

## Microbivalves from the Monte León Formation (Early Miocene), Patagonia, Argentina

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### Abstract

Three new species (*Mysella donaciformis* n. sp., *Cosa helianthea* n. sp., and *Lissarca saraballentae* n. sp.) of small bivalves are described from early Miocene rocks in southern Patagonia. The outcrops lie along the coast of the province of Santa Cruz, within the boundaries of the Monte León National Park. The fossil-rich rocks exposed there at the base of the coastal cliff are included in the Punta Entrada Member of the Monte León Formation. This stratigraphic unit has been dated as early Miocene. It was probably deposited in a tidally-influenced near-shore and fully marine environment. The affinities of these small mollusks lie with taxa known to occur in other areas of the Southern Ocean, such as Antarctica, Australia, and New Zealand. The dispersal of these mollusks across vast expanses of water by means of rafting on drifting kelp is discussed.

### Keywords

Bivalvia, Galeommatoidea, Limosoidea, Miocene, Patagonia, Argentina.

### INTRODUCTION

A large number of mollusks living nowadays would fall within the category of micromollusks as used here (< 20 mm), and this has surely been the case in the past. However, because of their size, attention has been focused on the larger ones, which are more conspicuous in the field. Minute bivalves and gastropods have often gone unnoticed in the Cenozoic faunas of southern South America, despite the fact that they do occur in significant numbers, and are likely to appear in samples processed for foraminiferans and ostracods.

The material described herein comes from a locality lying on the Patagonian coast in the province of Santa Cruz (southern Argentina; Fig. 1). Such material is part of a large array of taxa that have not been previously recorded from Miocene rocks in Patagonia. All these non-described taxa have gone unnoticed and played no part in the numerous and divergent stratigraphic and paleoenvironmental interpretations of the Miocene mollusk-bearing Monte León Formation. Likewise, their role in the interpretation of paleoceanographic and paleobiogeographic patterns across the Cenozoic has remained hidden. Therefore, within a wider across-the-board revision of the faunas of micromollusks in this stratigraphic unit, the Families Montacutidae and Philobryidae revised herein are conspicuous elements with extant representatives presently living off the

Patagonian coast and beyond in the circum-Antarctic realm. They may constitute important additions to the fauna when investigating paleobiogeographic patterns of marine mollusks in the southern oceans during the Caenozoic.

### GEOLOGICAL SETTING

DARWIN (1846) was the first to record marine fossils in this area, and the material he collected was studied by SOWERBY (1846). DARWIN believed that the sediments containing the marine invertebrates from Santa Cruz that he collected were exposed continuously along the Atlantic coast from the mouth of the Río Negro down to Santa Cruz; he called these sediments “Great Patagonian Formation”, following in part D’ORBIGNY’s ideas on the subject (D’ORBIGNY, 1842). The pioneering work of AMEGHINO (1896, 1898, 1906) and IHERING (1896, 1897, 1899, 1900, 1907, 1914), together with the work carried out by HATCHER (1897) and ORTMANN (1902), laid out the bases for subsequent interpretations on the geological framework of the area. AMEGHINO (1898) believed that the sediments exposed around the mouth of the Santa Cruz River could be separated into two distinct units, i.e., a marine unit of sandstone and tuffaceous sandstone, overlain by mainly non-marine mammal-bearing sediments. The former he divided into two

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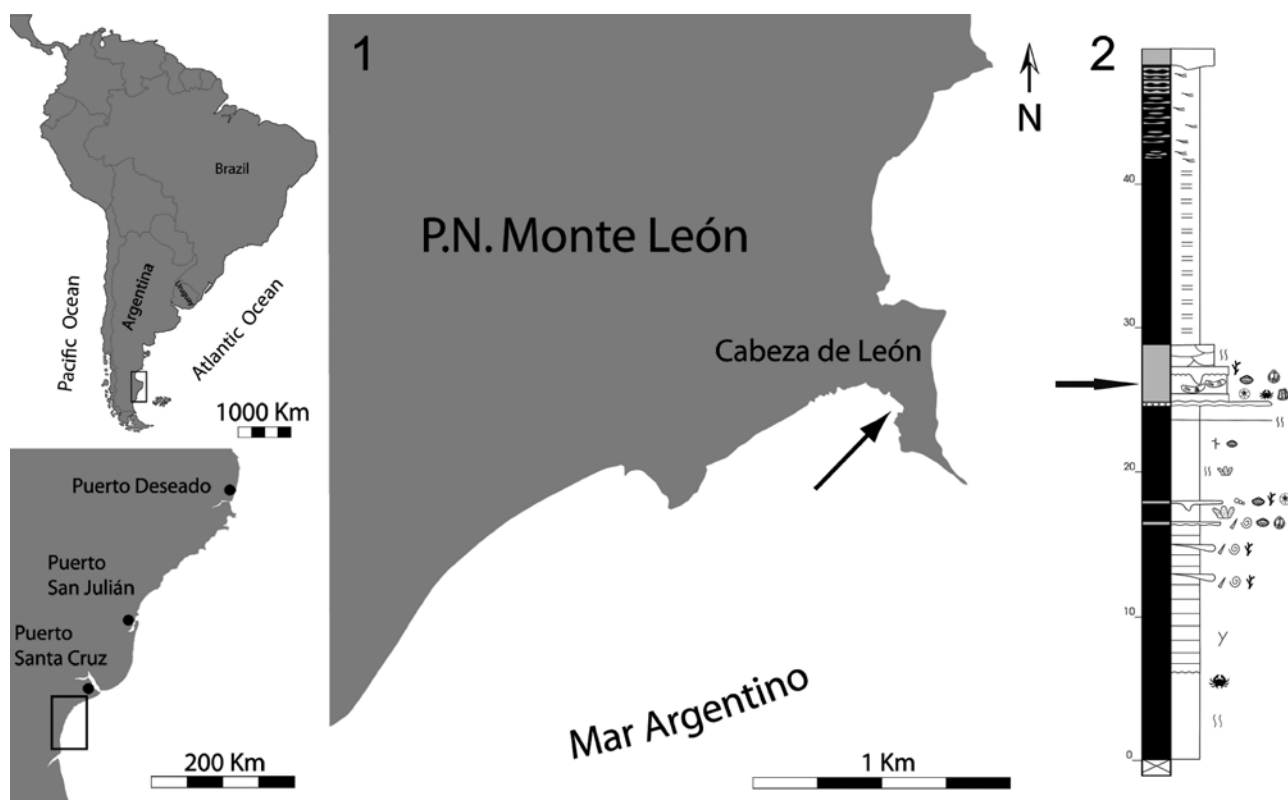


Fig. 1: Location map showing type locality (arrow head) and stratigraphic section with fossil-bearing bed (arrow).

“pisos”, i.e. “Juliense” and “Leonense”. The non-marine unit he divided into “Piso Santacruzense” comprising tuffs and tuffaceous sandstones with mammals, overlying the “Piso Superpatagoniense”, a series of loose marine sandstones with an abundant invertebrate fauna (CRAWFORD *et al.*, 2008; PARRAS & GRIFFIN, 2009). IHERING, who described the mollusks contained in these units, generally supported AMEGHINO’S views, with some minor discrepancies. However, HATCHER, who also carried out geological investigations in this area, strongly disagreed with AMEGHINO and IHERING. In this he counted with the full support of ORTMANN, whom he had given the fossils he collected to describe. An account on the stratigraphic framework of the localities involved in the dispute can be found in ZINSMEISTER (1981) and MARSHALL *et al.* (1986).

The fossils described herein come from shell-beds at the top of the Punta Entrada Member of the Monte León Formation, as described by BERTELS (1970, 1980). The locality (50° 21' 25.4"S, 68° 53' 05.9"W) lies within the boundaries of the Monte León National Park. The material comes from shell-beds lying within loose or very poorly cemented sandstone exposed along the cliff just south of the Monte León beach. These beds are correlated with those exposed at the mouth of the Santa Cruz River and are interpreted as part of a regressive cycle represented by the Monte León Formation; they are tidal

channel deposits. These sedimentological concentrations are parautochthonous and contain also a rich, abundant and well preserved megafauna (IHERING, 1907, DEL RÍO & CAMACHO, 1994; DEL RÍO, 2004a, b, DEL RÍO & MARTÍNEZ, 2006, and references therein; GRIFFIN & PASTORINO, 2005, 2006). A schematic section of the locality is given in Fig. 2.

The age of the bearing sediments has also been a matter of great controversy ever since they were first mentioned in the literature. According to BERTELS (1970, 1975) the Monte León Formation ranges between Chattian and Rupelian, based on the foraminiferans it contains. NÁÑEZ (1988, 1990), also based on the content of foraminiferans, suggested a late Oligocene – early Miocene age for the Monte León Formation. BARREDA & PALAMARZUCK (2000) considered it early Miocene based on palynological data. Material recovered from our samples point to an early Miocene (Waitakian= early Miocene) age for the beds containing it (T. EDWARDS, *in litt.*, see PARRAS *et al.*, 2008).

## MATERIAL AND METHODS

The samples were washed with diluted H<sub>2</sub>O<sub>2</sub> and sieved following the usual procedure for foraminiferans and small mollusks as described in BEU & MAXWELL (1990).

It was then photographed under SEMs at the Institute of Geological and Nuclear Sciences, Lower Hutt, New Zealand, the Museo de La Plata, La Plata, and the Museo Argentino de Ciencias Naturales, “Bernardino Rivadavia”, Buenos Aires, Argentina.

Abbreviations: LV: left valve; RV: right valve. MLP: Invertebrate Paleontology collections, La Plata Natural Sciences Museum, La Plata, Argentina.

## SYSTEMATICS

**Class Bivalvia LINNAEUS, 1758**

**Superfamily Galeommatoidae J. E. GRAY, 1840**

**Family Montacutidae W. CLARK, 1855**

**Genus *Mysella* ANGAS, 1877**

**Type species:** *Mysella anomala* ANGAS, 1877; original designation.

***Mysella donaciformis* n. sp.**

**Fig. 2A-D**

**Diagnosis:** Small *Mysella* with solid elongate shells; umbones inconspicuous; two strong and straight right pseudo-cardinals, anterior one stronger than posterior; RV resilifer deep, triangular and anteriorly inclined; left cardinals blunt, LV resilifer with conspicuous posterior crest. Shells smooth, except for fine growth lines and a few comarginal ledges.

**Description:** Shell small (up to 2.5 mm long), solid, elongate; umbones low, placed near posterior end;

postero-dorsal margin straight, antero-dorsal margin very slightly concave, merging smoothly with widely convex ventral margin; anterior margin rounded; antero-dorsal margin and posterior margin forming an angle of less than 105°; shell surface ornamented with fine commarginal striae and a few inconspicuous “ledges”; hinge solid; right valve hinge with two pseudo-cardinals, anterior one stronger; pseudo-cardinals converging at an angle of ~90°; resilifer deep, triangular and inclined anteriorly, deeper towards posterior edge; left valve hinge with two blunt pseudo-cardinals and a wide resilifer carrying posterior “crest”; adductor muscle scars strong, anterior one kidney-shaped and posterior one rounded; pallial line wide and strongly impressed; internal shell margins smooth.

**Material:** MLP 33684 (holotype); MLP 33685-MLP 33686 (paratypes; eleven specimens).

**Etymology:** Referring to the *Donax*-shaped shell of this species.

**Remarks:** Species of *Mysella* have not been previously recorded as fossils from Cenozoic rocks in Argentina. However, STILWELL & ZINSMEISTER (1992, p. 66-68, pl. 5, fig. a-c) described *Mysella trigonoelliptica*, which they compared with extant New Zealand species. The Antarctic species seems to be proportionally higher and with a stronger hinge. It is otherwise very similar to *Mysella donaciformis* n. sp.

The species from Monte León shows the closest resemblance with *Mysella mabillei* (DALL, 1908), which occurs in the Magellan Strait and off southern Chile (DELL, 1990, p. 46, figs. 71, 72, 73, 89, 90) in water 18-

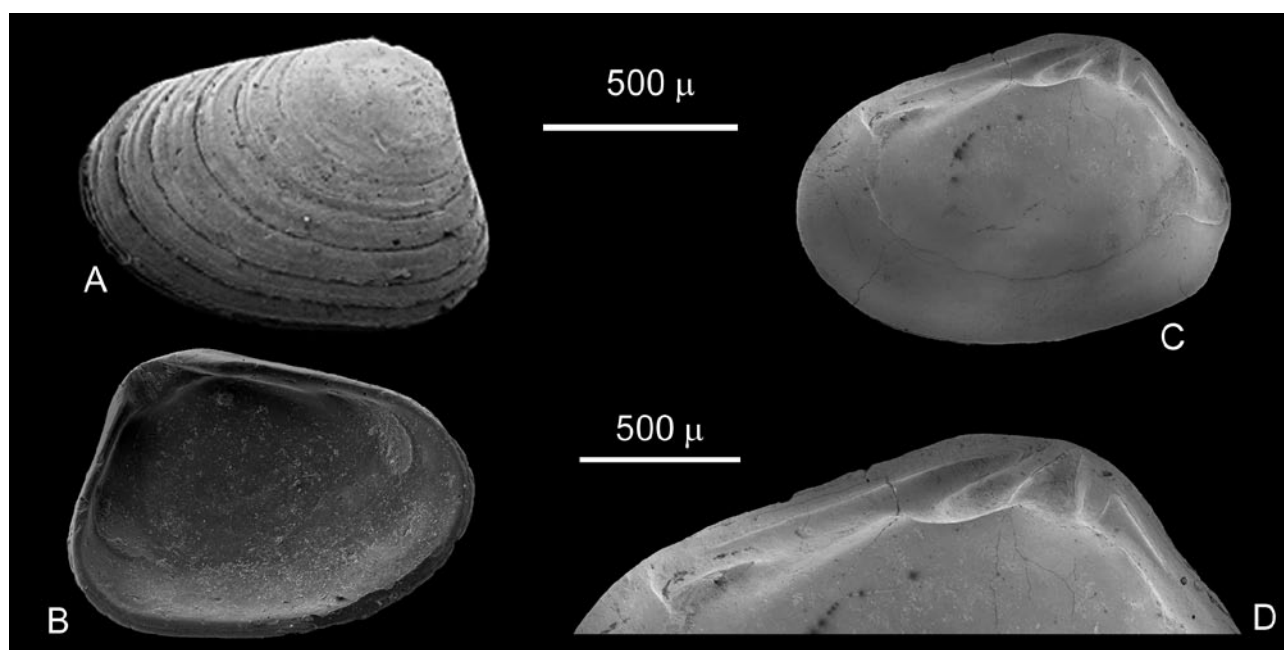


Fig. 2: Microbivalves from Monte León Formation (Early Miocene) collected in the Monte León National Park (50°21'25.4"S, 68° 53' 05.9"W). A-D: *Mysella donaciformis* n. sp. A-B: Holotype [MLP 33684], external and internal views. C-D: Paratype [MLP 33685], internal view and enlargement of hinge.

247 m deep. Both species are very similar, and are only distinguishable by the smaller angle of convergence of the teeth in the living species, which also exhibits a more evenly rounded anteroventral margin. Additionally, the commarginal sculpture is coarser in *Mysella donaciformis* n. sp.

From *Mysella charcoti* (LAMY, 1906) – another species living around the Antarctic Peninsula and the Bellinghousen Sea – it can be separated because the recent species shows an even finer commarginal sculpture, the resilifer seems to be smaller and the hinge teeth somewhat weaker (DELL, 1990, p. 43-45, figs. 68, 69, 70). Also, the antero-dorsal margin is straight instead of slightly concave as in *Mysella donaciformis* n. sp.

*Mysella narchii* PASSOS & DOMANESCHI, 2006, a species sympatric with *Mysella charcoti*, is also similar but the teeth are weaker than in the fossil species. Biology of this brooding deposit-feeding species indicates that they inhabit the first few millimeters below sediment water interface, in sandy or sandy-clayish seafloors. Interestingly, this species was reported as withstanding passage through the digestive tract of fish (DOMANESCHI *et al.*, 2002). Although more studies are required on the different extant species of *Mysella*, this possible dispersal mechanism should be considered in any (paleo) biogeographic analysis of the genus.

#### Superfamily Limopsoidea DALL, 1895

#### Family Philobryidae BERNARD, 1897

#### Genus *Cosa* FINLAY, 1926

**Type species.** *Hochstetteria costata* BERNARD, 1896; original designation.

#### *Cosa helianthea* n. sp.

#### Fig. 3A-G

**Diagnosis:** *Cosa* with 12-14 strong external and 36-37 internal radial ribs; commarginal ornamentation restricted to strong ribs in radial intercostal areas.

**Description:** Shell small, up to 3.4 mm long, subrounded; prodossoconch flat, ornamented with about 18 complete and incomplete fine radial ribs, margin with a thick cord; hinge simple, with two series of vertical striations separated by long and posteriorly directed triangular ligament pit; shell interior shiny, smooth; external ornamentation of adult shells of 13 narrow but conspicuous radial ribs, and fairly strong commarginal ribs; commarginal ribs occupying only spaces between radials and not crossing them; ostracum with 36-37 internal radial ribs, not matching external ones; internal ribs producing crenulations along most of shell margin, missing only in areas immediately next to hinge.

**Material:** MLP 33693 (holotype); MLP 33687-MLP 33692; MLP 33694 (paratypes; ten specimens).

**Etymology:** From the Latin *Helianthum*, because of the sun-flower appearance of the prodossoconch.

**Remarks:** This species is referred to *Cosa* because of its

robust shell, strong radial costae, and lack of hinge teeth that distinguish it from *Philobrya*. The genus is known from the late Oligocene to Recent in New Zealand and southeastern Australia (BEU & MAXWELL, 1990). The type species, *Cosa costata* (BERNARD, 1896), is known from shallow water around New Zealand. The fewer, very strong radial ribs and the more asymmetric ligament distinguish *Cosa costata* from *Cosa helianthea* n. sp. A group of species living in caves and crevices in the Indo-Pacific region from Indonesia to Hawaii (HAYAMI & KASE, 1993) include *Cosa waikikia* (DALL, BARTSCH & REHDER, 1938) and two other less common species. However, all of them appear to be very different from the New Zealand and South American species, as the prodossoconch is sharply domed and the ornamentation is very different with weak radials and strong commarginal ribs. In these features alone they differ enough from the type species to suggest that they may belong in a different genus. *Cosa wanganuica* FINLAY, 1930 (BEU & MAXWELL, 1990, p. 374, pl. 51, figs. e, g, h) was described on the basis of material collected in the Castlecliffian deposit at Wanganui, New Zealand. Like *Cosa helianthea* n. sp., it shows strong radial ribs, well developed commarginal ornamentation, and a crenulated margin. However, in the species from New Zealand, the radial ribs are much stronger and the prodossoconch appears to be smoother. The genus is unknown from rocks outside New Zealand and Australia. *Cosa helianthea* n. sp. is the first record for this genus in rocks exposed beyond the southwestern Pacific region. It is the first record of this peculiar philobryid in South America and yet another intriguing member of the Cenozoic mollusk fauna in the Southern Hemisphere. Its disjunct distribution may be – as in the case of the other philobryids from equivalent rocks – explained in view of their life habits. Members of this group of bivalves generally live in shallow water attached at brown alga (TEVESZ, 1977). Assuming a similar life habit for all genera of the family, the occurrence of *Cosa* in early Miocene rocks of southern South America and Australia/New Zealand may be the result of rafting, attached to stalks of kelp drifting across the southern ocean by means of the Circumpolar Antarctic Current (CCA).

#### Genus *Lissarca* E. A. SMITH, 1877

**Type species:** *Arca (Lissarca) rubrofusca* SMITH, 1877; monotypy.

#### *Lissarca saraballentae* n. sp.

#### Fig. 4A-I

**Diagnosis:** Average-sized *Lissarca* with one strong, evenly wide postumbonal ridge running from umbones to posteroventral margin; prodossoconch caplike and irregularly pitted; 4 to 6 chevron-like teeth in anterior series of ctenodont hinge; anterior teeth with very unequal branches forming a narrow angle-ventral branch



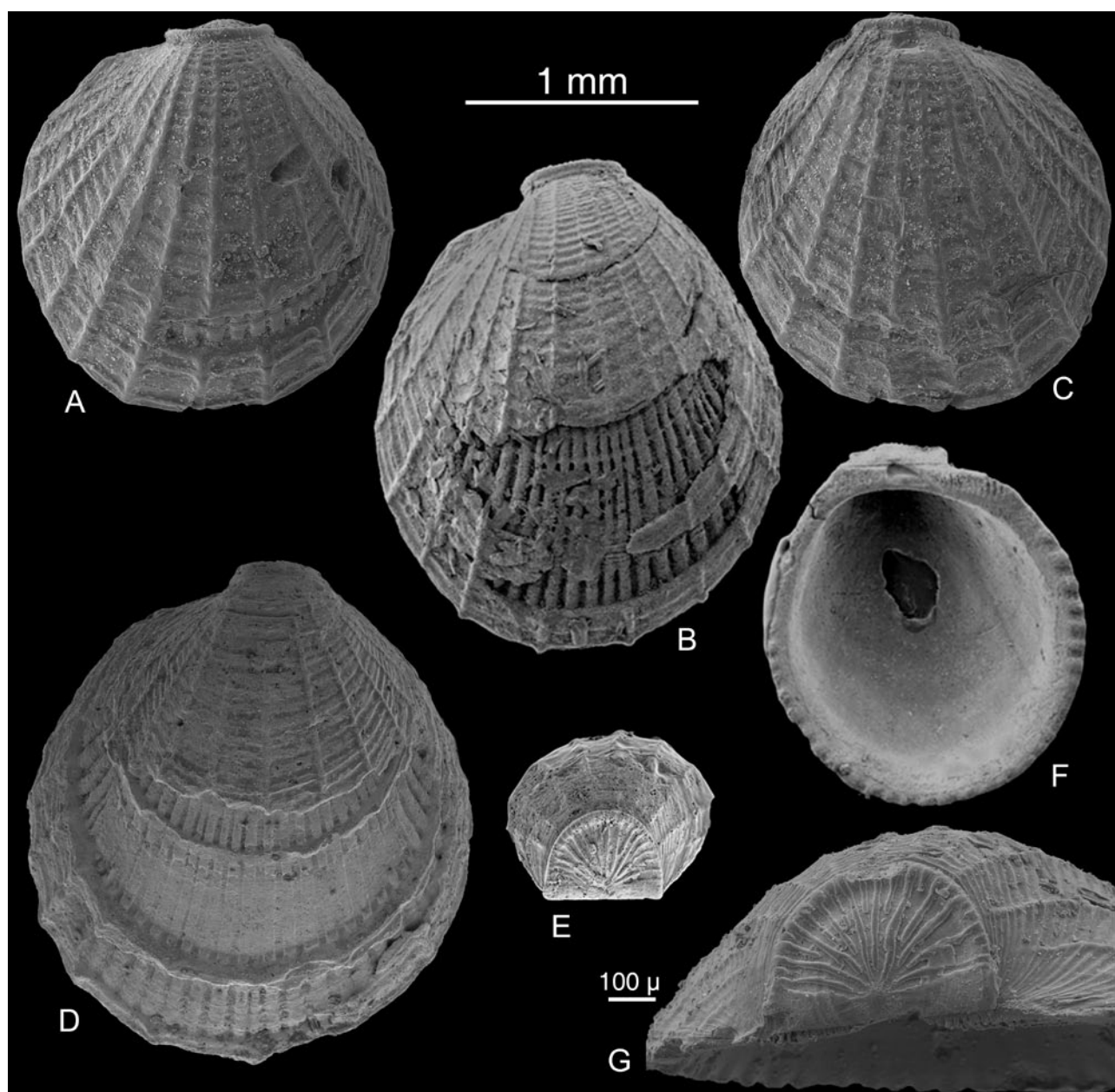


Fig. 3: Microbivalves from Monte León Formation (Early Miocene) collected in Monte León National Park (50°21'25.4"S, 68° 53' 05.9"W). **A-D**: *Cosa helianthea* n. sp. **A**: Holotype [MLP 33693], external view of right valve; **B**: Paratype [MLP 33692], external view of right valve; **C**: Paratype [MLP 33687, specimen a], external view of left valve (specimen damaged); **D**: Paratype [MLP 33691], external view of left valve; **E**: Paratype [MLP 33688], prodissoconch of juvenile specimen seen in dorsal view; **F**: Paratype [MLP 33689], internal view of right valve; **G**: Paratype [MLP 33690], detail of the prodissoconch of an adult specimen, dorsal view.

longer and almost parallel to hinge axis; 4 to 6 chevron-like teeth in posterior series, both branches almost equal and forming very obtuse angle; series generally perpendicular to hinge axis; most external tooth of two series obsolete and conical.

**Description:** Shell average for genus (up to 4 mm long and 4 mm high), opisthocline, fairly thick; umbones placed somewhat anteriorly; inconspicuous prodissoconch semicircular, cap-like, irregularly pitted; dorsal margin

relatively short; posterior margin rounded and merging into convex ventral margin; anterior margin very gently convex; weak radial postumbonal rib running from umbo to posteroventral margin of shell; postumbonal rib bounded by anterior and posterior narrow and shallow grooves; anterior groove slightly deeper than posterior one, rendering postumbonal rib asymmetric; shell surface behind postumbonal rib slightly elevated above general shell surface; hinge long, vertically striated immediately

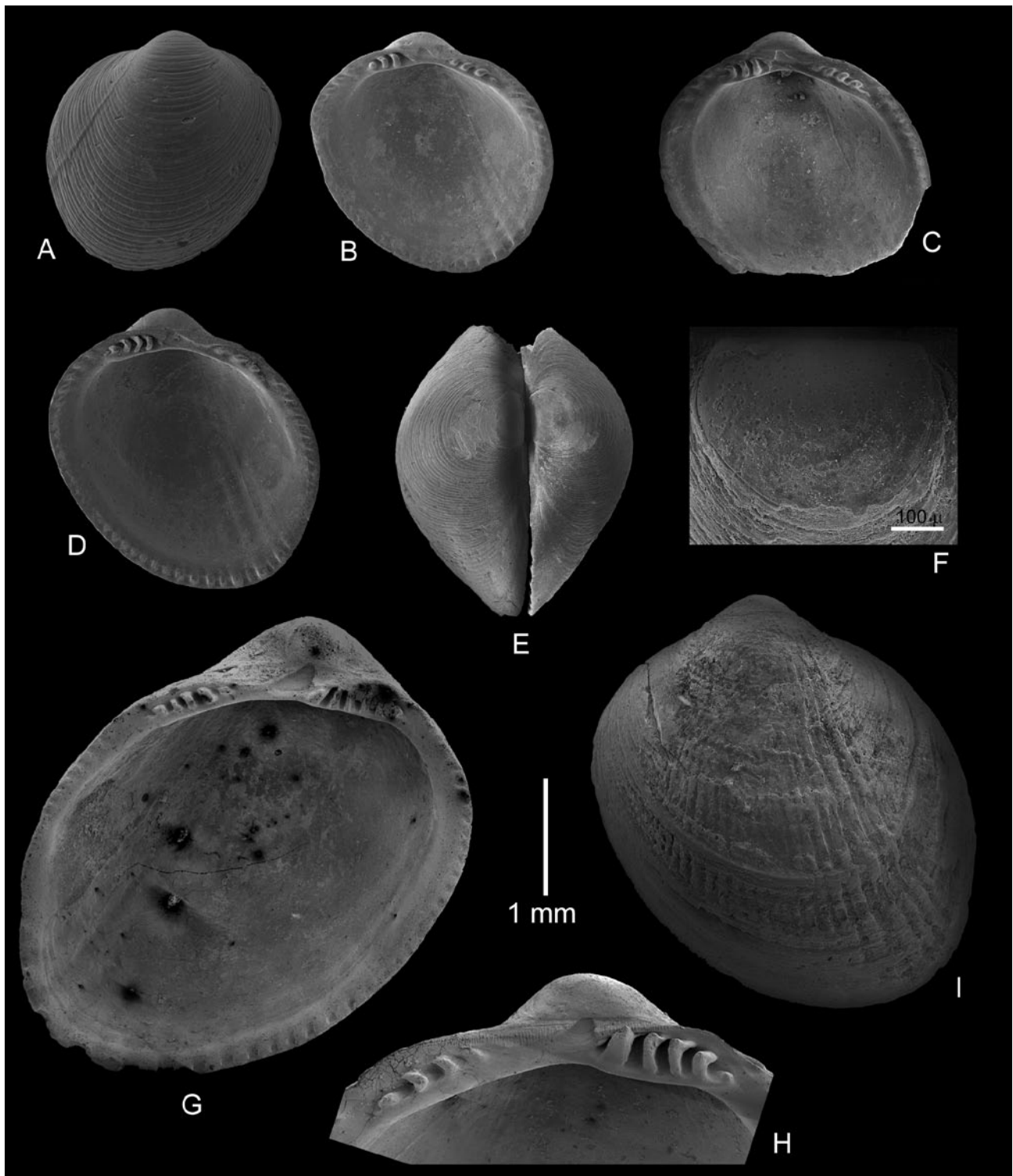


Fig. 4: Microbivalves from Monte León Formation (Early Miocene) collected in Monte León National Park (50°21'25.4"S, 68° 53' 05.9"W). **A-I:** *Lissarca saraballentae* n. sp. **A-B:** Holotype [MLP 33698], external and interior view of right valve; **C:** Paratype [MLP 3701], internal view of right valve; **D:** Paratype, [MLP 33697], internal view of right valve; **E:** Paratype [MLP 33695, specimen a, damaged], dorsal view of specimen with conjoined valves; **F:** Paratype [MLP 33695, specimen b, damaged], view of prodissoconch showing pitted surface; **G:** Paratype [MLP 33699], internal view of left valve; **H:** Paratype [MLP 33700], left valve hinge; **I:** Paratype [MLP 33696], external view of left valve, surface worn.

under umbones; resilifer wide, triangular and strongly inclined posteriorly; anterior teeth series with 4 to 6 chevron-like teeth, with narrow angle and very unequal branches, the ventral one far longer and almost parallel to hinge axis; posterior series with 4 to 6 chevron-like teeth, both branches almost equal and forming very obtuse angle; series generally perpendicular to the hinge axis; most external tooth of two series obsolete and conical; interior of shell with faint radial ribs, reflecting strong internal ribs not visible on outer shell surface; ribs wider and stronger along post-umbonal ridge; internal margins crenulated, more strongly near hinge and at postero-ventral end of shell; outer shell surface with regularly spaced flat commarginal ribs.

**Material:** MLP 33698 (holotype); MLP 33695-MLP33697 and MLP 33699-MLP33701 (paratypes; 66 specimens).

**Etymology:** Honoring our friend Sara BALLENT, Professor of Micropaleontology at the University of La Plata, in memory of her warm and enthusiastic encouragement over the years.

**Remarks:** POWELL (1960) recorded six species of *Lissarca* living at present in Antarctic and Subantarctic waters. Among them, *Lissarca miliaris* (PHILIPPI, 1845) is the one that most resembles the fossil from Santa Cruz. They can be distinguished by the generally stronger shell in the fossil species, which also shows far better developed commarginal ornamentation. The shell in *Lissarca miliaris* is also more opisthocline.

*Lissarca bennetti* PRESTON, 1916 (MACN-In 9340) from the South Shetlands Islands is significantly more prosocline, with umbones placed much more anteriorly, and much weaker hinges; the ornamentation is also weaker and not as regular as in the fossil species. Additionally, the shells are very thin, almost translucent and are missing the post-umbonal ledge present in *Lissarca saraballentae* n. sp.

*Lissarca notorcadensis* MELVILL & STANDEN, 1907, living in the circum-Antarctic region (including southernmost South America), shows a generally similar shell outline, but the ornamentation is much weaker than in the fossil species and the anterior portion of the shell is narrower, which renders it faintly modioliform.

## CONCLUDING REMARKS

The new species described herein are an initial step towards the revision of the abundant fauna of micro-mollusks contained mainly within the early Miocene Monte León Formation. Accurate identifications and assessment of the paleoecological traits of the fossil taxa should enable better interpretations on the paleobiogeographic history of the group, and consequently on the paleoceanographic setting and basin configuration at the moment the bearing stratigraphic units were deposited. All three species described belong in families with extant

species that can live attached to kelp stems in the Southern Ocean. They may be further proof of a more intense faunal exchange between the different land-masses surrounding the southern ocean and Antarctica, than has been previously acknowledged (BEU *et al.*, 1997; FRASER *et al.*, 2010; CASADÍO *et al.*, 2010). Drifting across vast expanses of ocean would have been facilitated by the West Wind Drift and the CCA. The life habits of the fossil species described was probably similar to that of extant representatives of the same genera. Therefore, attachment to kelp stems may have been common enough as to dramatically increase chances of dispersal for these mollusks, as already described for other groups of the same taxa (O' FOIGHIL *et al.*, 1999; DONALD *et al.*, 2005).

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