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**Article**

# Danian (Early Paleocene) echinoids from the Roca Formation, northern Patagonia, Argentina

**Sergio Martínez, Claudia J. del Río and Andrea Concheyro**

With 7 figures

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**Abstract:** Stratigraphically well-constrained echinoids from the Roca Formation in the province of Río Negro (Patagonia, Argentina) are analysed in detail. The poorly known *Linthia? joannisboehmi* Oppenheim in Böhm, 1903, recently reassigned to *Paraster*, is demonstrated to comprise in fact two distinct species, *Linthia? joannisboehmi* and *Linthia parmae* n. sp. In addition, specifically indeterminate species of *Plesiaster* and *Hemiaster* and a basal holasteroid are recorded. The analyses of calcareous nannofossil assemblages of the echinoid-bearing strata document their early Paleocene (Danian) age, which has an impact on patterns of survivorship across the K/Pg boundary.

**Key words:** Echinoidea, Danian, Roca Formation, Patagonia, Argentina, new species.

## 1. Introduction

The aims of the present paper are to describe and stratigraphically confine echinoids from the Danian Roca Formation (northern Patagonia, Argentina). This is accomplished by providing accurate stratigraphic data on the ranges of these echinoids in the type area and section of the Roca formation, demonstrating that the species studied are in fact confined to the Danian. Paleocene faunas from southern latitudes are poorly known, and shallow-water assemblages from the Cretaceous-Paleocene interval in Patagonia in particular are in need of detailed analyses. Research of these faunas has only recently been initiated (e.g., Feldmann et al. 1995; Casadío 1998; Casadío et al. 1999; Parma & Casadío 2005; Griffin et al. 2008; del Río et al. 2007, 2008, 2011). Key data on Danian biota from Argentina and the implementation of a high-resolution stratigraphic scheme for these latitudes are essential for a more detailed correlation with other localities which expose the Cretaceous/Paleogene (K/Pg) boundary in both the southern and northern hemispheres. Moreover, this study will aid in obtaining a clearer picture of how faunas suffered from the K/Pg extinction event.

The sedimentary sequence which comprises the K/Pg boundary interval in northern Patagonia is referred to as the Jagüel and Roca Formations and, although the exact position of the boundary between these units currently is unknown, stratigraphic ranges of different taxa have been speculated upon and numerous survivor/extinction scenarios have been proposed, even for echinoids (Parma & Casadío 2005).

Molluscs dominate early Paleocene (Danian) faunal assemblages in Patagonia. Echinoids, however, are relatively diverse and common at some levels. Some ten species, considered to be of Late Cretaceous or Paleo-


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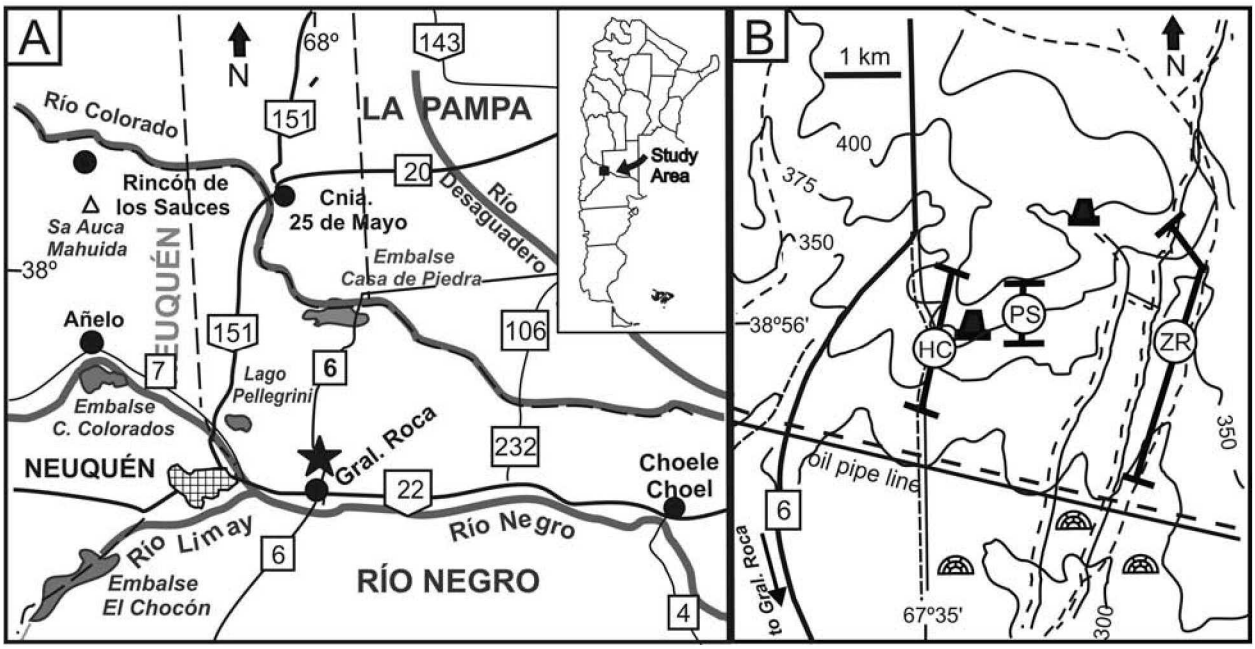


**Fig. 1.** The echinoid-bearing locality (star); 2. Topographic map showing sections mentioned in the present paper; abbreviations are as follows: ZR Zanjón Roca; PS = Picada Sísmica; HC = Horno de Cal.

gene age, have been listed or described since the first mention of echinoids by Burckhardt (1901). Parma & Casadío (2005) reviewed some Maastrichtian and/or Danian echinoid species collected from different localities in the region and evaluated their stratigraphic ranges within the context of the K/Pg extinction event. These authors, however, failed to provide accurate stratigraphic data for the material studied. As shown by del Río et al. (2007, 2008, 2011), careful field work and a high-resolution biostratigraphic control, on the basis of associated calcareous nannofossils, have now resulted in a new and better time-constrained picture of these sediments. This will allow more reliable studies of the K/P boundary in northern Patagonia to be carried out in future.

Echinoids described in the present paper originate from the Roca Formation exposed in its type area, 10 km north of General Roca City (Fig. 1), where this unit overlies the Jagüel Formation. The studied Roca Formation outcrops comprise 40 metres of greenish limestones with an upward increase of intercalations of highly fossiliferous marlstones, as described in detail by del Río et al. (2011). The boundary between the Roca and Jagüel Formations has conventionally been placed at the first occurrence of coquinas, a criterion also used in the present paper. The age of both units has been re-evaluated on the basis of exceptionally well-preserved calcareous nannofossil assemblages which assign a late Maastrichtian–Danian age (CC26-NP2 Zones) to the Jagüel Formation and a Danian age to the Roca Formation (NP2-NP4 Zones) (del Río et al. 2011). Echinoids were collected from beds #29 at Zanjón Roca, #10 at Picada Sísmica and beds #13 and #15 at Horno de Cal, the type section of the Roca Formation (Fig. 2), associated with a diverse molluscan fauna. Material from Zanjón Roca was retrieved from float on the indurated, basal, massive coquina. The specimens do not show any signs of abrasion and are filled with sediment from the overlying mudstone unit. In view of this, we believe that these echinoids could have originated from mudstones which were more easily eroded. In any case, the maximum age of these echinoids is that of the coquinas, which is Danian (NP2 Zone), and the minimum one corresponds to Zone NP4. Echinoids have neither been collected from underlying beds, nor from the base of the outcrops.

The following abbreviations are used to denote repositories of material illustrated and referred to: CPBA, Cátedra de Paleontología, Universidad de Buenos Aires, Argentina; GHUNLPam, Facultad de Ciencias Exactas y Naturales, Universidad de La Pampa, Argentina; MACN-Pi, Museo Argentino de Ciencias Naturales B. Rivadavia (Laboratory of Invertebrate Paleontology); MLP, Museo de La Plata, Argentina.

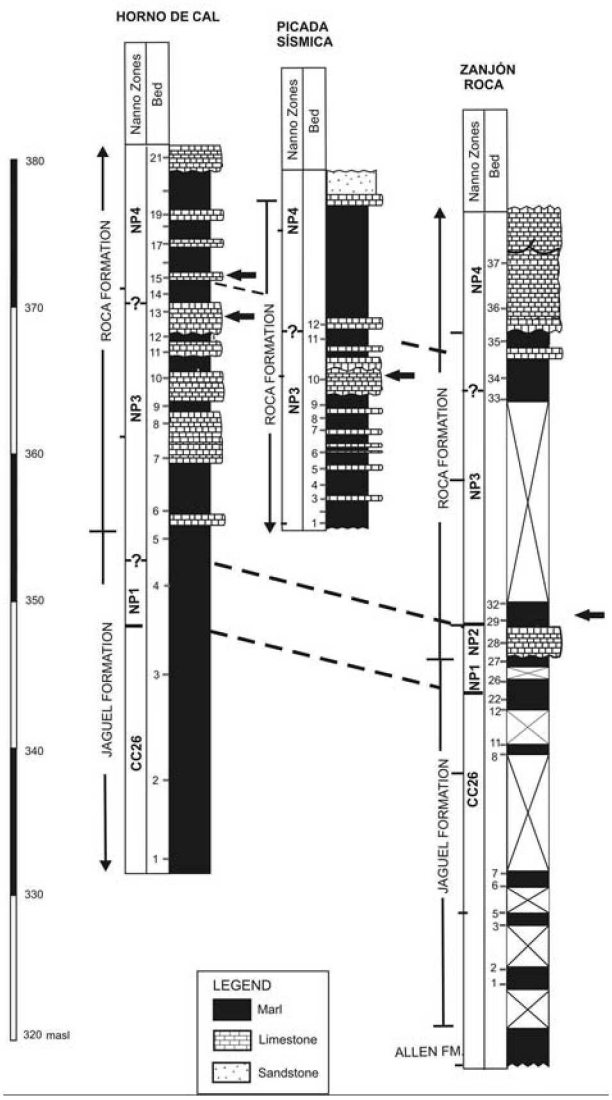


**Fig. 2.** Lithostratigraphic sections showing echinoid-bearing levels (arrows). Modified from DEL RÍO et al. (2011).

## 2. Systematic palaeontology
(following KROH & SMITH, 2010)

Order Holasteroida DURHAM & MELVILLE, 1957
Holasteroida indet.
Figs. 3A-E, 4A, B

**Material and occurrence:** MACN-Pi 5204, MACN-Pi 5205 and MACN-Pi 5214; Roca Formation (Danian), bed #29, Zanjón Roca (see DEL RÍO et al. 2011), 10 km north of General Roca City, Río Negro Province, Argentina.

**Description:** Test small, cordiform (test length and maximum width in MACN-Pi 5214, MACN-Pi 5204 and MACN-Pi 5205 being 19 and 16 mm, 17 and 15 mm, and 14.5 and 13 mm, respectively); posterior truncate; base flat, except for raised interambulacrum 5, especially posteriorly; adoral surface convex, slightly keeled posteriorly; widest part slightly anterior, sides weakly convex; frontal groove shallow, lacking carinae, continuous from apex to peristome, very shallow near apex; apical system central, elongate, of standard holasteroid configuration, with four gonopores, madreporite large, genital 3 small; ocular pores smaller than genital pores; paired ambulacra subpetaloid, flush and not constricted at extremities, enlarged pores extending to near margin; anterior paired ambulacra narrower than posterior ones; subpetaloid anterior pair of ambulacra with c. 18 enlarged pore pairs (test length 17 mm), 21 at test length 19 mm; pores in anterior series small and near circular, posterior ones elongated, oval; posterior pair of ambulacra with c. 15 elongated pore pairs (test length 17 mm), 16 at test length 19 mm; pores of anterior series subrounded to oval, smaller than oval to slit-like posteriors; anterior subpetals diverge at angle of 100°-120°, posterior ones at 70°-80°; anterior ambulacrum with c. 17 small, round, oblique isopores (test length 17 mm), 19 at test length 19 mm); pores non conjugate in all ambulacra; peristome anterior, transversely oval, with narrow rim, facing directly downwards; plate architecture of plastron not clear, most probably protosternous, somewhat keeled posteriorly; periproct oval, longer than wide, situated high on posterior truncate face; adapically there are enlarged primary tubercles: MACN-Pi 5204 has interambulacra 1, 2, 3 and 4 with two, while MACN-Pi 5214 bears two larger and two smaller ones in interambulacrum 1, two in interambulacrum 2, three rather larger ones than the anteriors in interambulacra 2 and 3, and two in interambulacrum 5; crenulations are not seen. Enlarged tubercles are situated along the interambulacra, rather than near the apical system. No fascioles seen.

**Remarks:** This material probably represents a new taxon, but the lack of key characters (e.g., detailed plastron plating) preclude formal naming. The specimens are similar to *Holaster* (i.e., cordiform test with a shallow sulcus, lack of carinae from apex to peristome, enlarged primary tubercles, paired aboral ambulacra subpetaloid with elongated, non-conjugate pores, anterior paired ambulacra narrower than posterior ones, absence of fascioles), but plastronal plating is obscure; from what is visible it seems to be protosternous or nearly so, rather than meridosternous.

*Pseudholaster* POMEL, 1883, according to SMITH & JEFFERY (2000: 289) and SMITH (2010), has a protosternous plastron but differs from our specimens in having a deep sulcus with sharp carinae, petaloid ambulacra with conjugate pore pairs, and a more oval and anterior peristome.

Our material cannot be assigned to *Giraliaster* FOSTER & PHILIP, 1978, on account of test proportions, *Giraliaster* being nearly as wide as long, while our specimens are longer than wide; moreover, the frontal sulcus is shallow, pores of the anterior ambulacrum are not separated by a granule, the posterior pore rows of each petal do not have conjugate pores, pores of the anterior rows are not rounded in the posterior ambulacra and there is no subanal fasciole. Tuberculation is also different in *Giraliaster*; this genus lacks enlarged interambulacral tubercles.

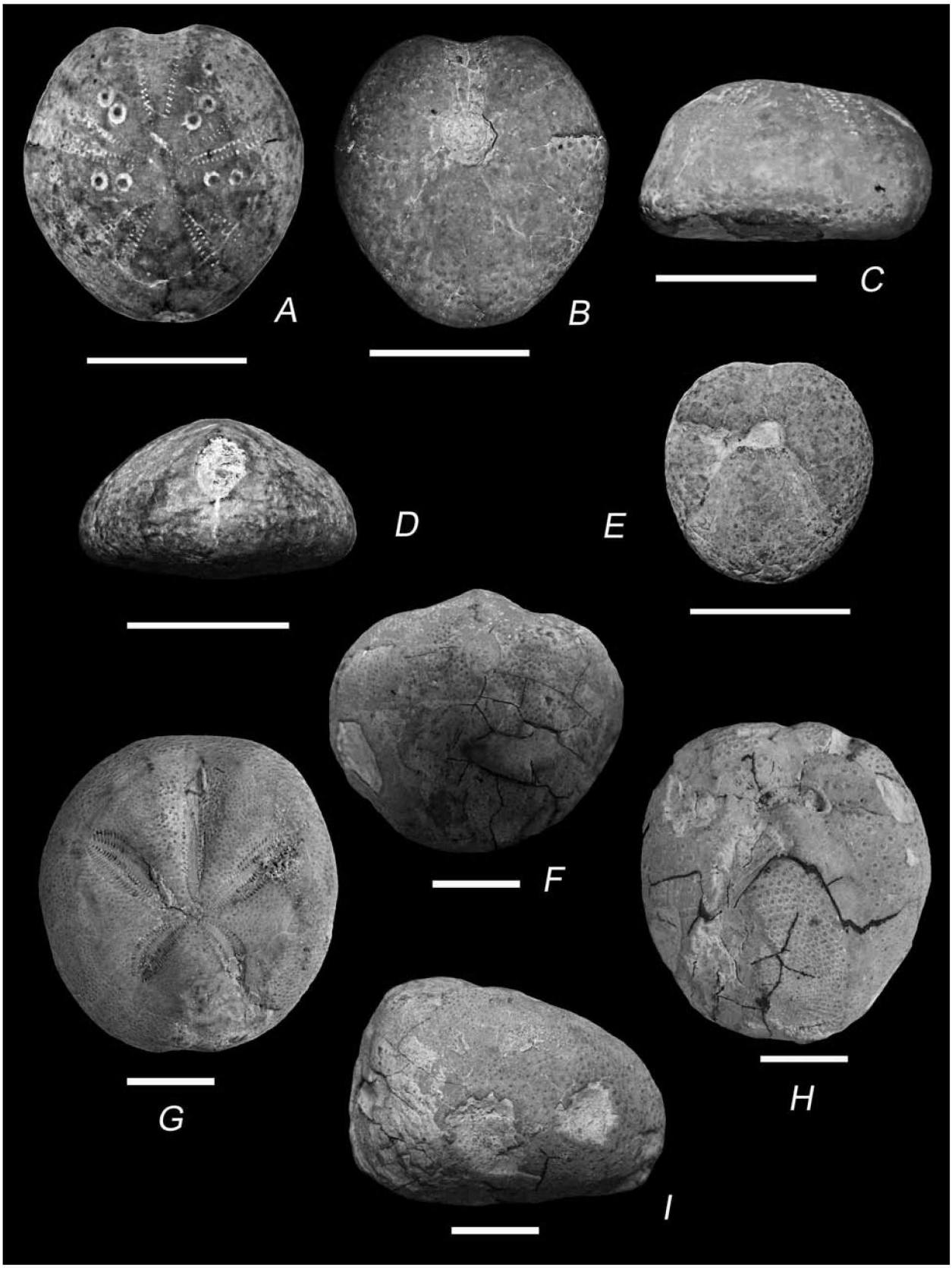


Fig. 3.

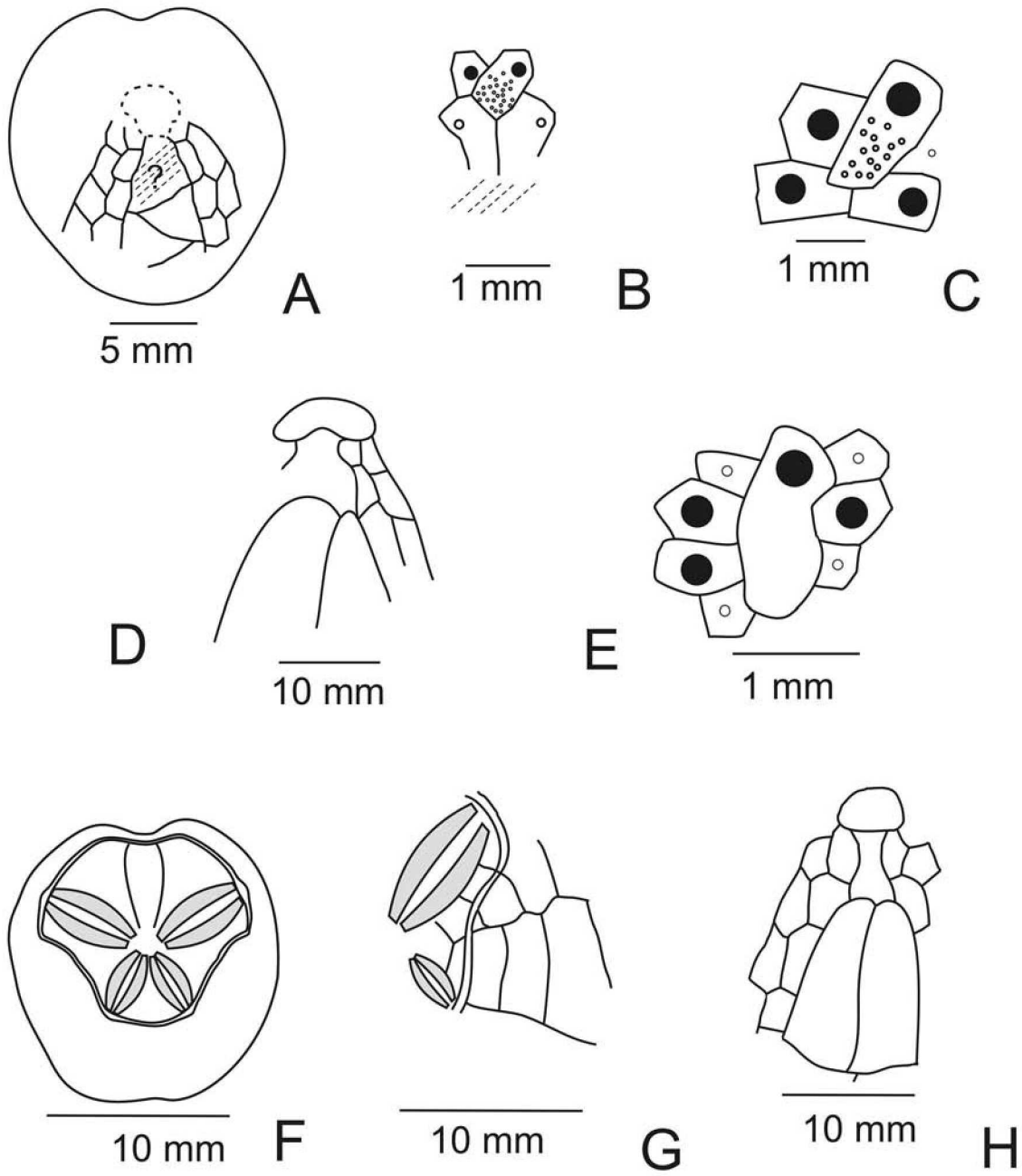


**Fig. 4.** A-B. Holasteridae indet., A. MACN-Pi 5204, partial plastron plating; B. MACN-Pi 5214, anterior part of apical system. C-D. *Hemiaster* sp., MACN-Pi 5206, sketch of apical system and partial plastron plating, respectively. E-H. *Linthia*? *joannisboehmi*, E. MACN-Pi 5207f, sketch of apical system; F. MACN-Pi 5207c, sketch of apical view, showing the general trajectory of the fasciole; G. MACN-Pi 5207c, sketch of apical view, showing the detailed trajectory of the fasciole at interambulacrum 1. H. MACN-Pi 5207e, partial plastron plating.

**Fig. 3.** A-D. Holasteridae indet., MACN-Pi 5204, in apical, oral, lateral and posterior views, respectively; E. Holasteridae indet., MACN-Pi 5205, oral view; F-I. *Hemiaster* sp., MACN-Pi 5206, in posterior, apical, oral and lateral views, respectively. Scale bar represents 10 mm.

*Entomaster* Gautier 1888, according to Smith (2010), has a chordate test, and the aboral enlarged primary tubercles resemble our material, but *Entomaster* is conical in profile, has a deeper anterior sulculs in oral surface, and a transverse periproct.

With respect to previous records of holasterids from Argentina, *Holaster feruglioi* Melinossi, 1935, from the mid- or Late Cretaceous in the vicinity of Lago Argentino (Santa Cruz Province), differs from our specimens in being larger, with different proportions (i.e., W>L), with a more depressed posterior, higher profile and with the frontal ambulacrum widening towards the ambitus. Despite our efforts, we have been unable to trace the type specimen (presumably lost), and the original description and figures do not allow us to be conclusive about its generic placement.

*Holaster mortenseni* Bernasconi, 1953, from the ?Senonian at Río Grande (Tierra del Fuego Province, Argentina), is much larger than the present material and has well-developed petals. Moreover, it lacks any diagnostic characters of *Holaster*, and undoubtedly does not belong to that genus. Unfortunately, the type is lost, and with only the description and plates in Bernasconi (1953), we are unable to determine its generic placement.

*Holaster lorioli* Lambert, 1910, from the Maastrichtian of Snow Hill Island (Antarctica), should be reassigned to *Giraliaster*, according to Néraudeau et al. (2000).

## Order Spatangoida Claus, 1876
## Family Hemiasteridae H. L. Clark, 1917
## Genus *Hemiaster* L. Agassiz in L. Agassiz & Desor, 1847

**Type species:** *Spatangus bufo* Brongniart in Cuvier & Brongniart, 1822 (84), by the subsequent designation of Savin (1903: 22).

### *Hemiaster* sp.
### Figs. 3F-I, 4C, D

2005 *Hemiaster hawkinsi* Lambert, 1933 – Parma & Casadío, p. 1080 *partim*, figs. 11.1-11.3.

**Material and occurrence:** MACN-Pi 5206, bed # 29 at Zanjón Roca (see del Río et al. 2011), 10 km north of General Roca City, Río Negro Province, Argentina.

**Description:** Test medium sized (length 37 mm, maximum width 33.5 mm); ovate-subtrapezoidal in outline, widest at centre, with a very weak frontal depression; posterior margin truncated, highest point posterior to apical disc, on keel; periproct not visible from above; apical disc posterior to centre, ethmophract, with four genital pores; anterior ambulacrum long, depressed, with nearly straight edges, with 34 rounded, obliquely aligned pore pairs, pores of each pair separated by protuberance; anterior paired petals rather wide, arched, distally flexed, with 31 pairs of elongated pores (poriferous zones wider than interporiferous zones), diverging at about 95°; anterior paired petals 1.5-2 times longer than posterior ones; posterior paired petals short, slightly arched, with 27 pairs of elongated pores, diverging at about 75°; poriferous zones wider than interporiferous zones; peripetalous fasciole not indented, widest at base of petals; peristome anterior, with thin rim, labrum projecting over reniform peristome; plastron amphisternous, left sternal plate larger than right, suture oblique; labral plate longitudinally elongate, widened posteriorly and anteriorly near rim; periproct oval, longer than wide, not visible from above, situated near top of posterior face.

**Remarks**: Parma & Casadío (2005) described and illustrated some specimens, presumably of Maastrichtian-Danian age, from several localities in Argentina which they attributed to *Hemiaster hawkinsi* Lambert, 1933, from the Maastrichtian-Danian of Madagascar (see Tanaka et al. 1979). Our revision of those specimens has revealed that two morphotypes, probably two different species, are represented. The present specimen is closely to one of these (e.g., GHUNLPam 22031); they differ from *H. hawkinsi* in being larger, with a posterior (rather than central) apical system, an unindented fasciole plus a more trapezoidal (dorsal view) and wedge-shaped (lateral view) outline. Our material probably represents a new species, but as only a single specimen is available, we prefer the use of open nomenclature. In addition, current knowledge of the taxonomy of the genus *Hemiaster* (see Smith et al. 2010) is such that introducing a new taxon seems unwarranted.

## Suborder Paleopneustina Markov & Solovjev, 2001
## Family Schizasteridae Lambert in Doncieux, 1905
## Genus *Linthia* Desor, 1853

**Type species:** *Linthia insignis* Desor, 1853, by original designation.

### *Linthia? joannisboehmi* (Oppenheim in Böhm, 1903)
### Figs. 4E-H, 5A-D

1901 *Hemiaster pullus* Stoliczka – Burckhardt, p. 21, pl. 1, figs. 1-4.

**Fig. 5.** A-C. *Linthia? joannisboehmi*, MACN-Pi 5207d, apical, oral and lateral views, respectively; D. *Linthia? joannisboehmi*, MACN-Pi 5207e, posterior view; E-H.
*Linthia parmae* n. sp., holotype, MACN-Pi 5208, lateral, posterior, apical and oral views, respectively. Scale bar represents 10 mm.

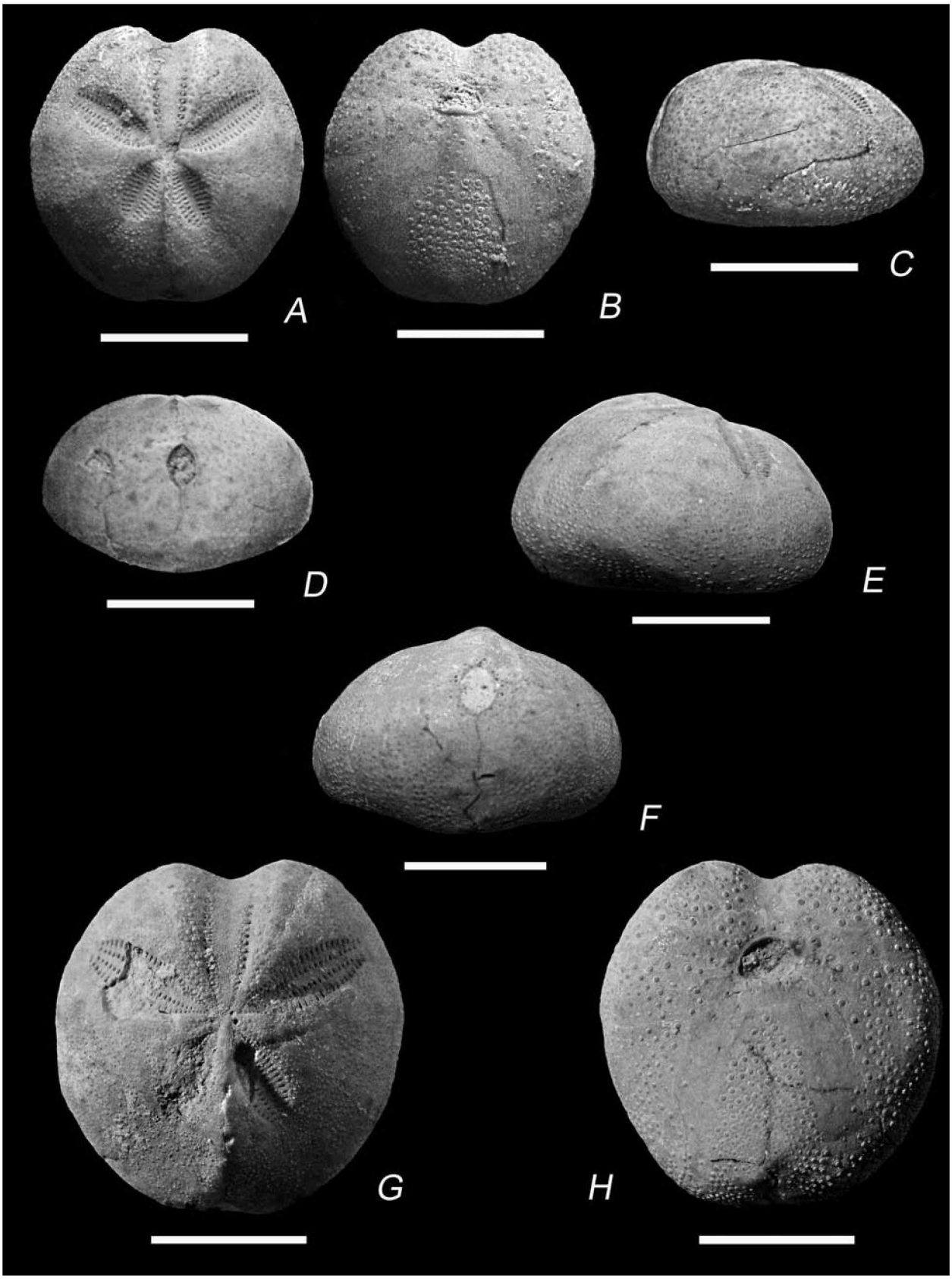


Fig. 5.

1901 *Hemiaster* aff. *cristatus* Stoliczka – Burckhardt, p. 21, pl. 1, figs. 5-8.
1903 *Linthia(?) Joannis Böhmi* Oppenheim *in* Böhm, p. 72.
1959 *Linthia joannis-böhmi* Oppenheim – Bernasconi, p. 166, pl. 4, figs. 1, 2.
2005 *Paraster joannisbohemi* (Oppenheim in Böhm) – Parma & Casadío, p. 1080 *partim*.

**Material and occurrences:** MLP 9347 (Burckhardt Collection), Roca, Río Negro Province; MACN-Pi 5207a-f, bed #29 at Zanjón Roca (see del Río et al. 2011), 10 km north of General Roca City, Río Negro Province, Argentina. Also known from beds #13 and #15 in the Horno de Cal section, and from bed #10 at Picada Sísmica (del Río et al. 2011).

**Description**: Test small (average length of MACN-Pi 5207a-f, 16 mm), ovate-subhexagonal with anterior margin indented; posterior margin truncated or weakly concave; widest slightly anteriorly, higher posterior to apical disc; posterior face rather inclined, periproct visible from above; apical disc central to slightly anterior, ethmolytic; posterior gonopores rather wider apart than anterior ones; anterior and posterior gonopores on either side close together; posterior oculars not in contact; petals broad and sunken, anterior ones 1.5-2 times longer than posterior ones; anterior petals with 22 pore pairs, posterior with 15 pairs in each column (test length 17 mm), 20 and 10 pore pairs, respectively, at test length 14 mm; petal pores elongate, of near-equal size or with internal row slightly smaller; anterior petals diverge at around 105-115°, posterior ones at around 55-60°; interporiferous zone about two-thirds the width of column; anterior ambulacrum sunken, pore pairs rather small, well separated by ridge, 12 (test length 17 mm), and 11 at test length 14 mm; peripetalous fasciole widest at base of petals; peristome anterior, 1.5-2 times as broad as long; labrum with thin rim, projecting slightly over peristome; plastron amphisternous, posteriorly convex; labral plate longitudinally elongate, widened posteriorly and very anteriorly at rim, extending to second ambulacral plate; left sternal plate rather larger than right, or nearly equal (the variation in this character is not wide) ; periproct oval, longer than wide, visible from above, situated in upper half of inclined posterior face.

**Remarks**: This species was named by Oppenheim (in Böhm 1903), with reference to material illustrated by Burckhardt (1901). One of those specimens (i.e., the one illustrated as *Hemiaster* aff. *cristatus* Stoliczka) is housed in the collections of the Museo de La Plata (MLP 9347), but another specimen (illustrated as *Hemiaster pullus* Stoliczka) has not been traced, although unfigured representatives of that species are contained in these collections (MLP 9324). The new material presented here allow us to state that Oppenheim was right in treating this material as a single species, but to remark also that it is clear that two 'morphotypes' , on the basis of test shape, can be distinguished. Burckhardt (1901) also noted this, and considered these echinoids to correspond to two different species. Representatives of the present species were also described, albeit briefly, by Bernasconi (1959).

Parma & Casadío (2005) referred to specimens from Roca as *Paraster joannisboehmi*, but re-examination of that material shows that two species may actually be differentiated, namely *Linthia*? *joannisboehmi* (e.g., GHUL-Pam 22066, 68, 71-75, 22151 and CPBA 6468) and an undescribed one (see below). This would account for the wide range of variation noted by those authors, especially in features which usually are more constant in spatangoids, e.g., relative length and width of petals, or distance between peristome and test margin.

The species resembles closely those attributed to the genus *Linthia*. A subanal fasciole, however, seems to be genuinely absent in the material studied here and thus the the generic attribution has to remain tentative at present.

## *Linthia parmae* n. sp.
Figs. 5E-H, 6A-D

2005 *Paraster joannisboehmi* (Oppenheim in Böhm) – Parma & Casadío, p. 1080 *partim*, figs. 13.1-13.4, 14.

**Etymology**: After Sara Graciela Parma, in recognition of her contributions to our knowledge of Argentinean fossil echinoids.

**Type**: Holotype is MACN-Pi 5208, bed # 29 at Zanjón Roca (see del Río et al. 2011), 10 km north of General Roca City, Río Negro Province, Argentina.

**Other material and occurrences:** MACN-Pi 5209a-f, same provenance as holotype; also known from beds #13 and #15 in the Horno de Cal section, and from bed #10 at Picada Sísmica (del Río et al. 2011).

**Description**: Small to medium-sized (holotype: length 23 mm, maximum width 22 mm), ellipsoidal-subhexagonal, with anterior margin indented; posterior margin truncate; widest in centre, tallest at posterior carina between posterior petals; in profile, test somewhat flattened, and posterior side vertical; apical disc rather anterior, ethmolytic with four gonopores; petals sunken, anterior ones c. 1.3 times longer than posterior, diverging at about 120°, and with c. 24 elongate pores (test length 23 mm); posterior petals diverge at around 80°, and with 18-20 elongate pore pairs; interporiferous zone about two-thirds to three-quarters of width of column; anterior ambulacrum moderately sunken, wide with flattish surface, 10-11 (test length 23 mm), pore pairs well separated by ridge; fasciole with fairly wide peripetalous and rather thin lateroanal bands; peripetalous band indented between anterior and posterior petals; peristome anterior; plastron amphisternous, sternal plates symmetrical; labral plate longitudinally elongate, widened posteriorly and very anteriorly at rim, extending to second ambulacral plate; periproct oval, longer than wide, located very high on posterior side; labrum elongated widening anteriorly and with very broad base, not extending beyond second ambulacral plate, with rim weakly projecting over peristome.

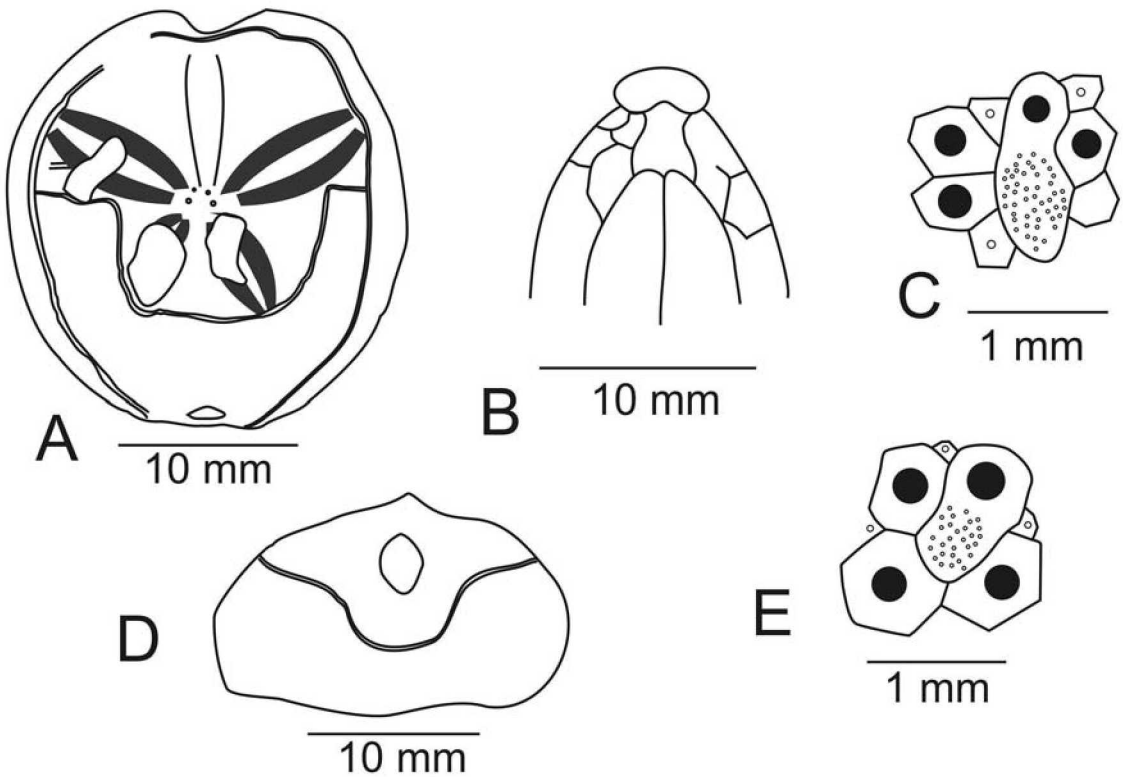


**Fig. 6.** A-D. *Linthia parmae* n. sp., A. holotype, MACN-Pi 5208, sketch of apical view, showing the trajectory of the fasciole; B. MACN-Pi 5209a, partial plastron plating; C. holotype, MACN-Pi 5208, posterior view showing periproct and the trajectory of the fasciole. D. MACN-Pi 5210, sketch of apical system. E. *Plesiaster* sp., MACN-Pi 5211, sketch of apical system.

**Remarks**: As stated above (under *Linthia*? *joannesboehmi*), PARMA & CASADÍO (2005) confused specimens of *Linthia*? *joannesboehmi*, e.g., GHUNLPam 22067 and 22069 from Roca, and numerous examples from other localities, and those here referred to *Linthia parmae* n. sp. The first one has only a peripetalous fasciole, indented by one plate, and comparatively shorter posterior paired petals, among other differences with *Linthia parmae* n. sp.

The new species is placed in *Linthia* because the longitudinally elongated labral plate extends to the second ambulacral plate, while it does not extend beyond the first one in *Paraster* (SMITH et al. 2010).

*Linthia parmae* n. sp. differs from *Linthia insignis*, type species of the genus, in having broader petals, markedly larger than the anterior ones, a longer labrum which weakly projects into the peristome, and the peristome is further removed from the frontal notch.

Other Paleocene species of the genus, such as *L. sudanensis* (BATHER, 1904) from Niger, Sudan, Somalia, Libya and Egypt (SMITH & JEFFERY 2000; SMITH et al. 2010) or *L. houzeaui* COTTEAU, 1879 from Belgium and France (SMITH & JEFFERY 2000), are easily distinguished from *Linthia parmae* n. sp. by the latter's anterior and posterior paired petals of subequal length. The new species resembles *Linthia cavernosa* DE LORIOL, 1880 from the lower to middle Eocene of North Africa (SMITH et al. 2010), but that species is larger and more rounded and has relatively longer posterior paired petals.

Suborder Micrasterina FISCHER , 1966
Family Plesiasteridae LAMBERT, 1920
Genus *Plesiaster* POMEL, 1883

**Type species:** *Micraster peini* COQUAND, 1862, by original designation.

*Plesiaster* sp.
Figs. 6E, 7A, B

**Material and occurrence:** MACN-Pi 5210 and 5211, bed #29 at Zanjón Roca (see DEL RÍO et al. 2011), 10 km north of General Roca City, Río Negro Province, Argentina.

**Description**: Medium-sized (length MACN-Pi 5210 = 23 mm; MACN-Pi 5210 = 34 mm), with subtriangular-ovate

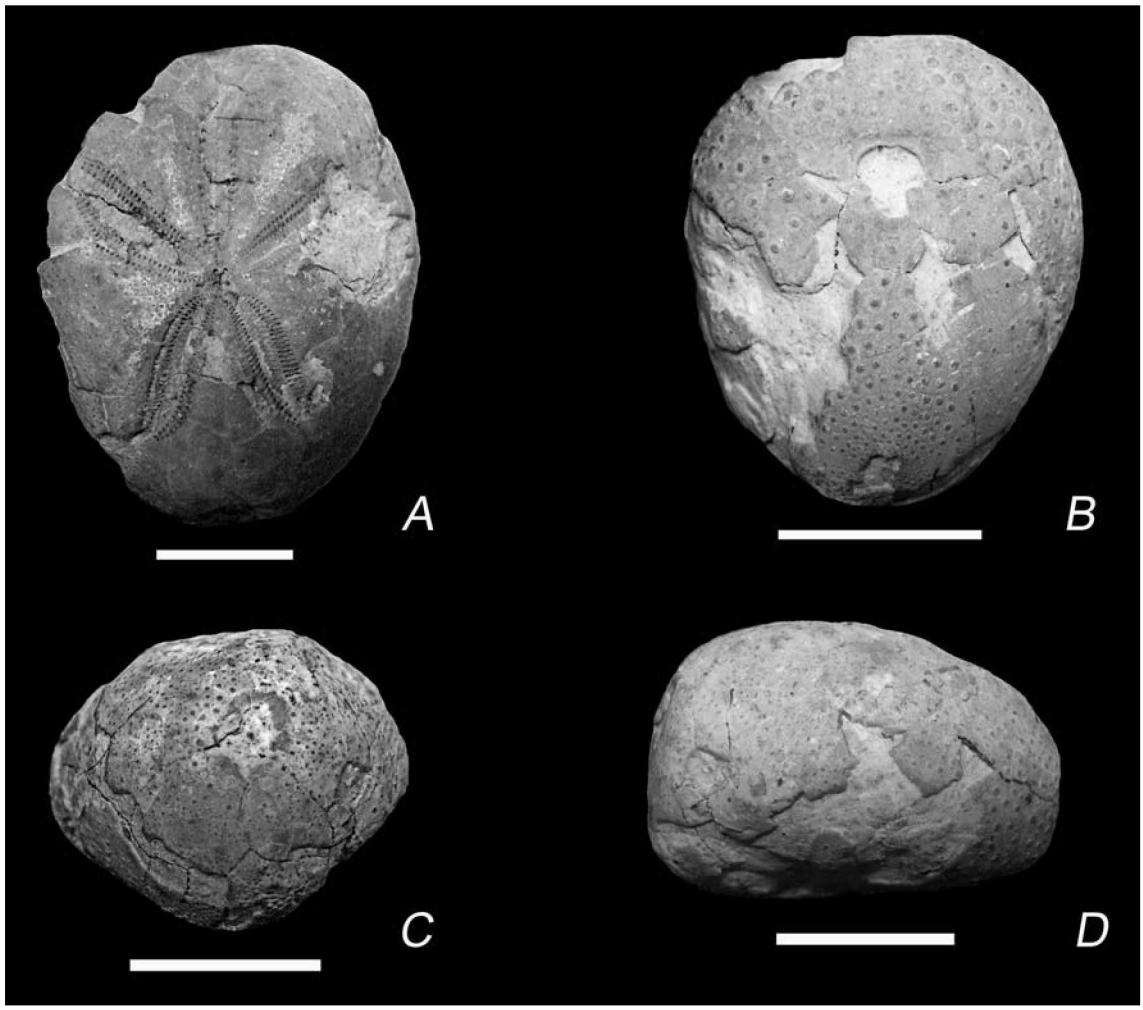


**Fig. 7.** *Plesiaster* sp., A. MACN-Pi 5211, apical view; B-D. MACN-Pi 5210, oral, posterior and lateral views, respectively. Scale bar represents 10 mm.

horizontal outline; anterior margin with shallow indentation, posterior margin truncate; widest anterior to centre, and tallest at posterior carina between posterior petals; in profile, somewhat flattened and posterior side vertical; adoral side convex with posterior keel; apical disc subcentral, ethmophract, with four gonopores; anterior ambulacrum narrow, sunken adapically, shallowing towards ambitus; poriferous zones narrow, with 22-23 (test length 33 mm) differentiated, rounded pore pairs obliquely placed and well separated by a ridge; paired petals long, weakly sunken, slightly arched, with poriferous zones narrower than interporiferous ones, more notably in anterior ones; anterior paired petals 1.1 times longer than posterior ones, diverging at around 105°, and with c. 33 elongate and conjugate pore pairs (test length 33 mm); posterior petals diverge at around 55°, and with c. 32 elongate and conjugate pore pairs; peristome anterior (one quarter of total length from anterior edge), broken, with narrow rim, labrum broken; periproct oval, longer than wide, located high on posterior side; plastron amphisternous, sternal plates symmetrical; subanal and peripetalous fascioles present; peripetalous fasciole near complete, with small discontinuities and of variable width; aboral tubercles small.

**Remarks**: Parma & Casadío (2005) listed *Diplodetus nutrix* (Lambert in Boule, 1899), a species previously known from the Campanian-Maastrichtian of Madagascar (see Lambert 1903; Smith & Jeffery 2000; Smith et al. 2010), from several localities in Patagonia, inclusive of the General Roca area. In some respects, their specimen from General Roca (GHUNLPam 22020) corresponds closely to the present material, rather than to other specimens available to those authors (p. 1078), with reference to such features as the angle between the anterior paired ambulacra (105° rather than 110-120°), or the 1.1-1.2 rate between length of anterior and posterior petals (not 1.4).

The material presented here is considered a species of *Plesiaster*, because it has rather long and weakly sunken petals, instead of the strongly sunken and parallel-sided petals of typical *Diplodetus*. Moreover, it differs from *D. nutrix* in having an angle of 125° between the anterior petals, which, in addition, are 1.3 to 1.5 times longer than the posterior ones. The peristome is situated at one third of test length from the anterior margin as well (compare SMITH & JEFFERY 2000).

*Plesiaster peini* (COQUAND, 1862) from the Santonian-Campanian of North Africa (SMITH et al. 2010), type species of the genus, differs from our specimens in having a wider, lower profile, elongate pores in the anterior ambulacrum and anterior paired ambulacra diverging between 125-130°, while *P. hourcqi* (LAMBERT, 1933) from the Campanian-Maastrichtian of Madagascar (SMITH et al. 2010) has elongate pores in the anterior ambulacrum, paired petals of equal length, the anterior ones diverging 125-130° and lacks fascioles.

*Plesiaster nobilis* (STOLICZKA, 1873), from the Campanian-Maastrichtian of Madagascar and southern India (SMITH et al. 2010), has elongate pores in the anterior ambulacrum, the anterior paired ambulacra diverge at 125-130° , and it lacks fascioles, while *P. nicklesi* (COLLIGNON & LAMBERT, 1928) from the Danian of Spain (SMITH et al. 2010) has an anterior apical system, paired petals of equal length, the anterior ones diverging at 140°.

In *Plesiaster amnicus* (GREYLING, 1996), from the Maastrichtian of Zululand and Spain (SMITH et al. 2010), the plastronal suture is offset to the right and the paired anterior ambulacra diverge at 125-130°, while *P. trangahyensis* (LAMBERT, 1936) from the Maastrichtian of Madagascar (SMITH et al. 2010), has anterior petals diverging at 120-130°, the anterior ones being 1.2-1.3 longer than the posterior.

For the time being, the material from Patagonia is left in open nomenclature; it cannot be ruled out that it represents a new species.

## Conclusions

It is demonstrated that *Linthia*? *joannisboehmi* OPPENHEIM in BÖHM, 1903, in fact comprises two distinct species, *Linthia*? *joannisboehmi* and *Linthia parmae* n. sp. Indeterminate species of *Plesiaster* and *Hemiaster* and a basal holasteroid have been also recorded. Although this paper is taxonomic in nature, the results have an impact on K/Pg boundary scenarios for northern Patagonia. The echinoid fauna described here is shown to be Danian in age, thus modifying previous speculations in which the fauna had been reported to have to crossed the K/Pg boundary.

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