

REVISION OF THE AMPHIASTRAEIDAE FROM THE MONTI D'OCRE AREA (SCLERACTINIA; EARLY CRETACEOUS)

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Abstract. The four *Amphiastrea* species from the Early Aptian of the Monti d'Ocre area described as new by Prever (1909) are revised on the basis of the type material. One species - *Amphiastrea paronai* - remains in this genus. Another - *Amphiastrea delorenzoi* - cannot be assigned to any genus. The remaining two species belong to the new genus *Hexamphiastrea*, which differs from all amphiastroid genera by its regular hexamerous septal symmetry. *Amphiaulastrea suprema* Morycowa & Marcopoulou-Diacantoni, 1997 from the Early Aptian of Greece is designated as the type species. The new genus is only known from the Early Aptian of Italy and Central Greece.

Riassunto. In questo lavoro vengono revisionate le quattro specie di *Amphiastrea* segnalate nell'Aptiano inferiore dei Monti d'Ocre e descritte come nuove da Prever (1909). Una specie, *Amphiastrea paronai*, viene mantenuta in questo genere. Un'altra, *Amphiastrea delorenzoi*, non può essere assegnata ad alcun genere. Le rimanenti due specie appartengono al nuovo genere *Hexamphiastrea*, che differisce da tutti gli amphiastroidi per la regolare simmetria esamerale dei setti. *Amphiaulastrea suprema* Morycowa & Marcopoulou-Diacantoni, 1997, dell'Aptiano inferiore della Grecia, viene designata come specie tipo. Il nuovo genere è conosciuto solo per l'Aptiano inferiore dell'Italia e della Grecia centrale.

Introduction

In the voluminous monograph on the Early Aptian (formerly Cenomanian) corals from the Monti d'Ocre area, Pietro Lodovico Prever (1909) established four species of the genus *Amphiastrea* Etallon, 1859: *A. delorenzoi*, *A. guiscardii*, *A. minima* and *A. paronai*. These species were often cited in the literature, sometimes with other genera (*Amphiaulastrea* Geyer, 1955; *Metaulastrea* Dietrich, 1926). Studies of the type material and other material from the type area revealed that

only one of these species remains *Amphiastrea*. One species cannot be identified and the remaining two belong to a new genus of the Amphiastraecidae family that is restricted to the Early Aptian.

Abbreviations

The following abbreviations are used:

BSPG, Bayerische Staatssammlung für Paläontologie und Geologie, München, Germany;

PU, Università degli studi di Torino, Dipartimento di Scienze della Terra, Italy;

UJ, Jagiellonian University, Instytut Nauk Geologicznych;

cl min, minimum calicular diameter (mm);

cl max, maximum calicular diameter (mm);

cn min, minimum diameter of the inner calice (mm);

cn max, maximum diameter of the inner calice (mm);

ccd, distance of calicular centres (mm);

s, number of septa;

n, number of measurements;

min-max, range (mm);

μ , arithmetic mean (mm);

σ , standard deviation (mm);

cv, coefficient of variation according to K. Pearson (%);

$\mu \pm \sigma$, first interval (mm).

The abbreviations used in the synonymy lists follow Matthews (1973):

*****, earliest valid publication of the specific name;

v, the specimen was observed by the author.

Material

The material discussed here comes from the Monti d'Ocre area in the Abruzzo (Italy) and from the Early Cretaceous of Greece. Localities are commented on and provided with additional references in

Löser et al. (2005). For details and discussion of the stratigraphy of the Monti d'Ocre area see Löser (2010).

Greece

Fokída, Agrostylia (GR.3537). Palaeontological data are published in Morycowa & Marcopoulou-Diacantoni (1997, 2002). The stratigraphy is discussed in Löser (2005: 237). The here described specimens are most probably from the Early Aptian, not from the Late Albian/Early Cenomanian. Specimens: UP 158P2#1, 158P2#2, 158P3.

Italy

Abruzzo, L'Aquila, Monti d'Ocre, Fossa Agnese (I.1735); Early Aptian. Specimens: BSPG 2003 XX 5302, 5303, 5309.

Abruzzo, L'Aquila, Monti d'Ocre, Fossa Mezza Spada (I.1732); Early Aptian. Specimens: PU 17929, 17931, 17932.

Abruzzo, L'Aquila, Monti d'Ocre, Sotto Colle Campetello (I.1731); Early Aptian. Specimen: PU 17928.

Abruzzo, L'Aquila, Monti d'Ocre, Sotto Colle Pagliare (I.1733); Early Aptian. Specimen: PU 17930.

Systematic description

Dimensions given for the Amphistraeidae species are based on systematic measurements, using the PaleoTax/Measure computer program (www.paleotax.de/measure/).

Order Scleractinia Bourne, 1900

Suborder Amphistraeina Alloiteau, 1952

Remarks. The suborder is often connected to Paleozoic ancestors (e.g. Permian Polycoeliidae; see Melnikowa & Roniewicz 1976). The suborder evolved probably from the Triassic family Pachythecalidae. Earliest stratigraphic records of the suborder is the Early Jurassic (Melnikowa & Roniewicz 1976), reaching its highest diversity during the Late Jurassic. Cretaceous Amphistreaeids are not just a continuation of Jurassic genera with a reduced number of taxa, but are represented by new taxa also. Kołodziej (1995) discussed the relationship between the suborder Amphistraeina and the suborder Heterocoeniina and included the latter suborder as a super family in the suborder Amphistraeina. Indeed, heterocoeniid corals shows many affinities with amphistreaeids. Both groups share the formation of wall, microstructure of septa and budding types, but differs in the septal ornamentation and presence or absence of a coenosteum. Heterocoeniids evolved in the Late Jurassic (*Latusastrea* Orbigny, 1849) and reached their highest diversity in the Cretaceous.

Recently some authors include the suborder Amphistraeina into the later established suborder Pachythecaliina Eliášová, 1976. Here, the suborder Amphistraeina is given priority because it was described earlier. Even if the IRZN do not cover taxa higher than the family level, I follow the general intention of the rules giving priority to earliest established taxon in or-

der to conserve stability and to avoid confusion. Probably it would be more clear to treat both suborders separately.

Classification of the suborder into families is a subject of discussion (e.g. Eliášová 1975; Melnikowa & Roniewicz 1976; Kołodziej 1995; Roniewicz & Stolarski 2001) because various authors give more or less importance to different morphological characteristics. The Amphistreaeidae is understood here in a very limited sense as encompassing cerioid and phaceloid corals with a hexamerous or bilateral symmetry and, in some genera, with a non-rhopaloid main septum. The Opisthophyllidae family comprises genera which clearly show two opposing septal groups (*Amphiaulaustrea* Geyer, 1955; *Hykeliphyllum* Eliášová, 1975; *Opisthophyllum* Ogilvie, 1897; *Pseudopisthophyllum* Geyer, 1955). Genera with a strong rhopaloid main septum (such as *Cuneiphyllia* Eliášová, 1978; *Pleurostylina* Fromentel, 1856; *Oyonaxastra* Alloiteau, 1952; *Sclerosmilia* Koby, 1888; *Thecidiosmilia* Koby, 1888 and their synonyms) have to be separated. The remaining genera without symmetry or with hexamerous symmetry are mostly phaceloid and are collected in the Donacosmiliidae, Intersmiliidae and Carolastraecidae families.

Family Amphistraeidae Ogilvie, 1897

Amphiastrea Etallon, 1859

Remarks. The type species is not *Amphiastrea basaltiformis* Koby nor *Amphiastrea basaltiformis* Etallon sensu Koby. It is *Amphiastrea basaltiformis* Etallon, 1859 by monotypy. The discussions in Alloiteau (1957: 355) and Beauvais (1964: 200) are unclear and do not agree with the IRZN. Beauvais (1976: 10) mentions moreover that the specimen figured by Koby (1885: pl. 65, fig. 1) seems to belong to *Pleurostylina conferta* (Ogilvie, 1897), which is probably identical with that figured by Beauvais (1964: fig. 43). The type species of *Amphiastrea* has never been illustrated by its author and the type material has probably been lost, which makes *Amphiastrea basaltiformis* a nomen dubium, but not an invalid taxon. Here, the material used to understand the characteristics of the genus comes from the type locality and corresponds with the description of Etallon.

Amphiastrea paronai Prever, 1909

Pl. 1, figs 1-3

*v 1909 *Amphiastrea Paronai* Prever, p. 133, text fig. 28, pl. 7, figs. 2, 3

Type: Lectotype PU 17931 (designated here) and paralectotype PU 17932.

Dimensions

	n	min-max	μ	σ	cv	$\mu \pm \sigma$
PU (17931)						
cl min	20	1.91-2.85	2.33	0.27	11.5	2.06-2.60
cl max	20	2.27-3.3	2.82	0.3	10.6	2.52-3.12
ccd	25	2.62-3.63	3.1	0.28	9.1	2.81-3.38
s	14-22					

Description. Cerioid colony. Calicular outline polygonal, slightly elongated. Septa compact. Microstructure of septa unknown. Septa in cross section externally slightly thicker, getting thinner towards the centre. Bilateral septal symmetry. Irregular septal cycles, but generations distinguishable. Septal generations differ in length and thickness. First septal generation reaches to the centre of calice, the following generations are shorter. Septa free. There is a main septum, which is thicker and longer than the others and rhopaloid. Septal upper border unknown, lateral face smooth, inner margin slightly swollen in places. Pali or paliform lobes absent. Lonsdaleoid septa absent. Costae absent. Synapticulae absent. Columella absent. Endotheca unknown. Wall compact, constitution unknown. Marginarium absent. Coenosteum absent. Budding intracalicular, marginal.

Remarks. In some respects the material differs from *Amphiastraea*, mainly by the rhopaloid main septum and the complete absence of a marginarium. The paralectotype is not sectioned; it is probably conspecific with the lectotype.

Occurrence. Early Aptian of Italy (Abruzzo, L'Aquila) Monti d'Ocre, Sotto Colle Pagliare (PU 17931).

Hexamphiastraea gen. n.

Type species: *Amphiaulastraea suprema* Morycowa & Marcopoulou-Diacantoni, 1997.

Origin of name: Amphiastroid coral with a hexameral symmetry.

Diagnosis: Cerioid colony. Elliptical or irregular polygonal calicular outline. Septa compact and very strong. Septa in cross section of equal thickness throughout the septum or getting slightly thicker towards the centre. Radial and regularly hexameral septal symmetry. Regular septal cycles, differing in length and thickness. Septa free. Septal upper border unknown, lateral face with fine thorns, inner margins swollen. Pali or paliform lobes absent. Most septa are lonsdaleoid. Costae absent. Synapticulae absent. Columella absent. Endotheca consists of central tabulae and large lateral dissepiments. Wall compact, constitution unknown. Marginarium present. Coenosteum absent. Budding intracalicular, marginal.

Comparison. The new genus differs from all other genera of the family by its regular hexameral symmetry. It is closest related to *Metaulastraea* from which it can only be distinguished by the absence of a main septum

Cerioid	Symmetry bilateral	Marginarium absent	<i>Amphiastraea</i>
	Only one septum	Marginarium present	<i>Metaulastraea</i>
	Sym. hexameral		<i>Amphiaulastraea</i>
Phaceloid	Main septum absent	Cal. kidney shaped	<i>Selenegyra</i>
	Main septum present	Calices large	<i>Aulastraea</i>
		Calices small	<i>Pleurophyllia</i>

Fig. 1 - The new genus in relation to the other genera of the family.

and the regular hexameral septal symmetry (see Fig. 1 for the relationship between genera within the family). The thick rhopaloid septa are uncommon to amphiastroids except for the above mentioned group related to *Sclerosmilia* where one rhopaloid main septum is present.

Remarks. The material of the type species is not very well preserved, although several thin sections were available. The Italian material was not suitable for preparing additional thin sections.

Species. Species are separated on the basis of their calicular diameter (cl). The diameter of the inner calices

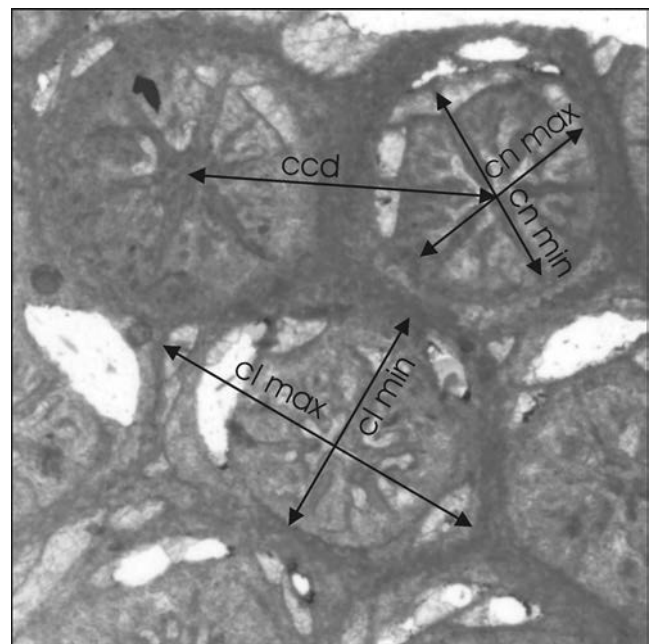


Fig. 2 - In *Hexamphiastraea* four types of calicular dimensions are taken: the larger and smaller calicular diameter, and the larger and smaller diameter of the so-called inner calice (abbreviations as in the text).

(cn) varies much more than the calicular diameter (Fig. 2). The known taxa are *Amphiastraea guiscardii* Prever, 1909, *Amphiastraea minima* Prever, 1909, and *Amphiaulastraea suprema* Morycowa & Marcopoulou-Diacantoni, 1997. The separation of species is difficult due to the small number of specimens available and the small number of calices available for measuring (Fig. 3).

Systematic position. The new genus shows closest relationships to the members of the family Am-

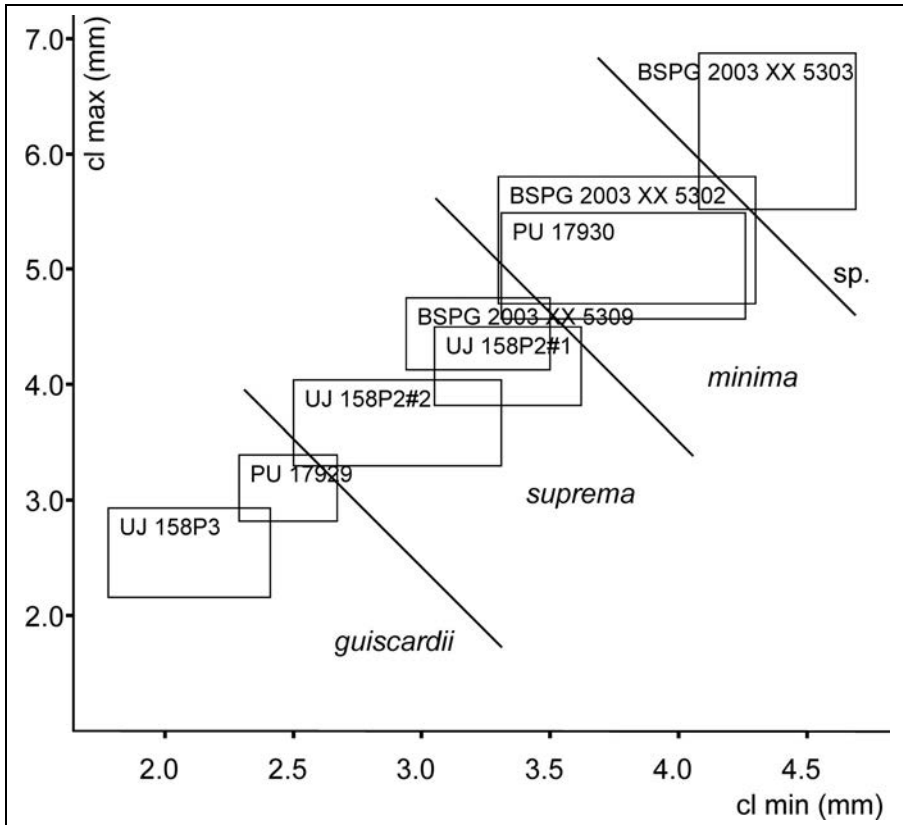


Fig. 3 - *Hexamphiastrea* specimens with smaller and larger calicular diameters and their assignation to species. Size and position of the rectangles corresponds to the first interval of the smaller and larger calicular diameter of the various specimens showing that species separation is critically when the amount of available specimens is low.

phiastraeidae and is therefore placed here. Traditionally, this family encompasses only genera with a bilateral symmetry and the presence of one or various main septa which are absent in the present material.

Range and distribution. Early Aptian of the Central Tethys (Italy and Greece).

***Hexamphiastrea guiscardii* (Prever, 1909)**

Pl. 1, figs 4-6

*v 1909 *Amphiastrea Guiscardii* Prever, p. 134, fig. 29, pl. 7, fig. 1

v non 1995 *Amphiaulastrea guiscardii* (Prever, 1909) - Abdel-Gawad & Gameil, p. 11, pl. 4, figs 1-2

v 2002 *Amphiaulastrea minima* (Prever, 1909) - Morycowa & Marcopoulou-Diacantoni, p. 15, fig. 10b

Type: Holotype PU 17929 by monotypy.

Dimensions

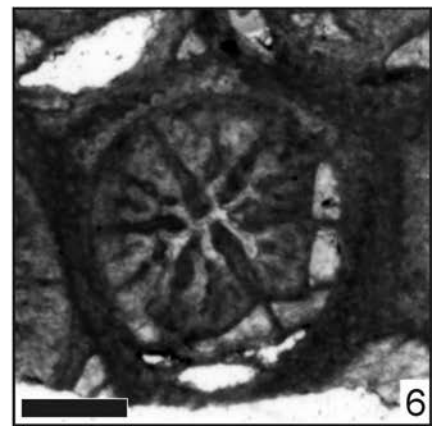
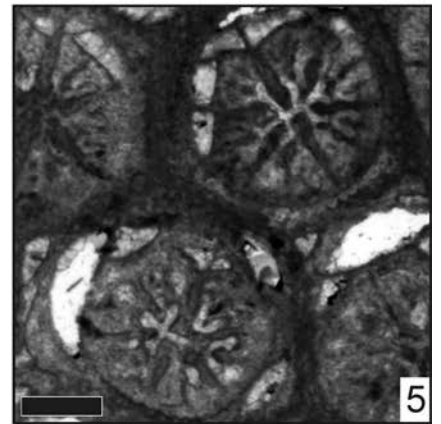
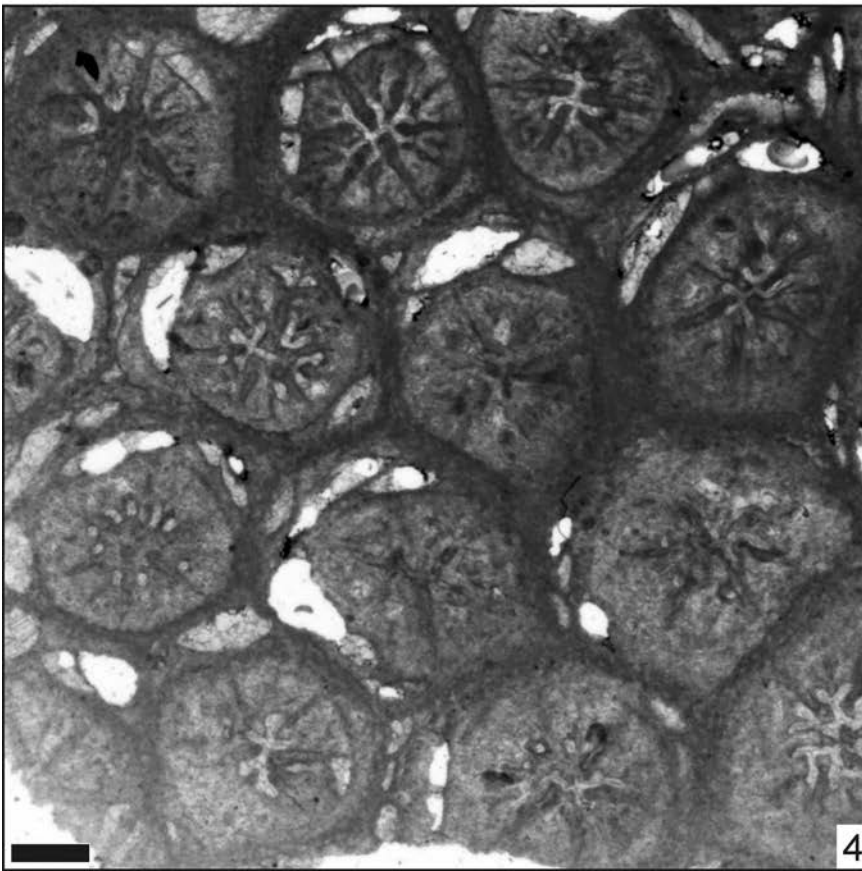
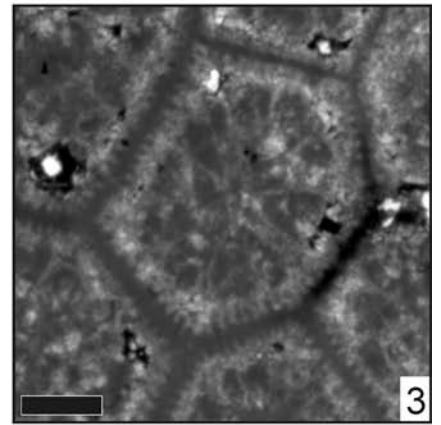
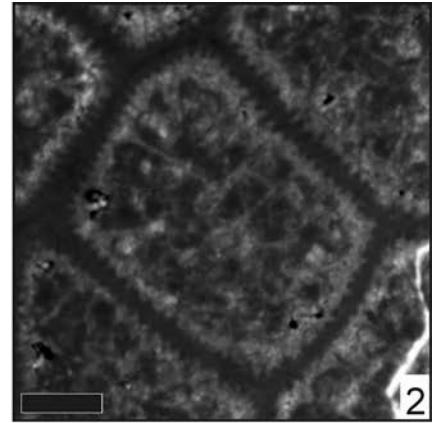
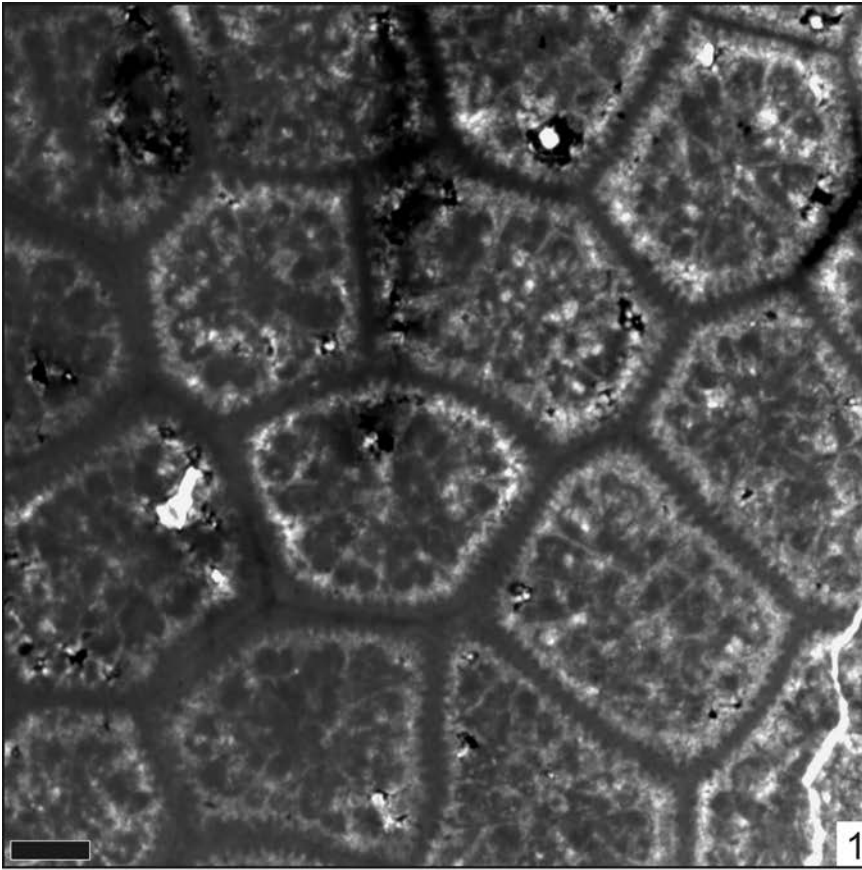
	n	min-max	μ	σ	cv	μ±σ
(PU 17929)						
cn min	15	1.28-2.21	1.82	0.27	14.9	1.54-2.08
cn max	15	1.63-2.34	1.96	0.23	11.6	1.73-2.19
cl min	15	2.2-2.79	2.49	0.19	7.6	2.29-2.67
cl max	15	2.62-3.48	3.11	0.29	9.1	2.82-3.39
ccd	15	2.77-3.62	3.18	0.24	7.5	2.94-3.42
s	24					

	n	min-max	μ	σ	cv	μ±σ
(UJ 158P3)						
cn min	11	1.18-1.8	1.54	0.22	14.2	1.31-1.75
cn max	6	1.27-2.23	1.81	0.39	21.4	1.41-2.19
cl min	15	1.61-2.61	2.1	0.31	14.8	1.78-2.41
cl max	15	2.03-3.2	2.55	0.38	15.0	2.16-2.93
ccd	20	2.34-3.19	2.72	0.27	9.9	2.44-2.98
s	12					

PLATE 1

- Fig. 1 - *Amphiastrea paronai* Prever, 1909, lectotype of *Amphiastrea paronai*, PU 17931, transversal thin section.
- Fig. 2 - *Amphiastrea paronai* Prever, 1909, lectotype of *Amphiastrea paronai*, PU 17931, transversal thin section, detail.
- Fig. 3 - *Amphiastrea paronai* Prever, 1909, lectotype of *Amphiastrea paronai*, PU 17931, transversal thin section, detail.
- Fig. 4 - *Hexamphiastrea guiscardii* (Prever, 1909), holotype of *Amphiastrea guiscardii*, PU 17929, transversal thin section.
- Fig. 5 - *Hexamphiastrea guiscardii* (Prever, 1909), holotype of *Amphiastrea guiscardii*, PU 17929, transversal thin section, detail.
- Fig. 6 - *Hexamphiastrea guiscardii* (Prever, 1909), holotype of *Amphiastrea guiscardii*, PU 17929, transversal thin section, detail.

Scale = 1 mm.



Remarks. The holotype is a small specimen with regular calices. Specimen UJ 158P3 differs from the type by showing only 12 septa, which is probably due to its poor preservation.

Occurrence. Early Aptian of Italy (Abruzzo, L'Aquila) Monti d'Ocre, Strada sopra Fossa Mezza Spada (PU 17929), Greece (Fokída) Agrostylia (UJ 158P3).

Hexamphiastrea minima (Prever, 1909)

Pl. 2, figs 1-3; Fig. 4A

*v 1909 *Amphiastrea minima* Prever, p. 136, fig. 31

Type: Holotype PU 17930 by monotypy.

Dimensions

	n	min-max	μ	σ	cv	$\mu \pm \sigma$
(PU 17930)						
cn min	9	2.1-2.92	2.35	0.3	13.0	2.04-2.65
cn max	7	2.45-4.33	3.13	0.69	22.1	2.43-3.81
cl min	10	3.31-4.69	3.79	0.47	12.4	3.31-4.26
cl max	6	4.48-5.58	5.04	0.46	9.0	4.57-5.49
ccd	15	4.08-5.09	4.72	0.34	7.1	4.38-5.05
s	24					
(BSP 2003 XX 5302)						
cn min	25	1.82-3.0	2.38	0.35	14.6	2.03-2.72
cn max	23	2.46-4.0	3.11	0.44	14.2	2.66-3.55
cl min	25	3.01-4.9	3.8	0.5	13.2	3.29-4.30
cl max	23	4.3-6.28	5.24	0.56	10.7	4.67-5.80
ccd	25	3.68-6.02	4.76	0.6	12.6	4.16-5.36
s	24					

Remarks. The holotype is a small specimen with calices tending to be elongated. Specimen 2003 XX 5302 with slightly more regular calices is much better preserved.

Occurrence. Early Aptian of Italy (Abruzzo, L'Aquila) Monti d'Ocre, Strada sopra Fossa Mezza Spada (PU 17930), Fossa Agnese (BSPG 2003 XX 5302).

Hexamphiastrea suprema (Morycowa & Marcopoulou-Diacantoni, 1997)

Pl. 2, fig. 4-6

*v 1997 *Amphiastrea suprema* Morycowa & Marcopoulou-Diacantoni, p. 254, fig. 4a, b, pl. 1: 1-3

v 2002 *Amphiastrea suprema* Morycowa & Marcopoulou-Diacantoni 1997 – Morycowa & Marcopoulou-Diacantoni, p. 14, fig. 10a

Type: Holotype UJ 158P2#1 by original designation.

Dimensions

	n	min-max	μ	σ	cv	$\mu \pm \sigma$
(5309)						
cn min	20	2.08-3.51	2.75	0.41	14.9	2.34-3.16
cn max	20	2.55-3.54	3.04	0.33	10.8	2.70-3.36
cl min	20	2.69-3.73	3.23	0.28	8.6	2.94-3.50
cl max	20	3.96-5.13	4.45	0.31	7.0	4.13-4.75
ccd	20	4.1-5.14	4.54	0.33	7.1	4.21-4.86
s	24					
(158P2#1)						
cn min	20	1.77-2.47	2.17	0.19	8.6	1.98-2.35
cn max	20	2.52-3.34	2.89	0.22	7.6	2.66-3.11
cl min	20	2.93-3.9	3.34	0.29	8.5	3.05-3.62
cl max	20	3.59-4.84	4.16	0.34	8.2	3.82-4.50
ccd	20	3.13-4.2	3.71	0.33	8.9	3.37-4.03
s	24					

Remarks. The material from Greece is not well preserved. The calicular centres are preserved only in part. Most thin sections are crooked.

Occurrence. Early Aptian of Greece (Fokída) Agrostylia (UJ 158P2#1, 158P2#2) and Italy (Abruzzo, L'Aquila) Monti d'Ocre, Fossa Agnese (BSPG 2003 XX 5309).

Hexamphiastrea sp.

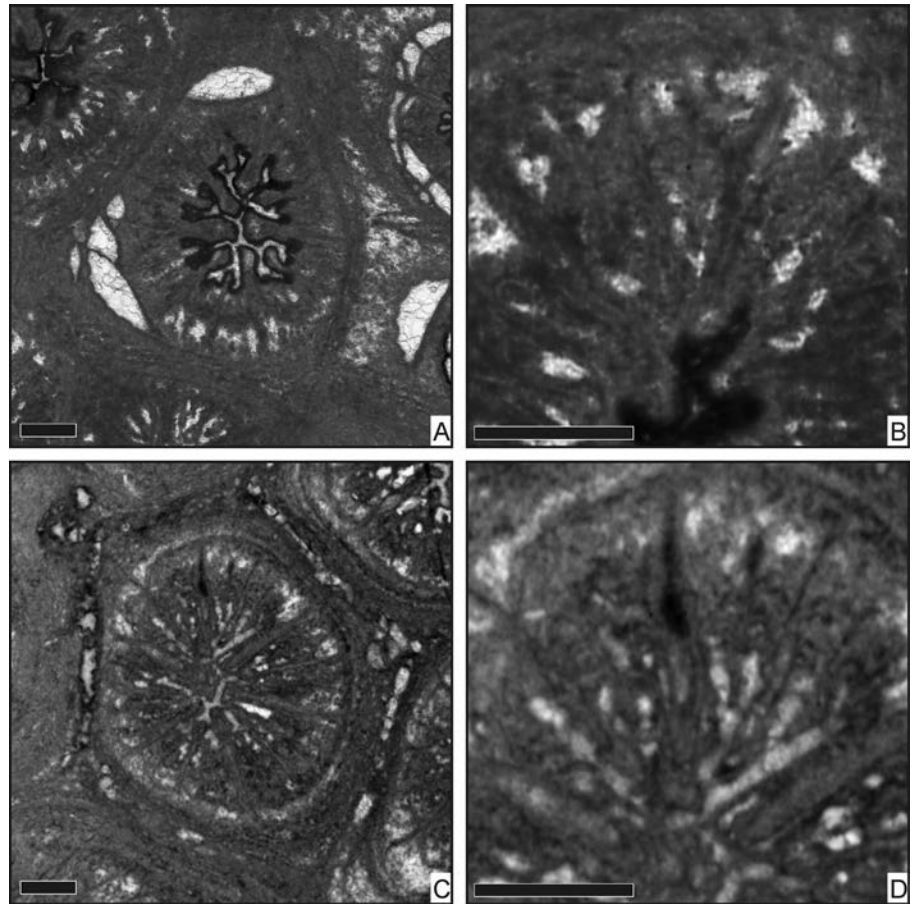
Pl. 2, figs 7-9; Fig. 4B

v 1995 *Amphiastrea guiscardii* (Prever, 1909) - Abdel-Gawad & Gameil, p. 11, pl. 4, figs. 1-2

Dimensions

(5303)	n	min-max	μ	σ	cv	$\mu \pm \sigma$
cn min	10	2.46-4.05	3.07	0.48	15.6	2.59-3.55
cn max	8	3.4-4.41	3.89	0.33	8.3	3.56-4.21
cl min	8	3.9-4.73	4.39	0.31	7.0	4.08-4.69
cl max	6	5.53-7.4	6.2	0.68	10.9	5.52-6.87
ccd	12	4.89-6.61	5.71	0.5	8.7	5.21-6.20
s		24-30				

Fig. 4 - A-B) *Hexamphiastrea minima* (Prever, 1909), BSPG 2003 XX 5302. D-C) *Hexamphiastrea* sp., BSPG 2003 XX 5303. Transversal thin sections with details on remaining skeletal microstructure and septal ornamentation. Scale = 1 mm.



Remarks. This specimen differs from all other species by its large dimensions and the larger number of septa, but as long as not more material is available, the introduction of a new species is hardly worthwhile.

Occurrence. Early Aptian of Italy (Abruzzo, L'Aquila) Monti d'Ocre, Fossa Mezza Spada (BSPG 2003 XX 5303) and Greece (Viotía), Levadia, Perachorion.

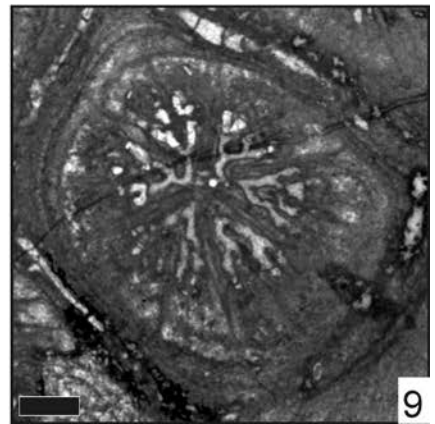
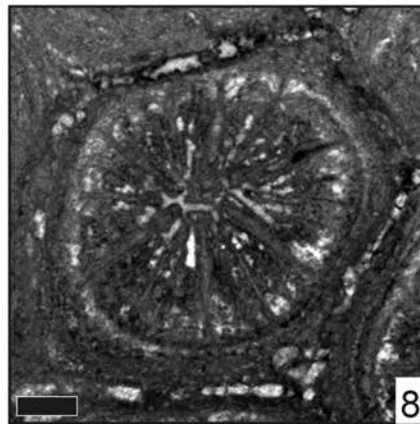
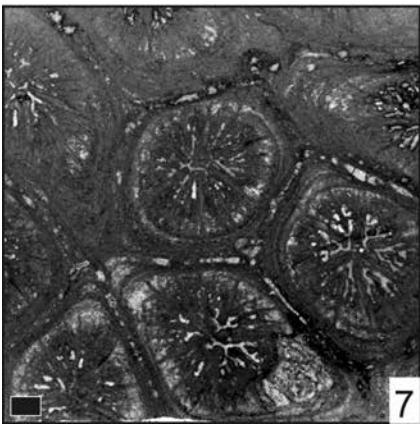
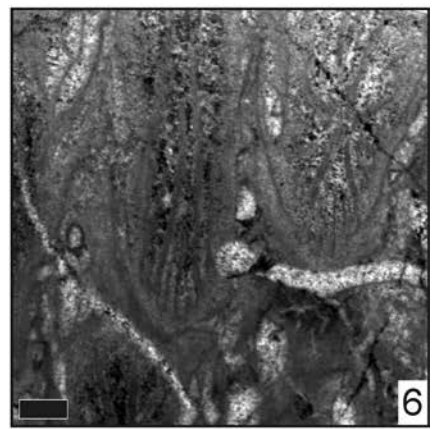
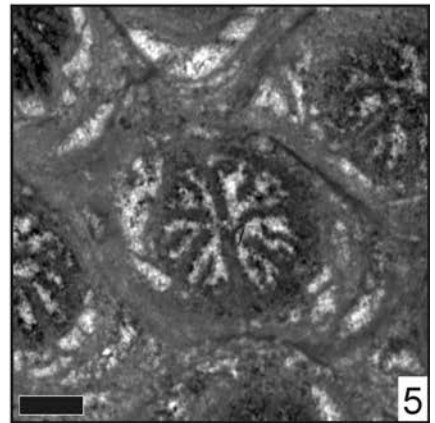
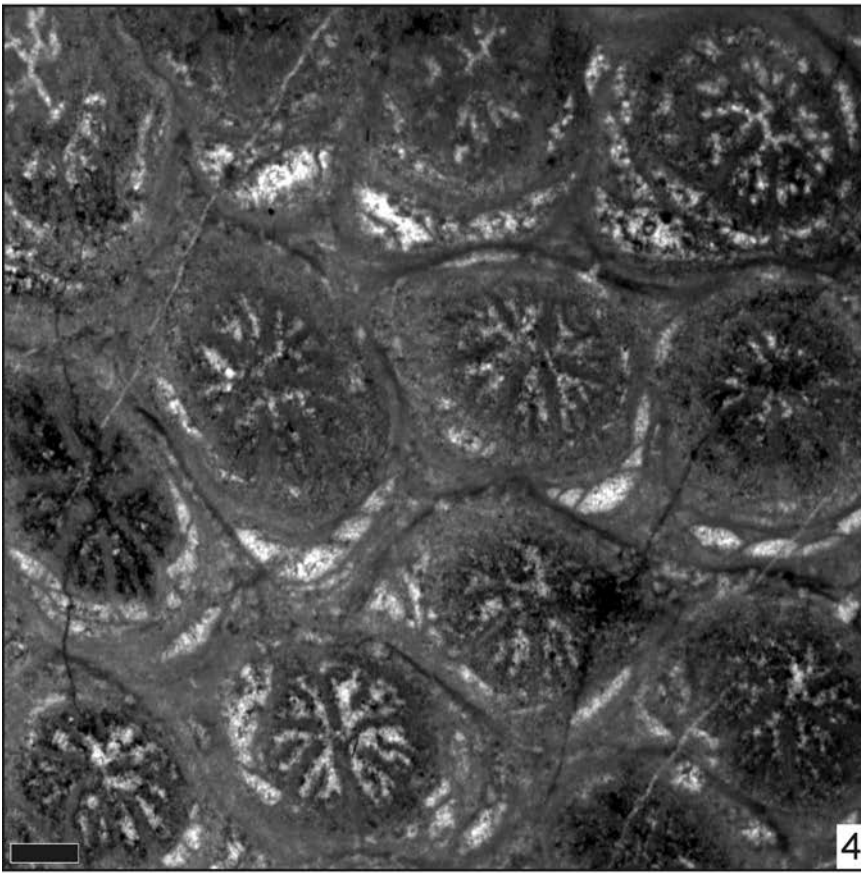
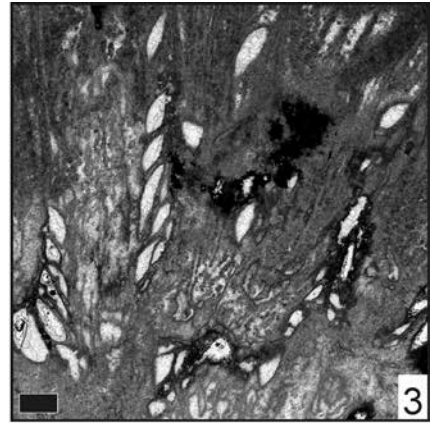
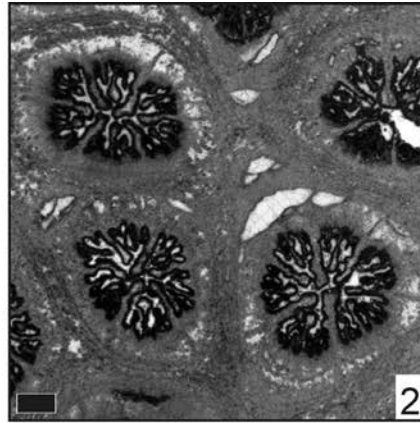
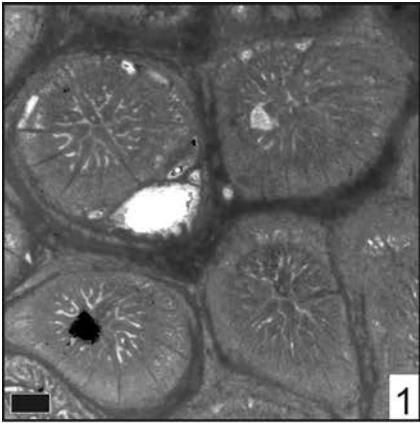
Other species. *Amphiastrea delorenzoi* Prever, 1909 (holotype is PU 17928 by monotypy) is not recognizable. It may belong to *Amphiastrea* or *Metaulastrea*. It proved to be impossible to obtain additional thin sections from the type specimen.

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PLATE 2

- Fig. 1 - *Hexamphiastrea minima* (Prever, 1909), holotype of *Amphiastrea minima*, PU 17930, transversal thin section.
 Fig. 2 - *Hexamphiastrea minima* (Prever, 1909), BSPG 2003 XX 5302, transversal thin section.
 Fig. 3 - *Hexamphiastrea minima* (Prever, 1909), BSPG 2003 XX 5302, longitudinal thin section.
 Fig. 4 - *Hexamphiastrea suprema* (Morycowa & Marcopoulou-Diacantoni, 1997), holotype of *Amphiaulastrea suprema*, UJ 158P2#1, transversal thin section.
 Fig. 5 - *Hexamphiastrea suprema* (Morycowa & Marcopoulou-Diacantoni, 1997), holotype of *Amphiaulastrea suprema*, UJ 158P2#1, transversal thin section, detail.
 Fig. 6 - *Hexamphiastrea suprema* (Morycowa & Marcopoulou-Diacantoni, 1997), holotype of *Amphiaulastrea suprema*, UJ 158P2#1, longitudinal thin section.
 Fig. 7 - *Hexamphiastrea* sp., BSPG 2003 XX 5303, transversal thin section.
 Fig. 8 - *Hexamphiastrea* sp., BSPG 2003 XX 5303, transversal thin section, detail.
 Fig. 9 - *Hexamphiastrea* sp., BSPG 2003 XX 5303, transversal thin section, detail.

Scale = 1 mm.



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