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The Cretaceous corals from the Bisbee Group (Sonora, Mexico; Late Barremian - Early Albian): Family Columastraeidae

Los corales del Cretácico del Grupo Bisbee (Sonora, México; Barremiense Tardío - Albiense Temprano): Familia Columastraeidae

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Abstract

The current work constitutes the fifth part of the systematic revision of the corals from the Bisbee Group in Sonora, north-west Mexico (Late Barremian to Early Albian) and deals with the family Columastraeidae. Nine species from the genera *Eocolumastrea* and *Nudacolumastrea* are described and illustrated . The genus *Eocolumastrea* is one of the most common genera in Lower Cretaceous coral faunas, whereas *Nudacolumastrea* is rarer.

Keywords: Corals, Bisbee Group, Early Cretaceous, Scleractinia.

Resumen

El presente trabajo constituye la quinta parte de la revisión sistemática de los corales del Grupo Bisbee, noroeste de México, (Barremiano Tardío a Albiano Temprano) trata sobre la familia Columastraeidae. Se reportan e ilustran nueve especies de los géneros Eocolumastrea y Nudacolumastrea. El género Eocolumastrea es uno de los géneros más comunes en el Cretácico Inferior mientras que el género Nudacolumastrea es más raro.

Palabras claves: Corales, Cretácico Temprano, Grupo Bisbee, Scleractinia.

1. Introduction

Building off the first part of the series (Löser, 2011), which introduced the Early Cretaceous (Late Barremian to Early Albian) coral fauna from the Bisbee Basin, this fifth part deals with material of the family Columastraeidae. The family occurs from the Valanginian to the Maastrichtian and encompasses nine genera (Löser and Zell, 2015; Löser, 2016). Members of two of these nine genera could be indicated in the Early Cretaceous of Sonora, encompassing nine species. Neither of the two genera were reported in previous studies (Baron-Szabo and González-León, 1999, 2003) because both genera were established in 2015 (Löser and Zell, 2015). Material described here was reported under the generic name *Columnocoenia*

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Alloiteau, 1952. Details on the study area, lithology, stratigraphy, and outcrops are reported in Löser (2011). Details on the sample locations that are noted in the systematic description in the occurrence section of this paper are given in Löser (2011: tab. 1).

2. Material

The material varies in its state of preservation. Samples from marly layers are slightly better preserved than samples from carbonates. For the latter, it was more difficult to obtain good thin sections for the purpose of exact measurements and illustrations. Colony surfaces are rarely well preserved. Only thin sections were used for the determination. All specimens described here are kept at the collection of the Universidad Nacional Autónoma de México, Instituto de Geología, Estación Regional del Noroeste in Hermosillo, Sonora, Mexico (ERNO). The material described by Baron-Szabo and González-León (1999, 2003) was available for study and, for many specimens, further thin sections were prepared to specify the morphology and taxonomy of species described by the two authors.

3. Methods

3.1. Sample preparation

Thin sections were prepared, all from well-preserved samples in both transversally and longitudinally oriented directions, where possible. The thin sections were scanned using a flatbed scanner with an optical resolution of 6400 dpi. The images were saved as 8-bit greyscale JPG files without compression. To increase the quality of the images, contrast stretching was applied. The images were used to prepare illustrations and to systematically record calicular dimensions.

3.2. Species separation

The material consists solely of colonial plocoid corals. Species separation in these forms is based on the smaller and larger corallite diameter and septal counts. The septal symmetry is regular and, therefore, the number of septa within one specimen is relatively constant.

3.3. Distribution data

The distribution data (as reflected in the synonymy lists and in the synonymy lists published by Garberoglio *et al.*, 2021) are entirely based on well-examined material. Material mentioned only in the literature and material not available for study has not been taken into account. To obtain better insight into the distribution patterns of the corals from Sonora, additional unpublished material was included.

4. Systematic description

Abbreviations

Collection abbreviations are as follows:

ERNO, Universidad Nacional Autónoma de México, Instituto de Geología, Estación Regional de Noroeste, Hermosillo, Mexico.

The following abbreviations are used to describe the dimensions of the corals:

- ccd, distance of corallite centres;
- clmax, large lumen;
- clmin, small lumen;
- septa, number of radial elements in adult corallites.

The following abbreviations are used to describe the statistical data:

- n, number of measurements;
- min-max, absolute range (mm);
- μ, arithmetic mean (mm);
- s, standard deviation (mm);
- cv, coefficient of variation (%);
- μ±s, first interval (mm).

The abbreviations used in the synonymy lists follow Matthews (1973): *: earliest valid publication of the species name; p: the described material belongs solely in part to the species concerned; v: the specimen was observed by the author.

Order Scleractinia Bourne, 1900
Superfamily Cladocoroidea d'Orbigny, 1851

Description. Solitary and (cerioid, phaceloid, plocoid) colonial corals. Septa compact and with regular thickness. Septal symmetry radial, regular or sub-regular. Septa often connected to each other. Septal lateral faces with thorns and/or granulae. Septal upper margin with fine granulations. Lonsdaleoid septa and main septum absent. Microstructure of medium-sized trabeculae. Synapticulae absent. Pali present in some genera. Columella present in most genera: styliform, lamellar, parietal, or by septal fusion. Endotheca generally present. Marginarium absent. Wall present: septothecal (made by septal thickening) or tabulothecal. Coenosteum present in plocoid genera. Budding extracalicinal (cerioid, plocoid) or intracalicinal (phaceloid).

Family Columastraeidae Alloiteau, 1952

Description. Plocoid colonies. Septal symmetry regular radial and mostly hexameral. Pali present in some genera. Columella varies: styliform, styliform and double, lamellar, or absent. Coenosteum with costae.

Eocolumastrea Löser and Zell, 2015

Type species. *Columnocoenia bucovinensis* Morycowa, 1971.

Description. Plocoid coral with septa in a regular hexameral or decameral symmetry. Columella lamellar or small and styliform. Irregular pali at the first septal cycle, not very pronounced. Coenosteum narrow.

Eocolumastrea gortanii (Prever, 1909)
Figure 1, A–C

*v 1909 *Ulastraea Gortanii* Prever, p. 91, pl. 5, 6, 7.
v 2021 *Eocolumastrea gortanii* (Prever, 1909). Garberoglio *et al.*, p. 6, fig. 5 [here, synonymy is more detailed].

Material. ERNO 2140 (two thin sections), 2151 (four thin sections), ERNO L-4321, 4927, 4945.

Dimensions. (ERNO 2151).

	n	min–max	μ	s	cv	μ±s
clmin	20	1.74–2.53	2.09	0.20	9.6	1.89–2.29
clmax	20	2.03–3.55	2.57	0.44	17.1	2.13–3.02
ccd	20	2.04–4.83	3.30	0.73	22.1	2.57–4.03
septa	6+6+12					

Occurrence. Barremian to lower Aptian and Lower Albian of Cerro de Oro.

Other occurrences. Hauterivian to Middle Cenomanian, worldwide.

Eocolumastrea magna (Prever, 1909)
Figure 1, D–F

*v 1909 *Leptastrea magna* Prever, p. 94, pl. 6, fig. 8
v 2021 *Eocolumastrea magna* (Prever, 1909). Garberoglio *et al.*, p. 7, fig. 6 [here, synonymy is more detailed]

Material. ERNO 2321 (3 thin sections).

Dimensions. (ERNO 2321).

	n	min–max	μ	s	cv	μ±s
clmin	20	2.72–3.42	3.16	0.20	6.3	2.96–3.36
clmax	10	3.85–4.55	4.15	0.27	6.6	3.88–4.43
ccd	20	3.54–5.05	4.25	0.41	9.6	3.84–4.66
septa	6+6+12					

Occurrence. Upper Barremian to lower Aptian of Cerro de Oro.

Other occurrences. Hauterivian of the Eastern Pacific (Argentina), lower Aptian of the Central Tethys (Italy).

Eocolumastrea octaviae (Prever, 1909)
Figure 2, A–B

*v 1909 *Ulastraea Octaviae* Prever, p. 91, pl. 5, fig. 5.

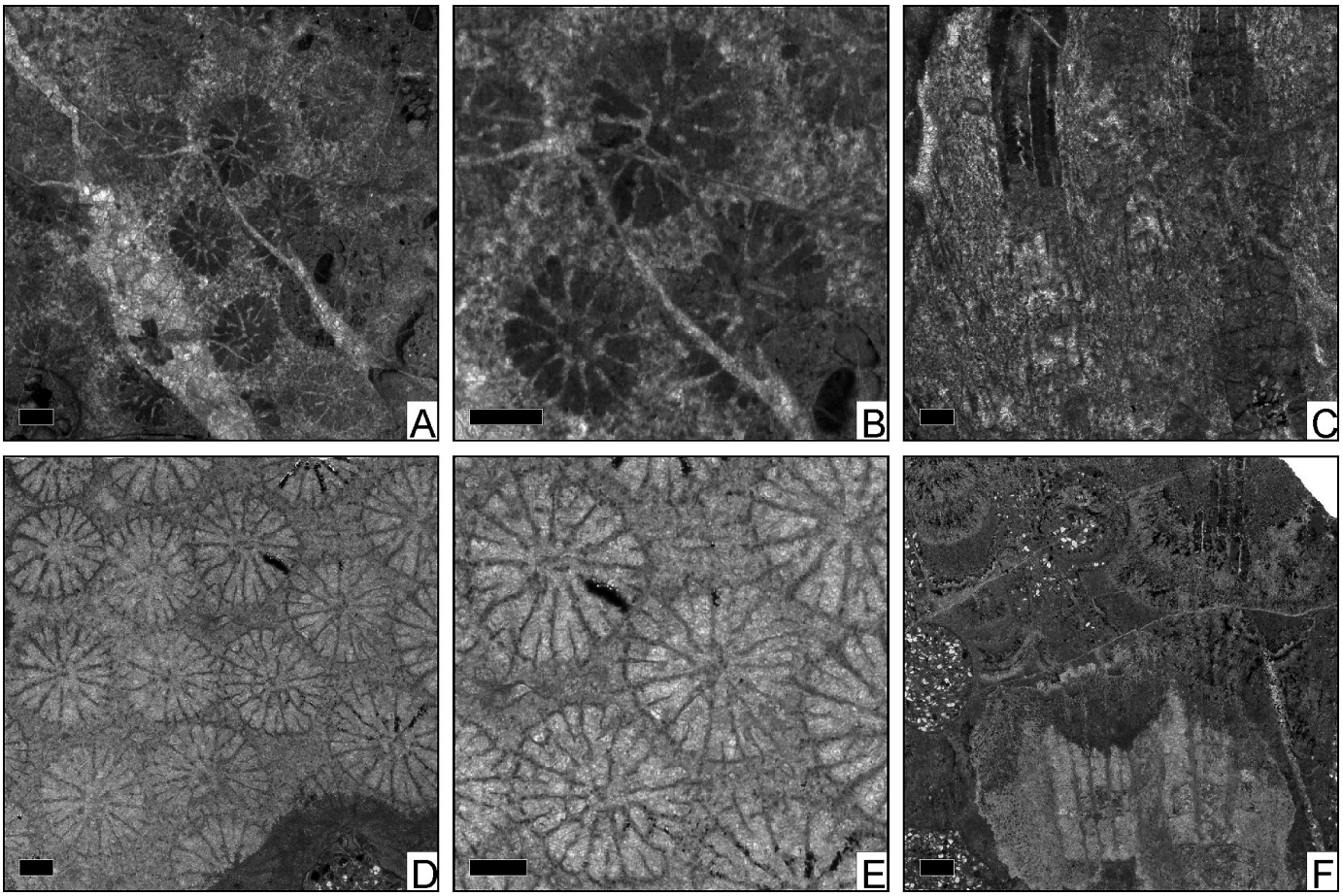

Figure 1. A–C, *Eocolumastrea* cf. *gortanii* (Prever, 1909), ERNO 2151, transversal thin section. B, transversal thin section, detail. C, longitudinal thin section. D–F, *Eocolumastrea magna* (Prever, 1909), ERNO 2321, transversal thin section. E, transversal thin section, detail. F, longitudinal thin section. Scale bar 1 mm.

v 2021 *Eocolumastrea octaviae* (Prever, 1909). – Garberoglio *et al.*, p. 9, fig. 8 [here, synonymy is more detailed].

Material. ERNO 2153A (one thin section), ERNO L-4403, 4841, 4843, 4847.

Dimensions. (ERNO 2153A).

	n	min–max	μ	s	cv	μ±s
clmin	30	1.25–1.56	1.39	0.10	7.0	1.29–1.49
clmax	30	1.41–1.82	1.60	0.11	6.8	1.49–1.71
ccd	30	1.81–2.42	2.16	0.19	8.8	1.97–2.35
septa	6+6+12					

Occurrence. Barremian to lower Aptian and Lower Albian of Cerro de Oro.

Other occurrences. Tithonian to Cenomanian, worldwide.

Eocolumastrea cf. *octaviae* (Prever, 1909)
Figure 2, C–D

v 2021 *Eocolumastrea* cf. *octaviae* (Prever, 1909). Garberoglio *et al.*, p. 9, fig. 9 [here, synonymy is more detailed].

Material. ERNO L-4350 (one thin section), 4848.

Dimensions. (ERNO L-4350).

	n	min–max	μ	s	cv	μ±s
clmin	25	1.07–1.48	1.26	0.11	8.5	1.15–1.36
clmax	25	1.29–1.58	1.47	0.07	5.0	1.39–1.54
ccd	25	1.67–2.51	2.04	0.25	12.4	1.79–2.30
septa	6+6+12					

Remarks. As already mentioned in Garberoglio *et al.* (2021), this material compares in its corallite dimensions to *E. octaviae* but the corallite diameter is still smaller to *E. octaviae*. It is possible that this material constitutes a new yet undescribed species. The naming and

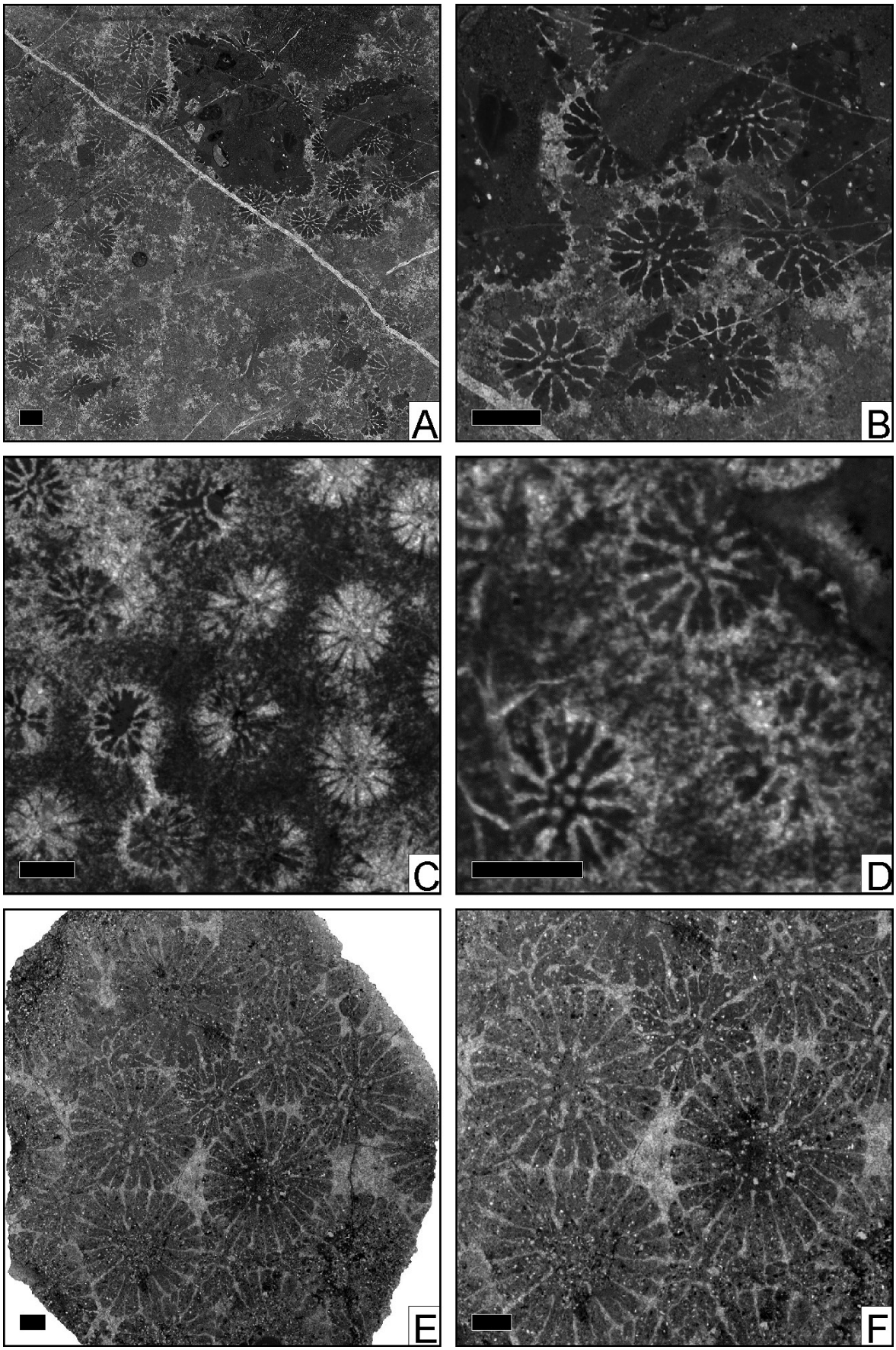

Figure 2. A–B, *Eocolumastrea octaviae* (Prever, 1909), ERNO 2153A, transversal thin section. B, transversal thin section, detail. C–D, *Eocolumastrea* cf. *octaviae* (Prever, 1909), ERNO L-4350, transversal thin section. D, transversal thin section, detail. E–F, *Nudacolumastrea* sp., ERNO L-4331, transversal thin section. F, transversal thin section, detail. Scale bar 1 mm.

describing are not done here for two reasons. Firstly, the material from Sonora is not well preserved, enough to allow the creation of a new species. Secondly, the genus *Eocolumastrea* is very common in the Early Cretaceous. It cannot be excluded that such a species is already established, but its type material is still unrevised.

Occurrence. Lower Albian of Cerro de Oro.

Other occurrences. Lower Hauterivian of the Eastern Pacific (Argentina), Lower Albian of the Western Atlantic (USA), Middle Cenomanian of the central Tethys (Germany).

Eocolumastrea ramosa (Stoliczka, 1873)
Figure 3, A–C

*v 1873 *Holocoenia ramosa* Stoliczka, p. 24, pl. 4, fig. 4, 5.
v 2018 *Eocolumastrea gortanii* (Prever, 1909). Löser *et al.*, p. 36, pl. 1, fig. 7–9.
v 2023 *Eocolumastrea ramosa* (Stoliczka, 1873). Samaniego-Pesqueira *et al.*, p. 122, fig. 4H–J [here, synonymy is more detailed].

Material. ERNO L-4363, 4420 (two thin sections).

Dimensions. (ERNO L-4420).

	n	min–max	μ	s	cv	μ±s
clmin	40	1.73–2.21	1.93	0.13	6.7	1.80–2.06
clmax	40	1.99–2.63	2.32	0.19	8.4	2.13–2.52
ccd	50	2.00–2.99	2.45	0.24	9.9	2.21–2.69
septa	6+6+12					

Occurrence. Lower Albian of Cerro de Oro and Rancho El Pimiento.

Other occurrences. Valanginian to Cenomanian, worldwide.

Eocolumastrea sp. 1
Figure 3, D–F

v 2021 *Eocolumastrea* sp. 2. Garberoglio *et al.*, p. 12, fig. 10 [here, synonymy is more detailed].

Material. ERNO L-4470 (two thin sections).

Dimensions. (ERNO L-4470).

	n	min–max	μ	s	cv	μ±s
clmin	28	0.83–1.28	1.05	0.11	10.3	0.94–1.16
clmax	27	1.01–1.64	1.27	0.15	11.7	1.12–1.42
ccd	21	1.39–2.35	1.80	0.27	14.7	1.54–2.07
septa	6+6+12					

Remarks. Material comparable to this specimen was assigned to *Eocolumastrea* sp. 2 in Garberoglio *et al.* (2021). It corresponds to one syntype of *Columnastraea antiqua* (Gerth, 1928). The present specimen has very small corallite dimensions, even smaller than in *E.* cf. o*ctaviae*.

Occurrence. Lower Albian of Cerro de la Espina.

Other occurrences. Upper Hauterivian of the Eastern Pacific (Argentina).

Eocolumastrea sp. 2
Figure 3, G–H

Material. ERNO L-4383 (three thin sections), 4929 (two thin sections).

Dimensions. (ERNO L-4383).

	n	min–max	μ	s	cv	μ±s
clmin	11	3.13–4.42	3.73	0.36	9.8	3.36–4.09
clmax	6	3.47–4.81	4.16	0.50	12.0	3.66–4.66
ccd	10	3.46–6.98	4.77	1.13	23.7	3.64–5.89
septa	6+6+12					

(ERNO L-4929).

	n	min–max	μ	s	cv	μ±s
clmin	20	2.70–4.49	3.55	0.37	10.6	3.17–3.92
clmax	20	3.75–6.53	4.59	0.78	17.0	3.81–5.38
ccd	20	3.53–5.64	4.79	0.56	11.6	4.24–5.35
septa	6+6+12					

Remarks. These two specimens cannot be assigned to an existing species, and even the generic assignment is questionable. They present very large corallite dimensions, the septa are very strong and there is nearly no coenosteum. These differences can also be the result of the diagenesis, and more material must be available in order to clarify the

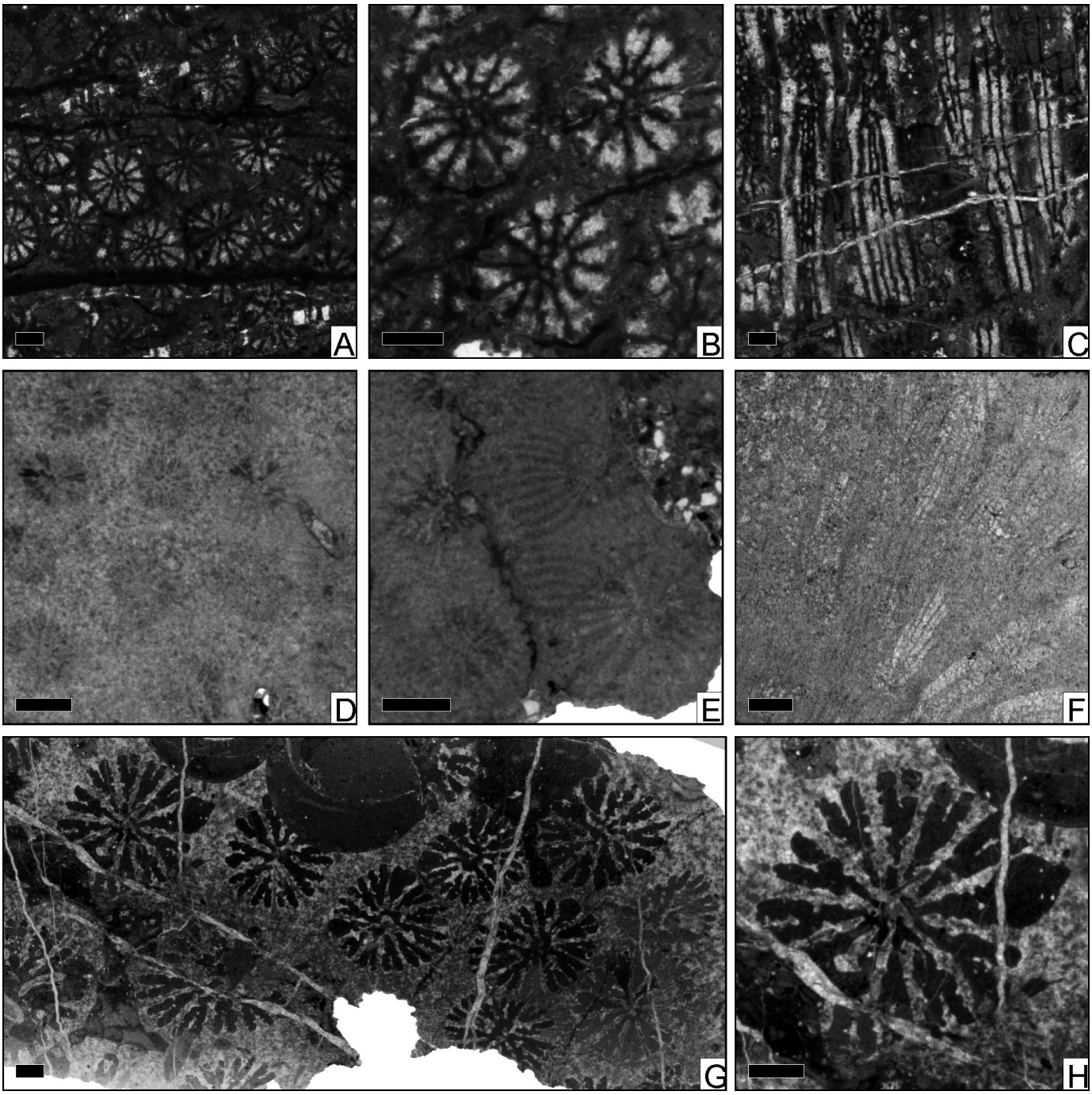

Figure 3. A–C, *Eocolumastrea ramosa* (Stoliczka, 1873), ERNO L-4420, transversal thin section. B, transversal thin section, detail. C, longitudinal thin section. D–F, *Eocolumastrea* sp. 1, ERNO L-4470, transversal thin section. E, transversal thin section, detail with visible microstructure in the costae. F, longitudinal thin section. G–H, *Eocolumastrea* sp. 2, ERNO L-4383, transversal thin section. H, transversal thin section, detail. Scale bar 1 mm.

relationship of this coral type to the genus *Eocolumastrea*. Moreover, the specimens were too small to allow the preparation of a longitudinal thin section that may help in a taxonomic differentiation.

Occurrence. Lower Albian of Cerro de Oro.

Nudacolumastrea Löser and Zell, 2015

Type species. *Nudacolumastrea stefani* Löser and Zell, 2015.

Description. Plocoid coral with septa in a regular hexameral. Columella absent but

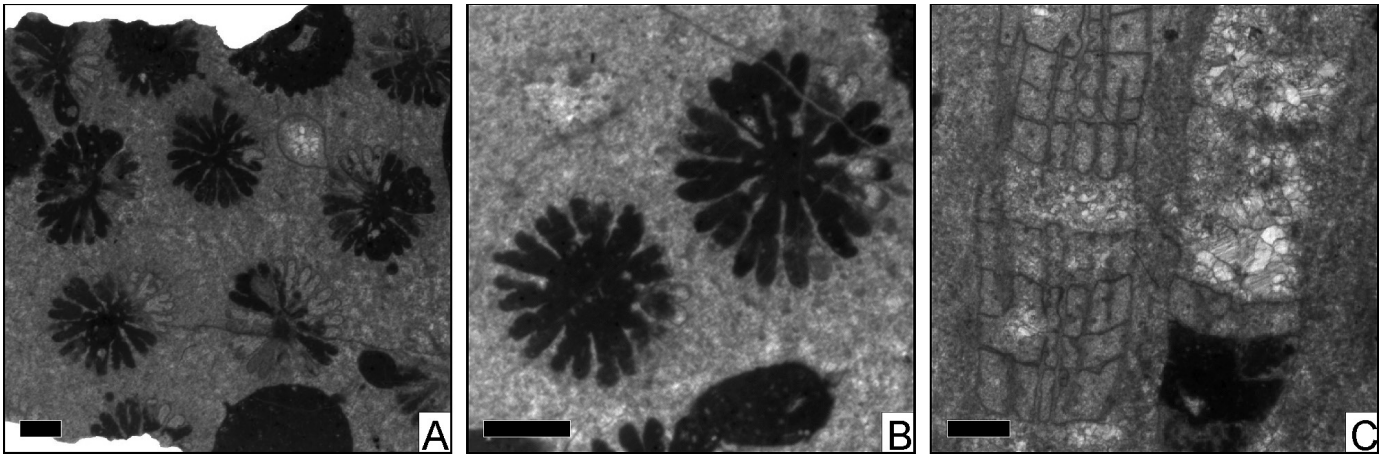

Figure 4. A–C, *Nudacolumastrea montsiani* (Bataller, 1936), ERNO L-4839, transversal thin section. B, transversal thin section, detail. C, longitudinal thin section. Scale bar 1 mm.

irregular pali at the first septal cycle, in some species also on the second cycle. Coenosteum very narrow.

Nudacolumastrea montsiani (Bataller, 1936)
Figure 4, A–C

*v 1936 *Phyllocoenia montsiani* Bataller, p. 38, pl. 1, fig. 1.
vp 2015 *Nudacolumastrea stefani* Löser and Zell, p. 162, fig. 6.1–3.
v 2016 *Nudacolumastrea montsiani* (Bataller, 1936). Löser and Zell, p. 9, fig. 3.3–5.

Material. ERNO L-4839 (two thin sections), 4840 (one thin section).

Dimensions. (ERNO L-4839).

	n	min–max	μ	s	cv	μ±s
clmin	25	2.17–2.74	2.49	0.17	6.9	2.32–2.66
clmax	25	2.64–3.30	2.93	0.21	7.1	2.72–3.14
ccd	40	2.50–4.40	3.38	0.51	15.1	2.87–3.89
septa	6+6+12					

Remarks. After a reexamination of the material of *Nudacolumastrea stefani* Löser and Zell, 2015, it was found that one non-type specimen of *Nudacolumastrea stefani* belongs to *Nudacolumastrea montsiani*.

Occurrence. Lower Albian of Cerro de Oro.

Other occurrences. Aptian of the Western Tethys (Spain).

Nudacolumastrea sp.
Figure 2, E–F

Material. ERNO L-4331 (one thin section).

Dimensions. (ERNO L-4331).

	n	min–max	μ	s	cv	μ±s
clmin	7	3.60–4.84	4.23	0.48	11.3	3.75–4.71
clmax	6	4.50–5.44	4.93	0.39	8.0	4.54–5.33
ccd	9	3.32–5.34	4.30	0.62	14.3	3.68–4.91
septa	5	26–29	27.80	1.10	3.9	27–29

Remarks. The unique specimen was too small to be able to obtain a longitudinal thin section. It cannot be compared to any existing species. The septal symmetry is heptameral and has three septal cycles. Such a symmetry is extremely rare in scleractinian corals.

Occurrence. Upper Barremian to lower Aptian of Cerro de Oro.

5. Discussion

Two genera of the family Columastraeidae are reported. Whereas *Nudacolumastrea* is very rare on a global scale, *Eocolumastrea* belongs to the most common genera of the time interval Hauterivian to Albian (Löser 2016, Fig. 6.3.3.4). Most of the species reported here occur from the Valanginian to the Cenomanian (Fig. 5), with one indication from the Late Jurassic.

Nudacolumastrea has its last occurrence in the Lower Albian and *Eocolumastrea* has its last occurrence in the Cenomanian. Palaeogeographically, the Sonoran species of the family Columastraeidae clearly separates into two groups; taxa from the Upper Barremian to lower Aptian, and taxa from the Lower Albian (Fig. 6). Whereas the Upper Barremian to lower Aptian faunas correlate only with the Neuquén Basin, the Lower Albian faunas correlate with faunas worldwide.

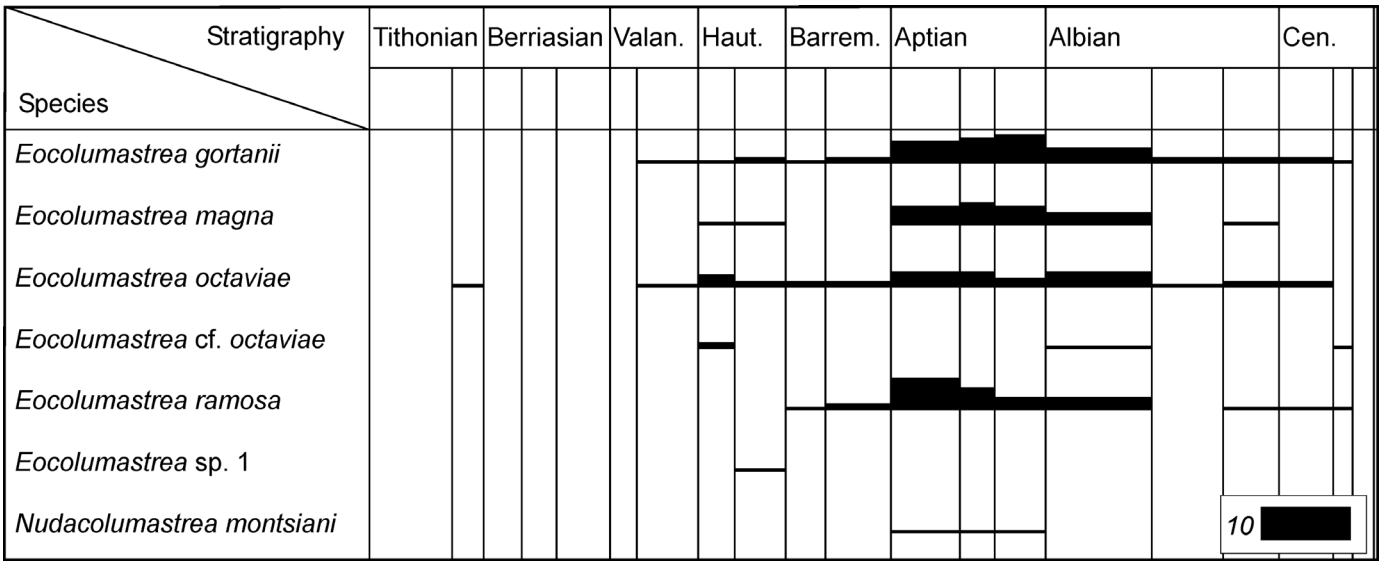

Figure 5. Distribution of species of the studied fauna in localities outside of the study area. The thickness of the horizontal bars corresponds to the number of localities where the species was found.

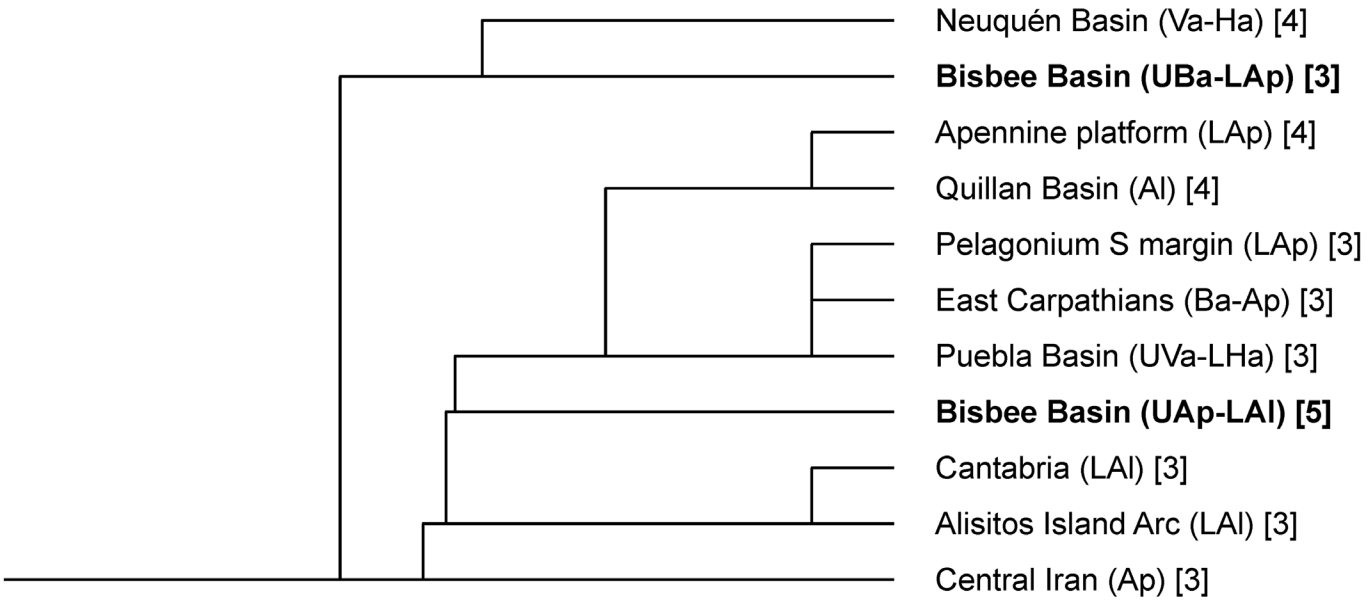

Figure 6. Correlation of the palaeo-provinces where species of the studied fauna occur. Only provinces with more than two species were included. The Correlation Ratio coefficient was applied. Abbreviations: Va, Valanginian; Ha, Hauterivian; Ap, Aptian; Al, Albian. The letter L indicates lower, the letter U indicates upper. The numbers in brackets are the numbers of joint species. The study area is marked in bold letters.

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