

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

Hannes Löser^{a,*}

^a Universidad Nacional Autónoma de México, Instituto de Geología, Estación Regional del Noroeste, Blvd. L. D. Colosio S/N y Madrid, Col. Los Arcos, 83250 Hermosillo, Sonora, México.

* hloeser@gmx.net

Abstract

The current work constitutes the fourth part of the systematic revision of the corals from the Bisbee Group in Sonora, northwest Mexico (Late Barremian to Early Albian) and deals with the suborder Heterocoeniina. Twelve species from three families are reported: Carolastraeidae (genera *Heteropistophyllum*, *Latusastrea*, *Pleurocoenia* and *Pleurodendron*), Heterocoeniidae (genus *Heterosmilia*), and Paronastracidae (genus *Tiarasmilia*) are described and illustrated. The family taxon Carolastraeidae is applied instead of the problematic family taxon Elasmocoeniidae which was temporarily applied to Heterocoeniina with a bilateral septal symmetry. With the exception of the genus *Pleurocoenia*, the genera are rare in the Cretaceous and do not show distinct palaeobiogeographic relationships.

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

Resumen

El presente trabajo constituye la cuarta parte de la revisión sistemática de los corales del Grupo Bisbee (Barremiano temprano al Aptiano tardío) que trata sobre el suborden Heterocoeniina. Se reportan doce especies de tres familias: Carolastraeidae (géneros *Heteropistophyllum*, *Latusastrea*, *Pleurocoenia* y *Pleurodendron*), Heterocoeniidae (género *Heterosmilia*), y Paronastracidae (género *Tiarasmilia*). La familia Carolastraeidae se utiliza en lugar de la familia Elasmocoeniidae que se ha usado temporalmente para el suborden Heterocoeniina que posee una simetría septal bilateral. Con la excepción del género *Pleurocoenia*, los géneros son escasos para el Cretácico y no presentan muchas relaciones paleobiogeográficas con otras áreas.

Palabras clave: Corales, Scleractinia, Cretácico temprano, Grupo Bisbee.

1. Introduction

Building off the first part of the series (Löser, 2011), which introduced the Early Cretaceous (Late Barremian to Albian) coral fauna from the Bisbee Basin, this fourth part deals with material of the suborder Heterocoeniina. The suborder occurs from the Late Jurassic to the Late Cretaceous and encompasses five families. Members of three of these families could be found in the Early Cretaceous of Sonora, encompassing twelve species in six genera. Two of these genera were reported in previous studies (Baron-Szabo and González-León, 1999; 2003), but newly collected material allows for an increase in the

number of genera and species. Details on the study area, lithology, stratigraphy, and outcrops are reported in Löser (2011). Details on the sample locations cited in the studied section referenced to in the systematic description 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 (ERNO) in Hermosillo, Sonora, Mexico. 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 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 6400dpi. The images were saved as 8-bit grey scale 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 of cerioid (*Latusastrea*, *Pleurocoenia*), phaceloid (*Heteropistophyllum*, *Heterosmilia*, *Pleurodendron*), and solitary (*Tiarasmilia*) forms. Species separation in these forms is based on the smaller and larger calicular diameter (in phaceloid forms the inner and outer diameter was measured) and septal counts. The number of septa within one specimen is fairly constant. The differentiation of species was relatively easy in the present material because the number of species of each genus is low.

3.3. Distribution data

The distribution data (as reflected in the synonymy lists) are entirely based on well-examined material. Material only mentioned in the literature as well as 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 – indicated by a collection acronym and sample number in parenthesis – was included.

4. Systematic Description

Abbreviations

Collection abbreviations are as follows:

- ANSP, Academy of Natural Sciences, Philadelphia, USA;

- BSPG, Bayerische Staatssammlung für Paläontologie und Geologie, München, Germany;
- ERNO, Universidad Nacional Autónoma de México, Instituto de Geología, Estación Regional del Noroeste, Hermosillo, Mexico;
- GPSL, Geologische und Paläontologische Sammlung der Universität Leipzig, Germany;
- IGM, Instituto de Geología, Mexico City, Mexico;
- MB, Museum für Naturkunde der Humboldt-Universität, Berlin, Germany;
- MNHN, Muséum National d'Histoire Naturelle, Paris, France;
- UP, Université de Provence, Marseille, France.

The following abbreviations are used describing the dimensions of the corals:

- c, calicular diameter;
- c max, larger outer calicular diameter;
- c min, smaller outer calicular diameter;
- cl, calicular diameter (calicular pit);
- cl max, large lumen;
- cl min, small lumen;
- s, number of radial elements in adult calices.

The following abbreviations are used describing the statistical data:

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

Statistical data for less than ten values are not given because of the low confidence. The abbreviations used in the synonymy lists follow Matthews (1973): *: earliest valid publication of the species name; p: the described material belongs only in part to the species concerned; v: the specimen was observed by the author.

Order Scleractinia Bourne, 1900

Suborder Heterocoeniina Beauvais, 1974

Remarks. The constitution of the suborder was just recently discussed (Löser *et al.*, 2013; Löser, 2014). Five families are distinguished mainly based on the septal symmetry and septal ornamentation.

Family Carolastraeidae Eliášová, 1976

Remarks. The family taxon Elasmocoeniidae Duncan, 1884 cannot be applied as proposed by Löser *et al.* (2013, p. 17) because Duncan (1884) introduced the name as an Alliance. In the nomenclatural rules this term is not mentioned as a level of the family group, and because Duncan has arranged it below the Tribus, an Alliance denotes a generic group. This family taxon cannot be used for genera formerly assigned to the informal *Latusastrea* group (Löser, 2013b). Here, it is therefore

proposed to apply the name *Carolastraeidae*. *Carolastraea* Eliásová, 1976 is a phaceloid coral with a bilateral septal symmetry and ornamented septa. Formerly the family was assigned to the suborder Amphiastraeina (e.g. Kolodziej, 2012). But a strong ornamentation of the septal lateral faces, as shown by *Carolastraea*, is not typical for this suborder. The use of the family is preliminary since the thin sections obtained from the type of the type species of the name giving genus *Carolastraea* are not accessible at the collections of the Czech Geological Survey (Prague).

Heteropistophyllum Löser *et al.*, 2013

Type species. *Pseudopistophyllum quinqueseptatum* Turnšek and Buser, 1976.

Heteropistophyllum carchensis Löser *et al.*, 2015

Figs. 1A–C

*v 2015 *Heteropistophyllum carchensis* Löser *et al.*, p. 52, figs. 6a-f.

Description. Phaceloid colony. Calicular outline elliptical. Septa compact. Septa in cross section slightly thicker close to the wall, becoming slightly thinner toward the centre. Symmetry of septa bilateral. Septa alternating in length and thickness. Septa rarely connected to each other in the calicular centre. Septal distal margin unknown, lateral face with thorns, inner margin T-shaped in places. Pali, costae, synapticulae, and columella absent. Endotheca consists of numerous thin tabulae. Wall compact, constitution unknown. Coenosteum absent. Budding intracalicial, marginal.

Material examined. ERNO L-4266, L-4282; 2 thin sections.

Dimensions

(L-4266)	n	min-max	μ	s	cv	μ±s
cl min	15	2.09-3.50	2.53	0.4	16.1	2.12-2.94
cl max	15	2.94-4.97	3.98	0.59	15	3.38-4.58
c min	15	2.99-5.39	3.97	0.62	15.6	3.35-4.59
c max	15	4.34-7.19	5.84	0.97	16.7	4.86-6.82
s		5				

Occurrence in Sonora. Early Albian of Municipio Arizpe, Arizpe, Cerro La Ceja, Municipio Cucurpe, Cucurpe, La Mesa.

Occurrence elsewhere. Early Late Aptian of Spain (Murcia) Jumilla, Sierra del Carche.

Heteropistophyllum quinqueseptatum (Turnšek and Buser, 1976)
Figs. 1D–F

*v 1976 *Pseudopistophyllum quinqueseptatum* Turnšek and Buser, p. 17, 41, pl. 7, figs. 1-3, pl. 8, figs. 1, 2, pl. 9, figs. 1, 2.

v 2003 *Pseudopistophyllum quinqueseptatum* Turnsek, 1976 - Baron-Szabo and González León, p. 205, figs. 6E, G.

v 2013 *Heteropistophyllum quinqueseptatum* (Turnšek and Buser 1976) - Löser *et al.*, p. 19, pl. 4, figs. 5-7.

Description. Phaceloid colony. Calicular outline elliptical, elongated. Septa compact. Septa in cross section slightly thicker close to the wall, becoming slightly thinner toward the centre. Symmetry of septa bilateral. Septa alternating in length and thickness. Septa rarely connected to each other in the calicular centre. Septal distal margin unknown, lateral face with thorns, inner margin T-shaped in places. Pali, costae, synapticulae, and columella absent. Endotheca consists of numerous thin tabulae. Wall compact, constitution unknown. Coenosteum absent. Budding intracalicial, marginal.

Material examined. ERNO 3065, L-4242, L-4277, L-4399; 3 thin sections.

Dimensions

(L-4242)	n	min-max	μ	s	cv	μ±s
cl min	30	1.39-2.83	2.04	0.4	19.7	1.64-2.45
cl max	30	2.79-4.99	3.82	0.56	14.6	3.26-4.39
c min	30	2.23-3.92	3.05	0.47	15.4	2.58-3.53
c max	30	3.84-6.47	5.23	0.62	11.9	4.61-5.86
s	15	5-7	5.66	0.72	12.7	5-6

Occurrence in Sonora. Early Albian of Municipio Cucurpe, Cucurpe, La Mesa; Municipio Naco, Naco, Sierra San Jose; Municipio Opodepe, Tuape, Cerro de la Espina; Municipio Ures, Cerro de Oro.

Occurrence elsewhere. Cretaceous of Slovenia (West Slovenia) Banjska planota, Kanalski Lom, southeast. Early Late Albian (*Mortoniceras inflatum* Zone) of Spain (Valencia, Alicante) Sierra de Llorençá.

Latusastrea Orbigny, 1849

Type species. *Explanaria alveolaris* Goldfuss, 1829

Latusastrea rubrolineata Löser *et al.*, 2009

Figs. 1G–I

v 2003 *Latusastrea* sp. - Kolodziej, p. 207, figs. 20a-c.

v 2003 *Confusaforma weyeri* Löser, 1987 - Baron-Szabo and González León, p. 207, fig. 7B.

*v 2009 *Latusastraeopsis rubrolineata* Löser *et al.*, p. 338, figs. 4, 5.1-5.4.

Description. Cerioid colony. Calicular outline elliptical, pit depressed. Septa compact. Septa in cross section slightly thicker close to the wall, becoming slightly thinner toward the centre. Symmetry of septa bilateral. Cycles of septa irregular, but size orders can be distinguished. Septal generations differ in length and thickness. Septa not connected to each other. A group of about five main

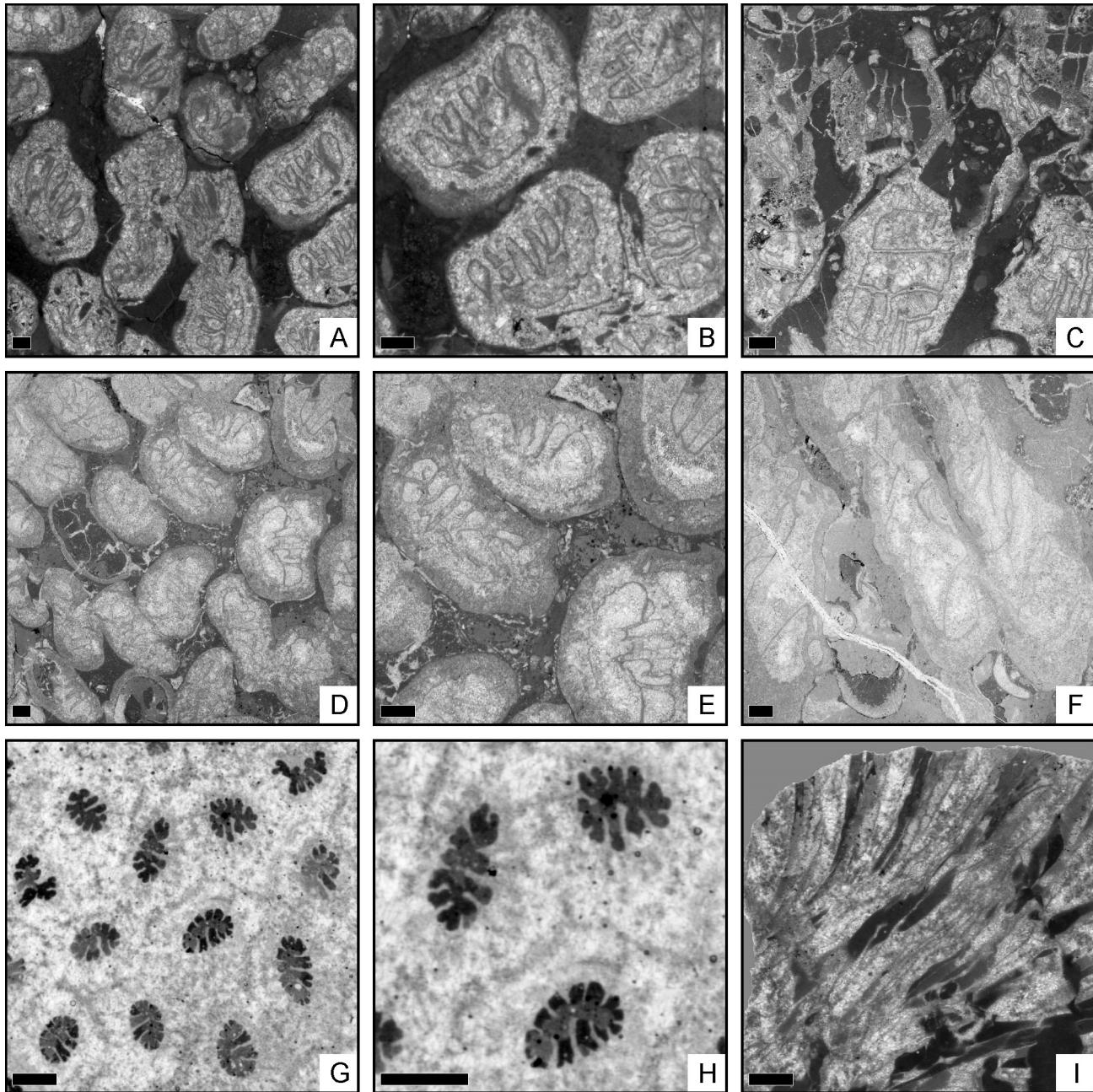


Figure 1. A–C, *Heteropistophyllum carchensis* Löser et al., 2015, ERNO L-4266. A, transversal thin section. B, transversal thin section, detail. C, longitudinal thin section. D–F, *Heteropistophyllum quinqueseptatum* (Turnšek and Buser, 1976), ERNO L-4242. D, transversal thin section. E, transversal thin section, detail. F, longitudinal thin section. G–I, *Latusastrea rubrolineata* Löser et al., 2009, ERNO L-4309. G, transversal thin section. H, transversal thin section, detail. I, longitudinal thin section. Scale bar 1mm.

septa exist. One main septum slightly longer and thicker than the others. Septal distal margin unknown, lateral face with few thorns, inner margin swollen in places. Pali or paliform lobes absent. Costae absent. Synapticulae absent. Columella absent. Endotheca consists of regular tabulae and occasional dissepiments. Wall compact, structure unknown. Coenosteum absent. Budding extracalcinal.

Material examined. ERNO 3198, L-4284, L-4285, L-4287, L-4309, L-4820, L-4821, L-4822, L-4825, L-4827, L-4908; 11 thin sections.

Dimensions

(L-4309)	n	min-max	μ	s	cv	$\mu \pm s$
cl min	60	0.58-1.23	0.87	0.15	17.7	0.71-1.02
cl max	60	0.81-1.79	1.29	0.22	17.4	1.07-1.52
s	20	12-19	14.55	2.25	15.5	12-17

Remarks. The material differs from the type species by its more cerioid organisation form. The type of *L. rubrolineata* shows a very reduced coenosteum, but because

the present material differs from the type material only by the absence of the coenosteum, it does not seem useful to create a new species or even genus.

Occurrence in Sonora. Early Albian of Municipio Agua Prieta, east San Bernardino Valley, Cordon Caloso; Municipio Cucurpe, Cucurpe, La Mesa; Municipio Opodepe, Tuape, Cerro de la Espina; Municipio Ures, Cerro de Oro.

Occurrence elsewhere. Tithonian to Early Berriasian of Poland (Malopolskie, Wadowice) Wadowice, Wozniki. Hauterivian of Jamaica (Saint Catharine) Benbow Inlier, Copper. Early Albian of Mexico (Baja California) Santo Tomás, Arroyo de la Cueva (ERNO L-1347062).

Pleurocoenia Orbigny, 1849

Type species. *Pleurocoenia provincialis* Orbigny, 1849

Pleurocoenia irregularis Toula, 1884

Figs. 2A-C

- *v 1884 *Pleurocoenia irregularis* Toula, p. 1318, pl. 6, fig. 6.
- v 1909 *Heliopora decipiens* - Prever, p. 65, pl. 1, figs. 18, 18 a, 23, pl. 2, figs. 1, 1 a, 2.
- vp 1948 *Heliopora japonica* n.sp. - Eguchi, p. 363, pl. 60, figs. 1, 2, 5, 7.
- v 1971 *Heterocoenia minima* n.sp. - Morycowa, p. 66, text-fig. 19, pl. 12, figs. 1, 2.
- v 1981 *Latusastraea decipiens* (Prever) 1909 - Turnšek and Mihajlovic, p. 19, pl. 13, figs. 7, 8.
- v 1984 ? *Polytremacis* cf. *urgoniensis* Koby, 1897 - Scholz, p. 475.
- 1985 *Latusastraea exiguis* (Fromentel, 1862) - Sikharulidze, p. 23, text-fig. 2, pl. 8, fig. 1, pl. 9, fig. 1.
- 1993 *Latusastraea provincialis* (d'Orbigny 1850) - Baron-Szabo, p. 157, text-fig. 4, pl. 2, fig. 3.
- v 1997 *Latusastraea provincialis* (d'Orbigny, 1849) - Baron-Szabo, p. 46, pl. 2, figs. 5, 6.
- v 1999 *Latusastraea provincialis* d'Orbigny, 1849 - Baron-Szabo and González León, p. 482, fig. 4d.
- v 2006 *Latusastraea irregularis* (Toula, 1884) - Löser and Ferry, p. 480, fig. 4.3.
- v 2008 *Latusastraea irregularis* (Toula, 1884) - Löser, p. 44, pl. 2, fig. 5.

Description. Plocoid colony in form of a swallow's nest. Calicular outline elliptical to semi-circular, pit depressed. Septa in cross section slightly thicker close to the wall, becoming slightly thinner toward the centre. Symmetry of septa bilateral. Septa not connected to each other. Main septum present, other septa reduced to spines. Septal distal margin unknown, lateral face occasionally with thorns, inner margin smooth. Pali or paliform lobes absent. Costae present but short. Synapticulae and columella absent. Endotheca consists of regular tabulae. Wall compact, constitution

unknown. Coenosteum medium broad, consists of costae. Budding extracalcinal.

Material examined. ERNO 2175, 2200, L-4220, L-4221, L-4430, L-4449, L-4450; 8 thin sections.

Dimensions

(L-4220)	n	min-max	μ	s	cv	μ±s
cl min	25	0.49-0.82	0.66	0.08	13.1	0.57-0.75
cl max	25	0.66-1.14	0.9	0.11	13	0.78-1.01

Occurrence in Sonora. Early Albian of Municipio Opodepe, Tuape, Cerro de la Espina; Municipio Opodepe, Tuape, Cerro de la Espina; Municipio Ures, Cerro de Oro.

Occurrence elsewhere. Hauterivian of Georgia (Imereti) Kvemo-Chalovani. Barremian of Mexico (Puebla) Tehuacán, San Antonio Texcala (GPSL FLX 1606). Early Barremian of France (Drôme) Vercors Mts, section NW Archiane. Barremian to Early Aptian of Romania (Suceava) Pojorita area, Cimpulung-Moldovenesc. Late Barremian of France (Ardèche) St.Remèze, Belvedere du Gaud. Late Barremian to Early Aptian (*Gerhardia sartousiana* to *Deshayesites forbesi* zones) of Germany (Bayern) Allgäuer Helvetikum. Aptian of Mexico (Puebla) San Juan Raya (IGM 9228). Early Aptian (*Deshayesites oglanlensis* to *Deshayesites forbesi* zones) of France (Vaucluse) Sault. Early Aptian of Greece (Viotía) Arachova (BSPG 2003 XX 5515); Levadia, Perachorion (BSPG 2003 XX 5784). Italy (Abruzzi, L'Aquila) Monti d'Ocre (ERNO L-5402). Serbia (East Serbia) Pirot, Bela Palanka; Rajcinica; Zljebine. Early Aptian (*Deshayesites forbesi* to *Dufrenoyia furcata* zones) of Tanzania (Tanganyika, Mtwara) Nambawala plateau, Kikomolela, Likwaja (MB K1366). Early Late Aptian of Algeria (Tebessa) Commune Ouenza, Ouenza Mt (UP M 5133). Late Aptian of Spain (País Vasco, Vizcaya) Gamecho, Playa de Laga. Latest Aptian of Japan (Iwate-ken) Shimohei-gun, Iwaizumi-cho, Moshi, Matsushima. Early Albian of Mexico (Baja California) El Progreso, Los Torotes section (ERNO L-4390); Eréndira, Playa Blanca (ERNO L-134906). Early Cenomanian of UK (Wiltshire) Norton Bavant 2 miles S Warminster (ANSP 72289).

Pleurocoenia provincialis Orbigny, 1849

Figs. 2D-F

- *v 1849 *Pleurocoenia provincialis* Orbigny, p. 7.

- v 1891 *Latusastraea provincialis* - Felix, p. 158, pl. 25, fig. 16.
- v 1909 *Heliopora aprutina* - Prever, p. 65, pl. 27, fig. 1.
- v 1964 *Latusastraea exiguis* (Fromentel, 1862) - Morycowa, p. 69, pl. 22, fig. 3.
- v 1964 *Latusastraea provincialis* (d'Orbigny, 1850) - Morycowa, p. 70, pl. 19, fig. 3, pl. 20, fig. 4.
- v 1971 *Heterocoenia* sp. - Morycowa, p. 68, pl. 13, fig. 3.
- v 1981 *Latusastraea decipiens* (Prever) 1909 - Turnšek and Mihajlovic, p. 19, pl. 13, fig. 7, 8.

- 1993 *Latusastraea decipiens* Prever 1909 - Baron-Szabo, p. 157, pl. 2, fig. 4.
 v 1994 *Latusastrea xigazeensis* (sp. nov.) - Liao and Xia, p. 67, 221, pl. 5, fig. 5, 6.
 1995 *Latusastraea exiguis* (Fromentel, 1862) - Morycowa et al., p. 18, fig. 1, 2, 3 a-f.
 v 1996 *Latusastrea provincialis* (d'Orbigny, 1850) - Baron-Szabo and Steuber, p. 18, pl. 7, fig. 6.
 v 1997 *Latusastrea provincialis* (d'Orbigny, 1849) - Baron-Szabo, p. 46, pl. 2, fig. 5, 6.
 v 2006 *Latusastrea cf. provincialis* (d'Orbigny, 1849) - Löser and Ferry, p. 480, fig. 4.6, 4.7.

Description. Plocoid colony in form of a swallows nest. Calicular outline circular, elliptical or irregular, pit depressed. Septa in cross section thicker close to the wall, becoming thinner toward the centre. Symmetry of septa bilateral. Septa not connected to each other. Main septum present, other septa reduced to spines. Septal distal margin unknown, lateral face occasionally with thorns, inner margin swollen in places. Pali or paliform lobes absent. Costae present but short. Synapticulae and columella absent. Endotheca consists of regular tabulae. Wall compact, constitution unknown. Coenosteum narrow, consists of costae and trabeculae. Budding extracalcinal.

Material examined. ERNO L-4219, L-4230, L-4459; 4 thin sections.

Dimensions

(L-4459)	n	min-max	μ	s	cv	$\mu \pm s$
cl min	37	0.57-1.28	0.84	0.12	14.8	0.71-0.96
cl max	22	0.75-1.41	1.1	0.15	13.9	0.95-1.26

Occurrence in Sonora. Early Albian of Municipio Opodepe, Tuape, Cerro de la Espina.

Occurrence elsewhere. Barremian of Mexico (Puebla) Tehuacán, San Antonio Texcala. Late Barremian of France (Ardèche) St.Remèze, Belvédère du Serre-de-Tourre. Late Barremian to Early Aptian of Switzerland (Bern) Rawil pass. Poland (Malopolskie) without precise locality (UJ 4P10#2). Late Barremian to Early Aptian (*Gerhardtia sartousiana* to *Deshayesites forbesi* zones) of Germany (Bayern) Allgäuer Helvetikum, Brandalpe. Aptian of Mexico (Puebla) San Juan Raya (IGM 9224). Early Aptian of Greece (Viotía) Arachova; Perachorion (BSPG 2003 XX 5775); Italy (Abruzzi, L'Aquila) Monti d'Ocre, Fossa Mezza Spada; Poland (Malopolskie, Wadowice) Lanckorona, Jastrzebia (ERNO L-5427); Serbia (East Serbia) Zljebine. Early Aptian (*Palorbitolina lenticularis* Zone) of Romania (Suceava) Pojorita area, Cîmpulung-Moldovenesc, Valea Izvorul Alb.

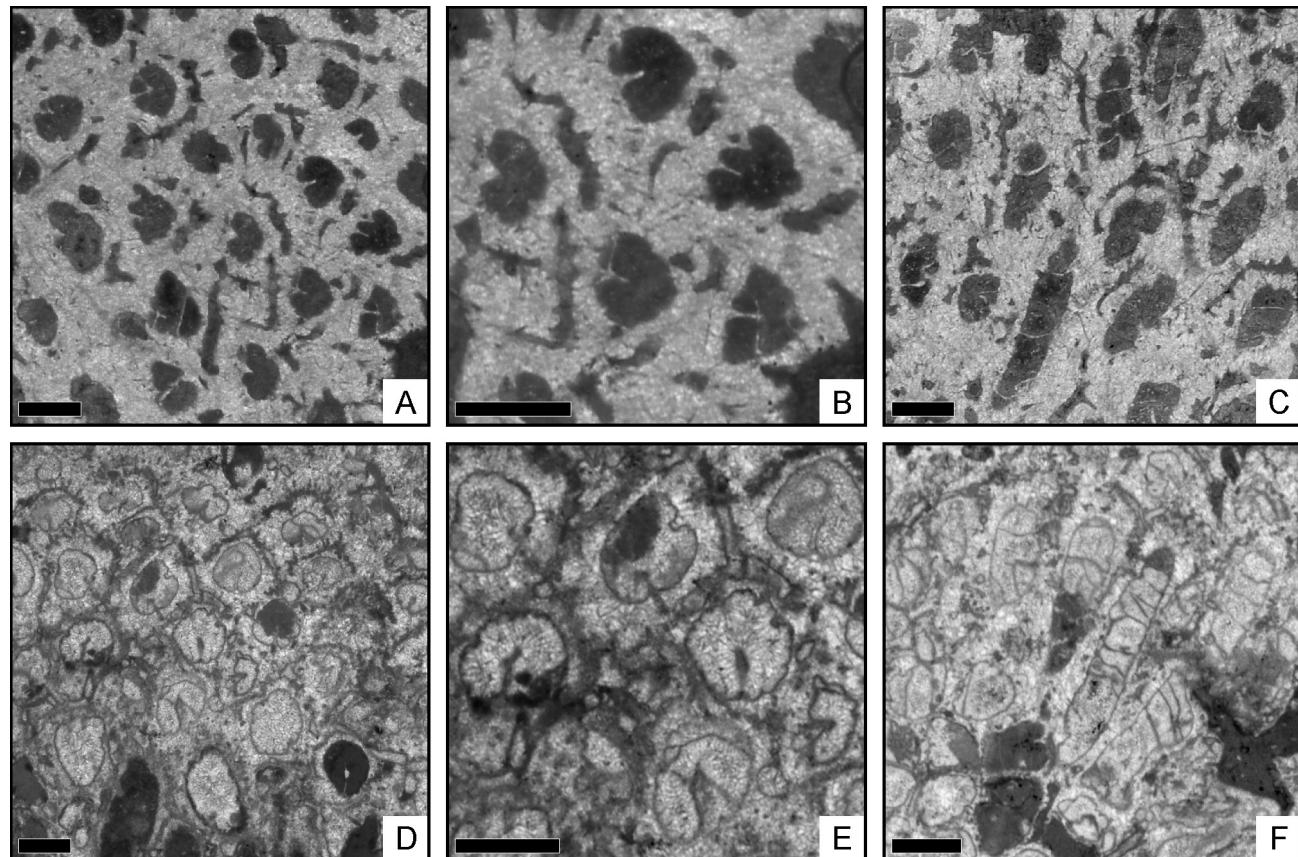


Figure 2. A-C, *Pleurocoenia decipiens* (Prever, 1909), ERNO L-4220. A, transversal thin section. B, transversal thin section, detail. C, longitudinal thin section. D-F, *Pleurocoenia provincialis* d'Orbigny, 1849, ERNO L-4459. F, transversal thin section. E, transversal thin section, detail. F, longitudinal thin section. Scale bar 1mm.

Late Aptian of Spain (País Vasco, Vizcaya) Gamecho, Playa de Laga. Early Cenomanian of China (Xizang [= Tibet] Autonomous Region) Xigaze county, Donggar district, suburb of Dongga. Late Turonian of France (Vaucluse) Orange, Uchaux.

Pleurocoenia sp.

Figs. 3A–B

- v 1905 *Heterocoenia verrucosa* - Angelis d'Ossat, p. 23, pl. 1, fig. 15, 16.
- v 1964 *Latusastraea decipiens* (Prever, 1909) - Morycowa, p. 71, pl. 20, fig. 1, 2.
- v 1974 *Latusastrea decipiens* (Prever) - Turnšek and Buser, p. 16, 34, pl. 6, fig. 3.
- v 2003 *Latusastrea provencialis* (d'Orbigny, 1849) - Baron-Szabo and González León, p. 206, fig. 7G.
- v 2013a *Pleurocoenia* cf. *irregularis* - Löser, p. 101, fig. 5.1-5.3.

Description. Plocoid colony in form of a swallows nest. Calicular outline circular, elliptical or irregular, pit depressed. Septa in cross section slightly thicker close to the wall, becoming slightly thinner toward the centre. Symmetry of septa bilateral. Septa not connected to each other. Main septum present, other septa reduced to spines.

Septal distal margin unknown, lateral face rarely with thorns, inner margin smooth. Pali or paliform lobes absent. Costae unknown. Synapticulae and columella absent. Endotheca unknown. Wall compact, constitution unknown. Coenosteum narrow. Budding extracalcinal.

Material examined. ERNO 3141; 1 thin section.

Dimensions

(3141)	n	min-max	μ	s	cv	$\mu \pm s$
cl min	30	0.37-0.71	0.57	0.08	15.1	0.48-0.66
cl max	30	0.58-0.90	0.72	0.07	9.9	0.64-0.79

Remarks. The specimen is comparable to *P. provencialis* but differs by larger calicular dimensions. It belongs probably to a new, yet undescribed species.

Occurrence in Sonora. Early Albian of Municipio Ures, Cerro de Oro.

Occurrence elsewhere. Barremian of Italy (Campania, Napoli) Isle of Capri, Venassino. Late Barremian of Poland (Malopolskie, Tarnów) Tarnów, Trzemesna. Early Aptian of Italy (Abruzzi, L'Aquila) Monti d'Ocre, Fossa Mezza Spada (BSPG 2003 XX 5331); Poland (Malopolskie, Wadowice) Lanckorona, Jastrzebia; Slovenia (West Slovenia) Banská Planota, Osojnice. Late Aptian of Greece (Viotía) Aliartos, Chiarmena.

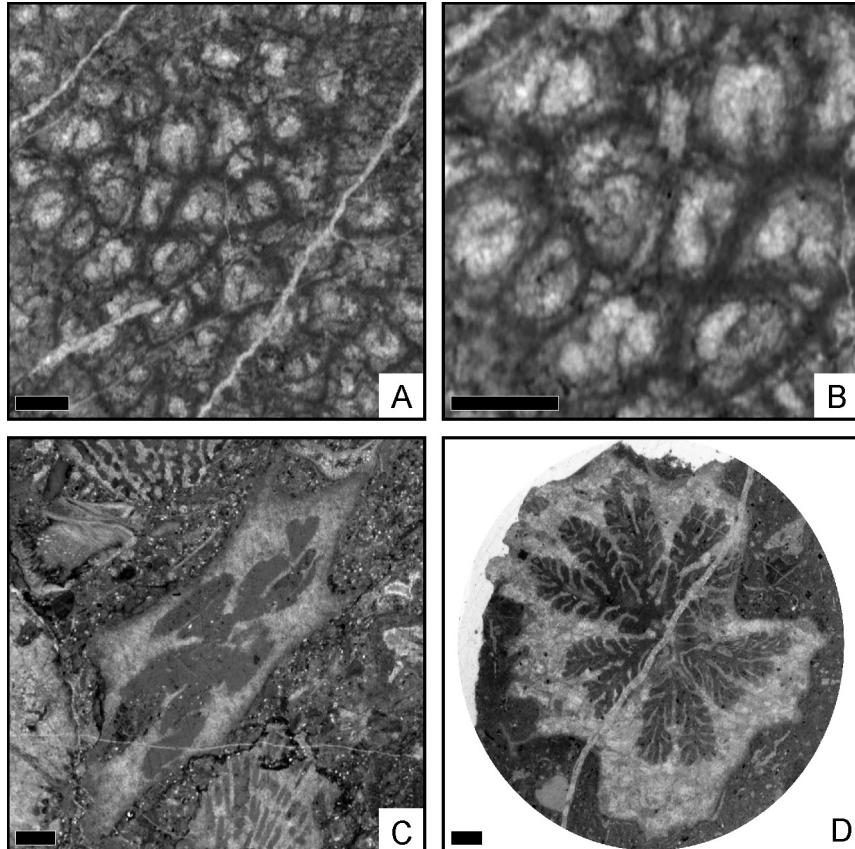


Figure 3. A–B, *Pleurocoenia* sp., ERNO 3141. A, transversal thin section. B, transversal thin section, detail. C, *Heterosmilia* sp., ERNO 3025, transversal thin section. D, *Tiarasmilia* sp., ERNO L-4276, transversal thin section. Scale bar 1mm.

Pleurodendron Löser et al., 2013

Type species. *Pleurodendron prebeticum* Löser et al., 2013

Pleurodendron microsa (Baron-Szabo and González León, 2003)
Figs. 4A–C

*v 2003 *Pleurophyllia microsa* Baron-Szabo and González León, p. 205, fig. 6C, D, 7C.

Description. Phaceloid colony, branches connected by apophyses. Calicular outline elliptical. Septa compact. Septa in cross section slightly thicker close to the wall, becoming slightly thinner toward the centre. Symmetry of septa bilateral. Cycles of septa subregular. Septal generations differ in length and thickness. Septa not connected to each other. Main septum present, septum thicker and longer than other septa. Septal distal margin unknown, lateral face with rare thorns, inner margin slightly swollen in places. Pali or paliform lobes, costae, synapticulae, and columella absent. Endotheca consists of tabulae. Wall compact, structure unknown. Coenosteum absent. Budding intracalicial.

Material examined. ERNO 3069; 4 thin sections.

Dimensions

(3069)	n	min-max	μ	s	cv	μ±s
cl min	15	0.58-1.34	0.92	0.24	26.9	0.67-1.16
cl max	15	1.03-1.80	1.29	0.22	17	1.07-1.51
c min	17	1.38-2.35	1.84	0.29	16.2	1.54-2.14
c max	17	2.10-3.03	2.54	0.3	11.9	2.23-2.84
s		5				

Remarks. The assignation of the species to this genus is questionable. It does not show apophysal connections between the calices, and no channels, as in *Pleurodendron*. The species cannot be assigned to *Pleurophyllia*. This genus shows much larger calices, and smooth septa.

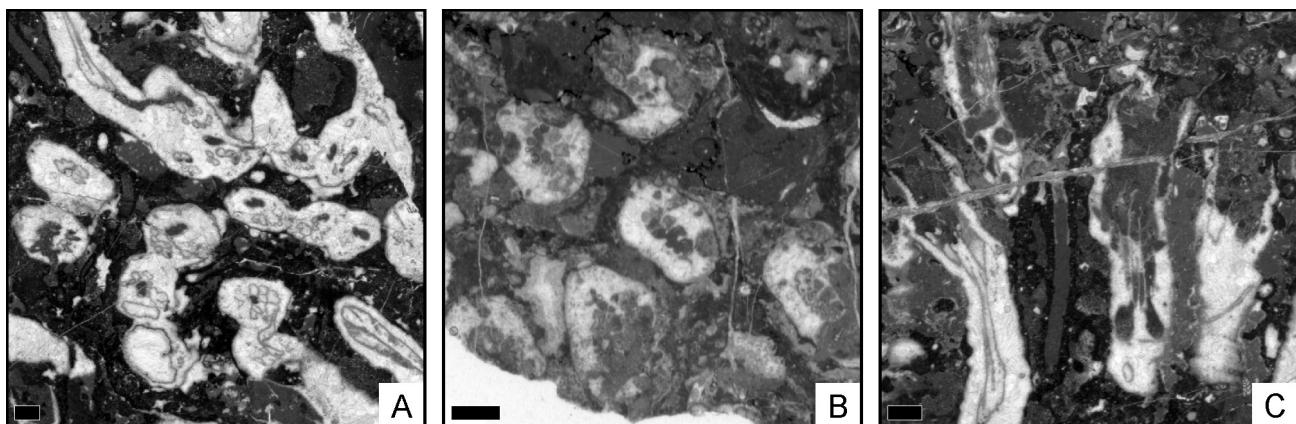


Figure 4. A–C, *Pleurodendron microsa* (Baron-Szabo and González León, 2003), holotype, ERNO 3069. A, transversal thin section. B, transversal thin section, detail. C, longitudinal thin section. Scale bar 1mm.

Occurrence in Sonora. Early Albian of Municipio Opodepe, Tuape, Cerro de la Espina.

Family Heterocoeniidae Oppenheim, 1930
Heterosmilia Kolodziej et al., 2012

Type species. *Heterosmilia spinosa* Kolodziej et al., 2012

Heterosmilia sp.
Figs. 3C

Material examined. ERNO 3025; one thin section.

Description. Phaceloid colony. Calicular outline polygonal. Septa compact. Septa in cross section thick close to the wall, thinner toward the centre. Symmetry of septa radial and regularly hexameral. Cycles of septa regular. Septal cycles differ in length and thickness. Septa not connected to each other. Septal distal margin unknown, lateral face with few apophysal septa, inner margin branching. Pali or paliform lobes absent. Costae present. Synapticulae, and columella absent. Endotheca unknown. Wall compact, structure unknown. Coenosteum absent. Budding unknown.

Dimensions

(3025)	
c	4
cl	2.5
s	6+6

Remarks. The only specimen is an oblique portion in thin section. It differs from *Heterosmilia* by its polygonal calicular outline.

Occurrence in Sonora. Late Barremian to Early Aptian (*Palorbitolina lenticularis* zone) of Municipio Ures, Cerro de Oro.

Occurrence elsewhere. Aptian of Mexico (Puebla) Tehuacán, Barranco San Lucas, N Plan de Fierro (ERNO L-100103).

Family Paronastraeidae Beauvais, 1974
Tiarasmilia Wells, 1932

Type species. *Tiarasmilia casteri* Wells, 1932

Tiarasmilia sp.
Figs. 3D

- 1997 *Trochoidomeandra* cf. *problematica* Morycowa 1971 - Baron-Szabo and Fernández Mendiola, p. 48, fig. 5 e.
v 2010 *Tiarasmilia* sp. 1 - Löser, p. 162, figs. 2.9, 3.1, 3.2.
v 2013b *Tiarasmilia* sp. - Löser, p. 18, fig. 6l.

Description. Solitary turbinate coral. Calicular outline irregularly circular. Septa compact. Septa in cross section thick close to the wall, thinner toward the centre. Symmetry of septa radial and regularly hexameral. Cycles of septa regular. Septal cycles differ in length and thickness. Septa not connected to each other. Main septum present, but barely distinguishable from the other septa of the first cycle. Septal distal margin smooth, lateral face with long apophysal septa, inner margin slightly swollen in places. Pali and paliform lobes absent. Costae present but short. Synapticulae and columella absent. Endotheca unknown. Wall compact, structure unknown.

Material examined. ERNO L-4276; 1 thin section.

Dimensions

(L-4276)	
c	10-11
cl	8-9
s	6+6

Remarks. The genus was just recently revised (Löser, 2010). The present material differs from all other species by its low number of septa. The present material does not allow to establish a new species because there exists only one specimen.

Occurrence in Sonora. Early Albian of Municipio Cucurpe, Cucurpe, La Mesa (ERNO L-4276).

Occurrence elsewhere. Late Barremian of Mexico (Puebla) Tehuacán, La Compañía (IGM 9263). Aptian to Albian of Greece (Fokída) Kiona massif, Panourgias [= Dremisa] (BSPG 2003 XX 5901). Early Albian of Spain (Cantabria, Santander) Cabo de Ajo. Late Early Albian (*Douvilleiceras mammillatum* Zone) of France (Aude) Padern, SE Le Crès, 1.45 km WWS Padern. Early Cenomanian of Greece (Kozani) Kozani, Nea Nikopolis (BSPG 2003 XX 5921). Middle Cenomanian (*Mantelliceras mantelli* to *Acanthoceras rhomagense* zones) of Belgium (Hainaut) Tournai-Chercq (MNHN M00283).

5. Discussion

The Sonoran species of the suborder Heterocoeniina belong to a rather rare genera, with the exception of *Pleurocoenia*, which is globally distributed, ranging from the Hauterivian to the Santonian. *Heteropistophyllum* has a wide geographic distribution, but is much rarer, and it is restricted to the Aptian and Albian. Distribution data of the just recently established *Heterosmilia* are poor; the genus is known from the Late Barremian to Middle Albian. *Latusastrea* reaches from the Late Jurassic to the Middle Albian. *Tiarasmilia* has a wide geographic distribution, but it is relatively rare. The genus ranges from the Barremian to the Early Cenomanian. Because of the rarity of most genera studied here, few distribution data are available (Fig. 5). Most of the reported species here occur from the Barremian to the Aptian, although there are a few appearances occurring as far back as the Late Jurassic, and some can be found ranging into the Turonian. As most genera have their last occurrence in the Albian (*Heteropistophyllum*, *Heterosmilia*, *Latusastrea*, *Pleurodendron*), they became extinct before OAE (Ocean Anoxic Event) 2. A possible explanation may be OAE 1c and 1d. Geographically, the Sonoran species of the suborder Heterocoeniina show only some relationship to Western and Central Tethyan faunas, but also to other regions on the American continent (Fig. 6).

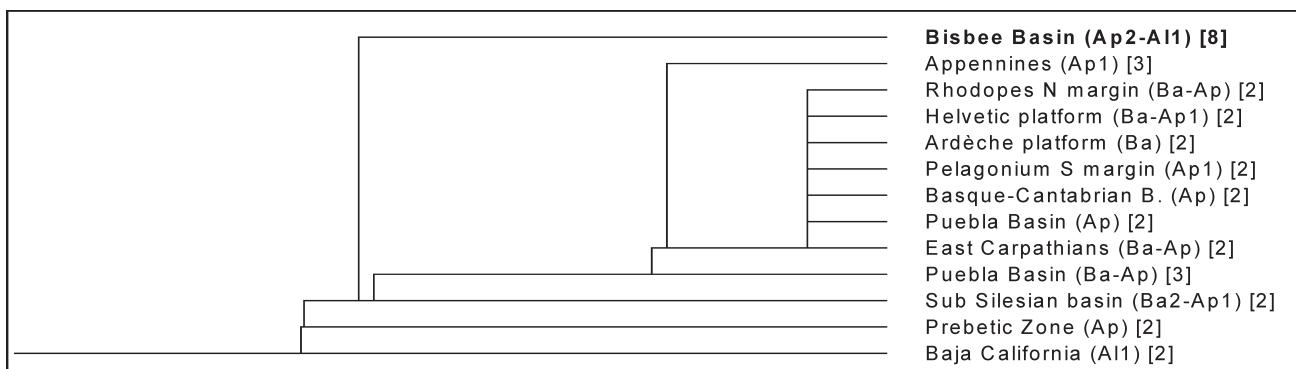


Figure 5. Correlation of provinces with joint species in the study area. Provinces with less than two joint species are suppressed. The Correlation Ratio coefficient was applied, the graph is logarithmic. For details of calculation see Löser and Minor (2007).

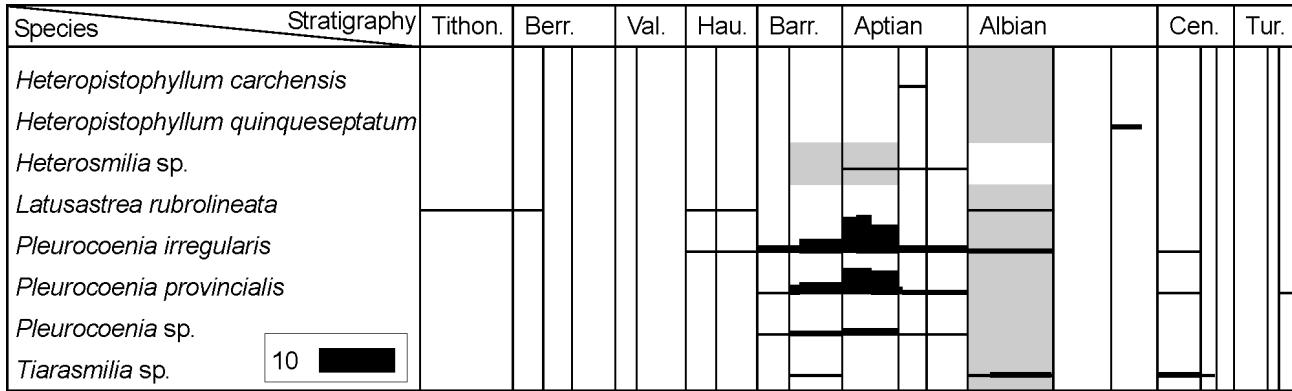


Figure 6. Stratigraphic distribution and commonness of species. The thickness of the bars indicates the number of localities (multiples localities within the same lithostratigraphic unit are counted as one) in which the concerned species was found. Grey bar indicates the study area.

The correlation is generally low because of the rarity of the genera, with the exception of *Pleurocoenia*.

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