mollusks have adapted. This adaptational ability is also well visible in the wide range of their bathymetric occurrences though they are most common in a depth range of few 100 m to more than 1000 m (Vilvens 2007). They are detritivorous, and the lateral expansion of the snouts is interpreted as an adaption for this deposit feeding. The Mesozoic marine *Calliotropis* (= *Riselloidea*; see above) is very well known from the European Jurassic and other Asian localities and commonly found in shallow marine environments.

Within the Pleurotomariidae, the genera *Pleurotomaria* and *Leptomaria* are related to the extant *Perotrochus* Fischer, *Mikadotrochus* Lindholm and *Entemnotrochus* Fischer. Modern pleurotomariids have twin pectinibranch gills and a small and horny operculum; are commonly found in tropical and subtropical waters, generally in

bathyal zones, and the depth ranges for living species are of 50–900 m in western Atlantic, western Pacific and India (Harasewych 2002). According to Harasewych (2002), the extant pleurotomariidae feed on sponges, foraminiferans and diatoms. Yonge (1973; in Harasewych 2002) suggested that carnivorous diet in this family is associated with deep water habitats from Eocene times; however, preliminary peleoecological interpretations suggest that some Triassic to Jurassic pleurotomariids lived in shallow marine environments (Begg and Grant-Mackie 2003). Kiel and Bandel (2004) found that the members of Pleurotomariidae were diverse and abundant in shallow waters until the Late Cretaceous.

According to Bandel (1993), the cirroideans, with their characteristic change in direction of coiling in the teleoconch, evolved from the Upper Devonian in a parallel and independent way from other Vetigastropoda, such as the Pleurotomarioidea, Trochoidea and Fissurelloidea. Members of Cirroidea lived in warm, tropical and well-agitated waters; in shallow marine environments over consolidated substrates and commonly in association with abundant, benthonic and colonial faunas. They were herbivorous grazers (such as many Trochoidea), or fed on bryozoans, tunicates and sponges (as Pleurotomarioidea), or fed probably on faunal associations (such as Fissurelloidea) (Bandel 1993).

In Early Jurassic marine deposits of Chubut Province, members of *Scurriopsis*, *Chartronella*, *Calliotropis*, *Pleurotomaria*, *Leptomaria*, *Hamusina* and *Jurassiphorus* are found in Lomas Occidentales and Cerro La Trampa localities, in fine- to medium-grained sandstones associated with an abundant and diverse invertebrate fauna including corals, echinoderms, cephalopods, brachiopods, infaunal and epifaunal bivalves and other gastropods. The most representative bivalves are the genera *Weyla*, *Cardinia*, *Chlamys*, *Isognomon*, *Plicatula*, *Kolymonectes*, *Malletia?*, *Nuculana*, *Palaeoneilo*, *Frenguelliella*, *Agerchlamys*, *Grammatodon*, *Ryderia*, *Parainoceramus*, *Entolium*, *Trigonia*, *Pinna*, *Ctenostreon* and *Posidonotis*. Brachiopods are represented by terebratulids, rynchonellids and spiriferinids. Also, but in lower proportion, there are Crinoidea, Bryozoa, Scleractinia and cephalopods (Belemnitida and Ammonoidea). All these invertebrate faunas integrate together with *Ataphrus mulanguiniensis* Ferrari (2011a), *Chartronella paganiae* Ferrari (2011a), *Chartronella spiralis* Ferrari (2011a), *Cryptaulax redelii* Ferrari (2012), *Procerithium nulloi* (Ferrari 2009), *Procerithium (Rhabdocolpus) patagoniensis* Ferrari (2012), *Procerithium (Infacerithium) nodosum* Ferrari (2012), *Pseudomelania feruglioi* Ferrari (2013), *Lithotrochus cf. rothi* Damborenea and Ferrari (2008), *Lithotrochus humboldtii* (de Buch, 1839), *Anulifera chubutensis* Ferrari (2013) and *Globularia cf. catanlilensis* (Weaver, 1931) the marine gastropod association (Figure 6).

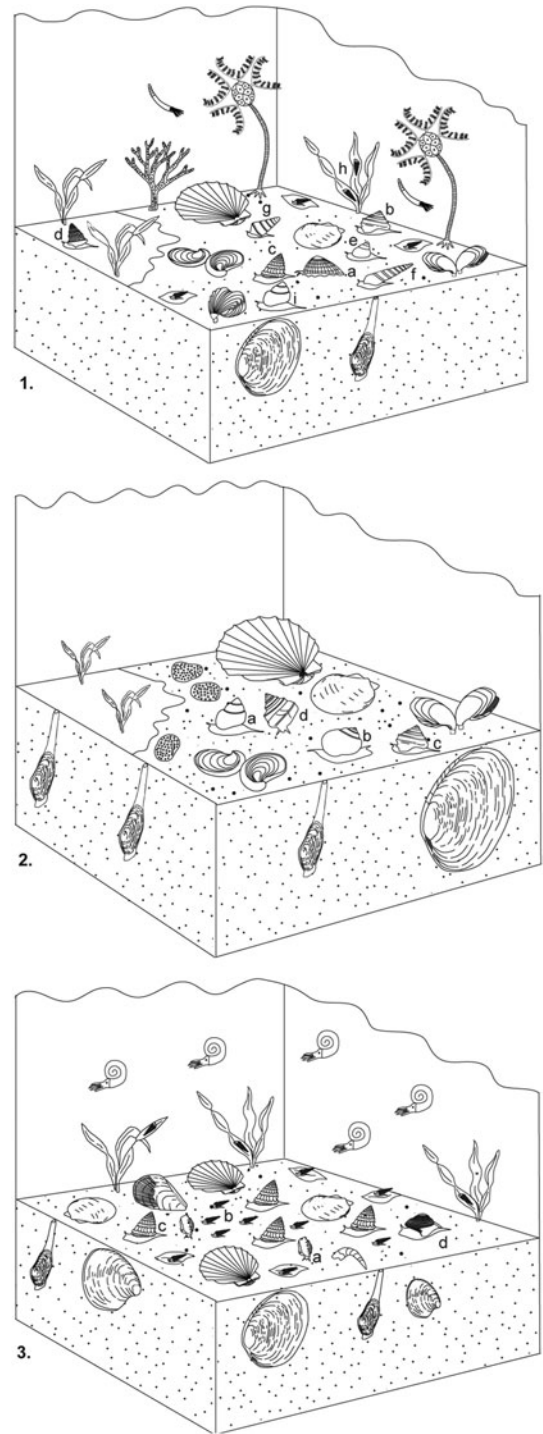


Figure 6. Shallow marine environments showing the associated invertebrate fauna in the three studied localities. (1) Lomas Occidentales: (a) *Scurriopsis*, (b) *Chartronella*, (c) *Calliotropis*, (d) *Hamusina*, (e) *Ataphrus*, (f) *Pseudomelania*, (g) *Anulifera*, (h) *Procerithium*, (i) *Lithotrochus*. (2) Cerro La Trampa: (a) *Lithotrochus*, (b) *Globularia*, (c) *Pleurotomaria*, (d) *Chartronella*. (3) Puesto Currumil: (a) *Colpomphalus*, (b) *Procerithiidae* (*Cryptaulax damborenae* Ferrari), (c) *Eucyclidae* (*Amberleya? espinosa* Ferrari), (d) *Ataphridae* (*Striatoconulus* sp. Ferrari).

The members of *Colpomphalus* were found in Puesto Currumil locality associated with hildoceratid ammonites, such as *Dactyloceras (Orthodactylites) hoelderi* Hillebrandt and Schmidt-Effing, gastropods as *Cryptaulax damboreneae* Ferrari, 2009, *Procerithium nulloi* (Ferrari, 2011b; 2012), *Amberleya? espinosa* Ferrari, 2009, *Striatoconulus* sp. Ferrari, 2009, a doubtful member of Zygopleuridae and the decapod *Mecochirus robbiano* Pagani et al. 2011 (Figure 6).

The entire fauna suggests a shallow marine environment for the gastropod-bearing sediments at Lomas Occidentales, Cerro La Trampa and Puesto Currumil, with a

gradual increase in depth from west to east along the Jurassic marine basin of Chubut Province (Figure 6).

6. Paleobiogeographical considerations

Marine gastropods were little used in the paleobiogeographical analysis of Mesozoic invertebrate faunas. Although earlier authors did not try to explain their distributional patterns, data on Early Jurassic marine gastropods from the western Tethys (Szabó 1994) showed that endemism among gastropods is highly developed and seems to be controlled climatically and paleogeographi-

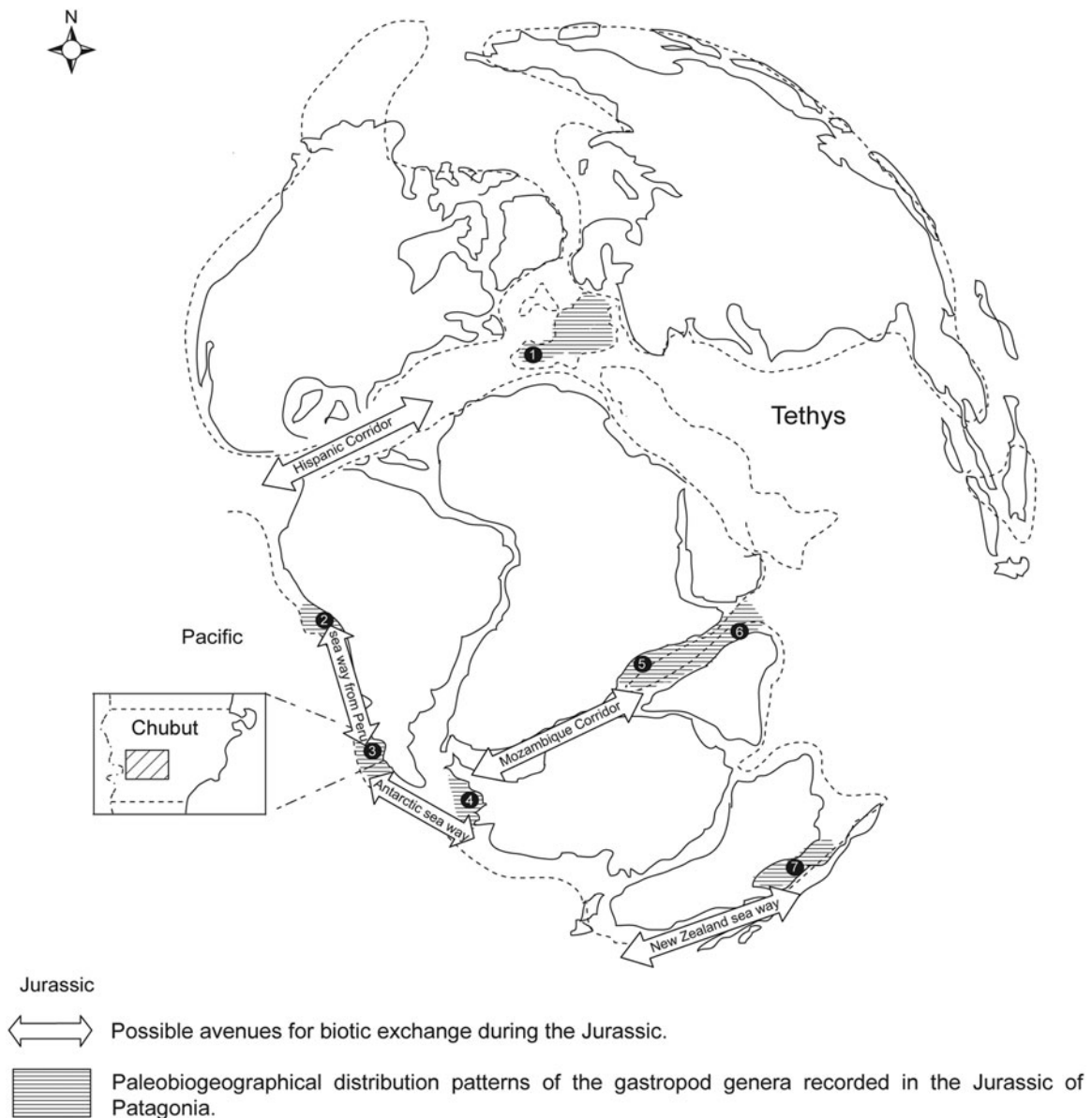


Figure 7. Map showing the paleogeographic distribution of the gastropod genera here reported during the Jurassic. (1) Western Tethys. (2) Peru. (3) Patagonia. (4) Antarctica. (5) Eastern Africa. (6) Western India. (7) New Zealand (modified from Damborenea and Manceñido 1979; Ferrari 2011a).

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cally, resulting in characteristic and separable paleobiogeographical units. Ferrari (2009) pointed out that Early Jurassic marine gastropods (at least at generic level) were of cosmopolitan distribution but show some indigenous species in west-central Patagonia and other localities of Argentina and Chile. Ferrari (2011a) suggested that the Jurassic distribution patterns of some Patagonian marine gastropods may be interpreted following the dispersal routes of the shallow marine bivalve faunas during the Early Jurassic, supporting the idea of a shallow marine connection between the Western Tethys and the eastern Pacific as early as Pliensbachian times, related to the opening of a Mid-Atlantic seaway: the Hispanic Corridor (Damborenea and Manceñido 1979; Damborenea et al. 2012). Ferrari (2011a) argued that the Hispanic Corridor may not have been the only dispersion route enabling faunal exchanges at that time. Peru (Haas 1953), Antarctica (Edwards 1980; Thompson and Turner 1986), New Zealand (Bandel et al. 2000), western India and eastern Africa (Cox 1965; Jaitly et al. 2000) were at that time closer to Patagonia than Europe, and thus may have been also possible avenues for biotic exchange with the Chubutean basin during the Mesozoic (Figure 7).

Several gastropod taxa are reported here for the first time from the Early Jurassic of Argentina and South America (*Scurriopsis*, *Leptomaria*, *Calliotropis*, *Colpomphalus*, *Hamusina* and *Jurassiphorus*), whereas *Pleurotomaria* and *Chartronella* were previously mentioned (Möricke 1894; Jaworski 1925, 1926a, 1926b; Weaver 1931; Piatnitzky 1936; Cox 1956; Aberhan 1992; Gründel 2001; Ferrari 2011a) from Jurassic localities of Peru, Chile and Argentina. The gastropod assemblage reported here testifies paleobiogeographical connections with other coeval gastropod associations from the western Tethys. However, there are some particular genera indicating dispersal routes different from the Hispanic Corridor. *Scurriopsis* is represented in the marine Jurassic of Antarctica and Africa (Cox 1965; Edwards 1980); *Chartronella* is also known from the Upper Jurassic of Africa (Cox 1965); members of *Calliotropis* (= *Riselloidea*), *Leptomaria* and *Pleurotomaria* were recovered from the Middle Jurassic of India (Jaitly et al. 2000) and the genus *Hamusina* was reported from the Jurassic of New Zealand (Bandel 1993; Bandel et al. 2000). The alternative dispersal routes of these genera and their connections with the Patagonia basin during the Jurassic may be interpreted considering the Antarctic, the New Zealand and the Mozambique seaways (Figure 7); such paleobiogeographical patterns agree with those suggested by Damborenea (2002a, 2002b) on the basis of Jurassic bivalve faunas.

Particularly, *Chartronella*, *Hamusina* and *Jurassiphorus* are also well known from the Late Triassic of Peru (Jaworski 1923; Cox 1949; Haas 1953; Bandel 1994). The occurrence of these genera in the Patagonian Jurassic may represent a component of survivors inherited from the end

Triassic extinction, considering the ancient seaway from Peru to the Patagonian basin (Figure 7), the most plausible hypothesis for biotic exchange during the Late Triassic–Early Jurassic boundary. However, it is appropriate to point out that *Jurassiphorus* and *Hamusina* are, until now, doubtfully reported in the Argentinean Jurassic; thus, the paleobiogeographical hypothesis based on these groups is just tentative. A more intensive collecting effort is currently under process to facilitate solid interpretations of the gastropod paleogeographical distribution patterns in the marine Jurassic of South America.

All gastropod genera reported here from Lomas Occidentales, Cerro La Trampa and Puesto Currumil show a wide distributional pattern in the Andean region, from central Peru extending to north-central Chile and Argentinean Patagonia. The new species *Chartronella gradata* sp. nov., *Hamusina? wahnishae* sp. nov. and *Colpomphalus musacchioi* sp. nov. are local to the Chubut Province with a short time range in the Early Jurassic, suggesting, together with the recent species recovered from the Chubut province (Ferrari 2009, 2011a, 2011b, 2012, 2013), a possible gastropod provinciality from the Late Pliensbachian to the Early Toarcian.

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