

New species of *Frechastraea* Scrutton, 1968 at the base of the Late Frasnian in Belgium

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ABSTRACT. *Frechastraea coeni* n. sp. is widely distributed at the base of the Late Frasnian from the Philippeville Massif, the north side of the Dinant Synclinorium, the south side of the Namur Synclinorium and the Vesdre Massif. It occurs within the Early *Palmatolepis rhenana* conodont Zone and is locally associated with *F. glabra* n. sp. and *F. phillipsastraeiformis* (Moenke, 1954). However, *F. phillipsastraeiformis*, which is also described in this paper, may be already present at the top of the Middle Frasnian from the Philippeville Massif and the south side of the Dinant Synclinorium.

KEYWORDS: Rugose corals, taxonomy, stratigraphy, Namur-Dinant Basin, Frasnian.

1. Introduction

This paper is devoted to the taxonomic description of *Frechastraea* species present at the base of the Late Frasnian of Belgium. These species are *Frechastraea phillipsastraeiformis* (Moenke, 1954), *F. coeni* n. sp. and *F. glabra* n. sp. They occur in the Neuville Formation from the Philippeville Massif and the north-western part of the Dinant Synclinorium as well as at the base of the Aisemont Formation from the north side of the Dinant Synclinorium, the south side of the Namur Synclinorium and the Vesdre Massif. These lithostratigraphic units have been described in detail by Boulvain et al. (1999) and Bultynck & Dejonghe (2002). As for the base of the Late Frasnian, it has been fixed recently by the Subcommittee on Devonian Stratigraphy (Newsletter N° 26 of the Subcommittee on Devonian Stratigraphy printed in March 2011, p. 11), at the entry of the conodont *Palmatolepis semichatovae*. According to Sandberg et al. (1992), the entry of *P. semichatovae* is observed within the Early *Palmatolepis rhenana* Zone, together with the first occurrence of *Ancyrognathus triangularis*, in bed 150 lying 2.6 m above the base of the Neuville Formation as it is exposed along the southern access road to the Lion quarry at Frasnes, on the south side of the Dinant Synclinorium.

The main part of the material described herein was collected by the author *in situ* during geological surveys made bed by bed in different localities from the southern part of Belgium (Fig. 1). This sampling is supplemented by a few older thin sections referred in this paper to the “Old collection from the Institut royal des Sciences naturelles de Belgique”.

2. Geological and stratigraphical setting

The Late Frasnian of the Philippeville Massif in the southwest

central part of the Dinant Synclinorium is noteworthy due to the occurrence of bioherms of red limestone belonging to the Petit-Mont Member. These bioherms start their development in the Neuville Formation and continue to grow up more or less high in the overlying Les Valisettes Formation (Fig. 2). The base of the Late Frasnian can be identified in Neuville about 6 m above the base of the Neuville Formation, at the first occurrence of *Ancyrognathus triangularis*. This locality has been studied among others by Coen (1978).

At the very base of the Neuville Formation, massive rugose corals are represented by *Hexagonaria davidsoni* (Milne-Edwards & Haime, 1851), *H. mae* Tsien, 1978 and *Scruttonia bowerbanki* (Milne-Edwards & Haime, 1851). *Frechastraea phillipsastraeiformis*, the first representative of the genus *Frechastraea* Scrutton, 1968 appears in association with the last specimens of *Hexagonaria davidsoni*. It is still present at the base of the Late Frasnian where it is accompanied by numerous colonies of *F. coeni*. The latter taxon occurs also in the lower part of the Petit-Mont Member together with *F. glabra* and sometimes *F. limitata* (Milne-Edwards & Haime, 1851). *F. micrastraea* (Penecke, 1904) appears in the upper part of the small lens of Les Bulants quarry at Neuville and is associated with *Phillipsastrea ananas* (Goldfuss, 1826) in the upper part of the larger bioherms of Petit-Mont quarry at Vodelée and Beauchâteau quarry at Senzeille. *Ancyrognathus asymmetricus* indicating the Late *Palmatolepis rhenana* Zone has been identified by Coen et al. (1977) in the first two outcrops together with *Frechastraea micrastraea* and *Phillipsastrea ananas*.

The Neuville Formation is also exposed in all the north-western part of the Dinant Synclinorium. In localities such as Barbençon (Dumoulin, 2001), Laneffe and Gourdinne (Dumoulin & Marion, 1997) and Gerpennes, *Frechastraea coeni* is abundant at the base of the lithostratigraphic unit and is associated with

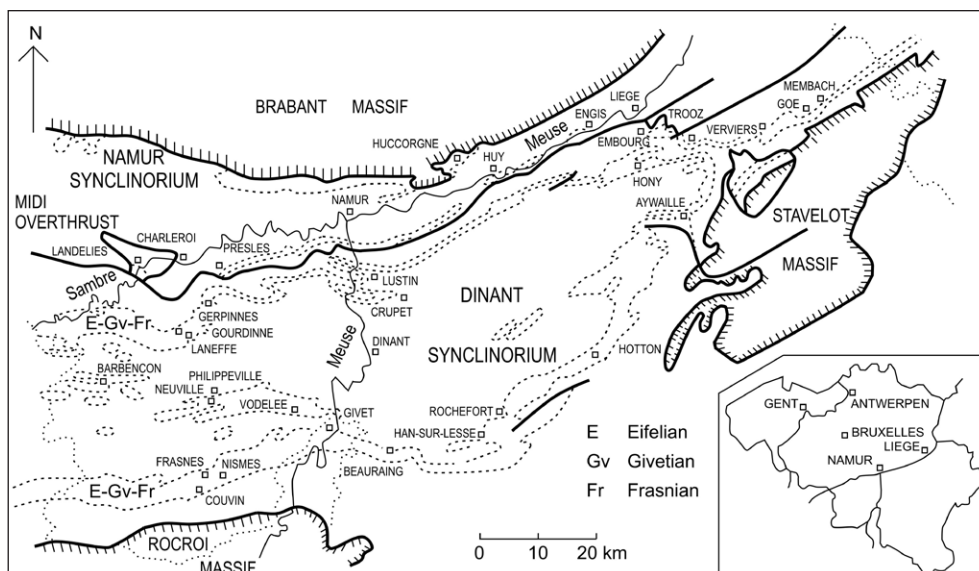


Figure 1. Geological setting and locality map in the southern part of Belgium.

NORTHWESTERN AND CENTRAL PARTS OF THE DINANT SYNCLINORIUM		NORTH SIDE OF THE DINANT SYNCLINORIUM SOUTH SIDE OF THE NAMUR SYNCLINORIUM VESDRE MASSIF	
	MATAGNE FORMATION		
	LES VALISETTES FORMATION	LAMBERMONT FORMATION	
	Petit-Mont Member	AISEMONT FORMATION	Upper Limestone
	Base of the Late Frasnian		Shales
			Lower Limestone
	NEUVILLE FORMATION		
<i>Scruttonia bowerbanki</i> <i>Frechastraea phillipsastraeiformis</i> <i>Frechastraea coeni</i> <i>Frechastraea glabra</i> <i>Frechastraea limitata</i> <i>Frechastraea micrastraea</i> <i>Phillipsastrea ananas</i> <i>Phillipsastrea veserensis</i> <i>Phillipsastrea falsa</i> <i>Frechastraea pentagona</i> <i>Frechastraea minima</i> <i>lowaphyllum rhenanum</i>	PHILIPPEVILLE FORMATION	LUSTIN FORMATION	<i>Frechastraea phillipsastraeiformis</i> <i>Frechastraea coeni</i> <i>Frechastraea glabra</i> <i>Frechastraea limitata</i> <i>Frechastraea micrastraea</i> <i>Phillipsastrea ananas</i> <i>Phillipsastrea veserensis</i> <i>Frechastraea pentagona</i> <i>lowaphyllum rhenanum</i>
	PONT DE LA FOLLE FORMATION		
	NISMES FORMATION		

Figure 2. Stratigraphic distribution of massive rugose corals in the Late Frasnian from the northwestern and central parts of the Dinant Synclinorium as well as from the north side of the same structural area, the south side of the Namur Synclinorium and the Vesdre Massif.

a few specimens of *F. phillipsastraeiformis* and *F. limitata*. However, *Hexagonaria davidsoni* is still present at Barbençon, about one metre before the first *Frechastraea*.

To the east of the Meuse valley, the Neuville Formation passes laterally into the Aisemont Formation which is characterized by two levels of limestone separated by shales. This lithostratigraphic unit occurs on the north side of the Dinant Synclinorium from Lustin to Hony (Coen-Aubert & Coen, 1975) and also at Aywaille and Comblain-la-Tour along its north-eastern border (Coen, 1974), in the Vesdre Massif and the Theux Window (Coen-Aubert, 1974a, 1974b), in the Landelies outlier (Coen, 1976), along the south side of the Namur Synclinorium from Presles to Engis (Coen-Aubert & Lacroix, 1979) and at Huccorgne on the north side of the Namur Synclinorium (Coen-Aubert & Lacroix, 1985). In this broad geographical area, the lower limestone level of the Aisemont Formation normally has its thickness reduced to a few metres and it is characterized by rather argillaceous limestones, that is to say more or less nodular limestones with shaly intercalations, containing brachiopods and some colonies of *Frechastraea*, especially at the base. Most of these massive rugose corals belong to *F. coeni*, although they are accompanied locally by *F. phillipsastraeiformis* and *F. limitata*. One colony of *Hexagonaria davidsoni* comes from the very base of the Aisemont Formation at Lustin, in contact with the underlying Lustin Formation.

In the more northern sections from the Vesdre Massif and the south side of the Namur Synclinorium such as at Embourg, Chaudfontaine, Streupas and Engis, the first level of limestone of the Aisemont Formation is much thicker and developed as a typical biostrome with numerous platy colonies of *Frechastraea* and *Alveolites*. This biostrome has been described recently by Poty & Chevalier (2007). *F. coeni* is common in the main part of this biostrome, once more associated with a few specimens of *F. phillipsastraeiformis* and *F. limitata*. But in its upper part appear *F. micrastraea* and *Phillipsastrea ananas*, just as is the case in the upper part of the Petit-Mont Member from the Philippeville Massif. At Engis, I have found also *F. glabra* at the top of the biostrome occurring in the lower part of the Aisemont Formation. As for the upper limestone level of this lithostratigraphic unit, it contains only *F. micrastraea*, *F. limitata* and *Phillipsastrea ananas*.

At first glance, it seems that there are many differences between the facies of the Philippeville Massif where the bioherms of the Petit-Mont Member are observed and the northern facies characterized by the three subdivisions of the Aisemont Formation.

Additionally, it can be noted that a bioherm of red limestone has been intersected by several boreholes in Chaudfontaine at the northwestern end of the Vesdre Massif. These boreholes have been investigated by Graulich (1967) and Graulich et al. (1980). Correlations between the deep bioherm of Chaudfontaine and the surface outcrops of the Aisemont Formation at the same locality have been proposed by Coen-Aubert (1974b). In fact, the biostrome corresponding to the lower limestone level of the Aisemont Formation serves as basement for the bioherm whereas the overlying shales and upper limestone level are lateral facies to this reefal lens.

3. Systematic Palaeontology

The types of the new species and figured specimens are also stored in the collections of the Institut royal des Sciences naturelles de Belgique (IRScNB).

Family Phillipsastreaeidae Roemer, 1883

Genus *Frechastraea* Scrutton, 1968

Type species. By original designation, *Cyathophyllum pentagonum* Goldfuss, 1826.

Diagnosis. Massive rugose corals, pseudocerioid to astreoid at times with small corallites. Septa of two orders, carinate or non-carinate, dilated in the dissepimentarium and occasionally thicker at its inner border, thin in the tabularium. Major septa extending nearly to the axis of the corallites or restricted to the dissepimentarium. Dissepimentarium composed of several rows of small globose dissepiments arranged in horizontal layers with a possible occurrence of a few horseshoe dissepiments at the border of the tabularium. Tabulae complete or incomplete.

Remark. The term pseudocerioid has been introduced independently and defined in precisely the same way by Sorauf (1967, p. 15) and Scrutton (1968, pp. 192 and 280; fig. 4b). It refers to a strong, straight or zigzagged pseudotheca of septal origin. In astreoid colonies, the pseudotheca is much thinner without reduction of septa which usually alternate in neighbouring corallites. Since its introduction, the term pseudocerioid has been widely used, among others by Tsien (1978), Wrzosek (1993), Sorauf (1994, pl. 4D and pl. 5), McLean (1994, 2010) and Brownlaw & Jell (2008).

***Frechastraea coeni* n. sp.**
(Pl. 1A-G)

- p. 1967 *Phillipsastraea pentagona* (Goldfuss); Sorauf: 29, figs. 13, 1c-d (non figs. 13, 1a-b, 1e-f).
 v 1974a *Phillipsastraea pentagona carinata* (Scrutton, 1968); Coen-Aubert: 14, pl. 2, figs. 4-5.
 v 1977 *Frechastraea pentagona carinata* Scrutton, 1968; Coen et al.: 325.
 v p. 1978 *Phillipsastraea goldfussi* (de Verneuil et Haime, 1850); Tsien: 203, pl. 1, figs. 4-5 (non fig. 4, pl. 1, fig. 6).
 v 1994 *Frechastraea carinata* Scrutton, 1968; Coen-Aubert: 30.
 v 1994 *Frechastraea goldfussi*; Sorauf: pl. 5.
 v 2000 *Frechastraea carinata* Scrutton, 1968; Coen-Aubert: 744.
 v 2011 *Frechastraea* n. sp. A; Coen-Aubert: 28.

Derivation of name. The species is dedicated to my husband Michel Coen (1943-2006), a distinguished field geologist and specialist of Devonian as well as Carboniferous ostracods and conodonts.

Holotype. IRScNB a12819 (= Pl. 1A-C). Specimen Beaumont MC-1979-9-G35 collected by M. Coen in 1998, 6 m above the base of the Neuville Formation.

Type locality and horizon. Active quarry 1300 m to the west of Barbençon, described and located by Dumoulin (2001, fig. 3). Map sheet Beaumont 52/6, Lambert coordinates: x = 142.425 and y = 100.75, western part of the Dinant Synclinorium. Base of the Neuville Formation, base of the Late Frasnian.

Material. With the exception of Embourg H92, all the colonies mentioned by Coen-Aubert (1974a, p. 14). In addition to this material, 70 specimens with 111 thin sections. Personal sampling with that of M. Coen, E. Groessens and D. Lacroix: Braives MC-1979-3-X67; Fontaine l'Évêque MC-1974-135-L2, L3 and L4; Tamines MC-1975-1-2, 3 and 4; Gesves MC-1978-2-U96; Huy MC-1977-8-U55; Saint-Georges MC-1978-5-V3, V4, V6, V7, V82, V9, V10, V11, V12, V13, V23, V25, V26 and V27; Naninne MC-1974-115-4.2; Malonnes MC-1975-9-719; Nalinnes MC-1975-2-1, 2 and 4; Walcourt MC-1974-131-P85, P86, P87, P89, P90 and P92; Walcourt MC-1976-5-U21, U22, U23, U24 and U25; Walcourt MC-1976-6-U29; Walcourt MC-1976-7-746, 747 and 748; Beaumont MC-1979-9-G1, G2, G3, G4, G5, G11, G14, G15, G19, G21, G26, G32, G33, G34 and G35; Senzeille MC-1974-106-T80 and T82; Senzeille MC-1976-4-LB1 and LB6; Surice MC-1974-133-V11. Old collection from the Institut royal des Sciences naturelles de Belgique: Beaumont 6306-F2i-14745; Beaumont 6306a-F2i-14757 and 14762; Saint-Georges 7010 (= Saint-Georges MC-1978-5)-F2IIc-16746 and 16787; Sautour 6802-F2i-15567; Senzeille 31a (= Senzeille MC-1974-106)-F2i-20805.

Diagnosis. A pseudocerioid species of *Frechastraea* with 18 to 24 septa at tabular diameters of 0.9 mm to 1.7 mm. Septa variably but typically carinate and restricted to the dissepimentarium.

Description. The material consists of laminar, tabular, nodular and discoidal colonies which are complete or fragmentary. Their height varies between 1 cm and 7 cm whereas the largest piece has a diameter of 20 cm. Some specimens are composed of several sheets; this may be due to the input of sediments or to a local disruption of colonial growth followed by rejuvenescence. The holotheca is sometimes preserved. At the upper surface of some samples are observed calices excavated and bordered by flat platforms. The corallites usually polygonal in shape are separated by a zigzagged or straight pseudotheca. In a few specimens, the outer zigzagged wall is weaker and locally absent so that colonies are more or less astreoid. There are only rare lateral and pericalicinal offsets.

The septa of both orders are dilated and generally restricted to the dissepimentarium. They bear frequent knobby carinae which are occasionally yardarm or spinose. However, this carination is less developed in some specimens. An inner thickening of the septa is rather uncommon at the boundary of the tabularium. It may happen that a few major septa become thinner

and are extending into the tabularium, normally without reaching the axis of the corallites. It is rare that the minor septa do not traverse the entire dissepimentarium.

The dissepimentarium consists of 3 to 9 or even 2 to 11 rows of globose dissepiments which are arranged in horizontal layers. In a few colonies occur occasionally at the border of the tabularium small specialized dissepiments close to the shape of horseshoes or one row of inclined dissepiments. The tabulae are concave, horizontal or incomplete and intersecting laterally without any trace of septa disrupting them.

There are 16 to 28 septa per corallite. The width of the tabularium ranges from 0.7 mm to 2 mm. The diameter of the corallites varies commonly between 2.5 mm and 5.5 mm and more generally between 2.1 mm and 7 mm.

Discussion. *Frechastraea coeni* shows some variability mainly concerning carinae, which are more or less strong and numerous, and to a lesser extent the outer wall which is usually typically pseudocerioid. The material assigned herein to *F. coeni* has been identified formerly by Coen-Aubert (1974a) as *F. carinata* Scrutton, 1968. In fact, it resembles the paratype illustrated by Scrutton (1968, pl. 9, fig. 2) where major septa are slightly shorter and do not reach systematically the axis of the corallites as it is the case in the holotype. Moreover, the tabularia of *F. carinata* are narrower than those of *F. coeni*. The new Belgian taxon has been confused by Sorauf (1967, 1994) and Tsien (1978) with *F. pentagona* (Goldfuss, 1826), which is the genotype of *Frechastraea* Scrutton, 1968 and *F. goldfussi* (De Verneuil & Haime, 1850). As mentioned by Scrutton (1968, p. 253) and Coen-Aubert (1974a, p. 19; 1994, p. 38), these two pseudocerioid species are very similar and characterized by non-carinate septa extending close to the centre of the tabularium. The lectotype of *F. pentagona* coming from the Frasnian of Limbourg, probably close to Verviers in Belgium, has been illustrated in thin sections by Pickett (1967) whereas the holotype of *F. goldfussi* also from the Goldfuss collection in Bonn, Germany and collected in the Frasnian from the vicinity of Namur in Belgium is lost. Therefore it is impossible to know what the species *F. goldfussi* is in actuality.

By its pseudotheca being zigzag to straight and by its septa being carinate and restricted to the dissepimentarium, *F. coeni* has some affinities with *F. regularis* (Chen, 1959) from the Frasnian of Guizhou Province in China. However, the latter taxon differs from the former by slightly greater septal number and diameters of the tabularia and corallites. The Chinese species has been introduced by Chen (1959, p. 308) as *Prismatophyllum pentagonum regulare* and has been referred by Kong & Huang (1978, p. 88) to the genus *Mixogonaria* Kong, 1978 whose type species is *M. sanduensis* Kong, 1978 also from the Frasnian of Guizhou. Pedder (2006, p. 52) considers that *M. sanduensis* and *M. regularis* are cerioid whereas *Mixogonaria* and *Frechastraea* are two related genera according to Liao & Birenheide (1985, p. 281) and Birenheide (1986, p. 13).

Distribution. The species is only known at the base of the Late Frasnian in different areas from Belgium. The material collected by the author, M. Coen, E. Groessens and D. Lacroix comes from:

- the base of the Aisemont Formation at Huccorgne on the north side of the Namur Synclinorium, at Presles, Strud, Huy and Engis on the south side of the same structural unit, at Landelies and Streupas in the La Tombe and Streupas outliers, at Embourg, Colonstère, Chaudfontaine, Prayon, Trooz, Goffontaine, Pepinster and Les Surdents close to Verviers in the Vesdre Massif, at La Reid in the Theux Window, at Lustin, Lesves and Crupet on the north side of the Dinant Synclinorium and at Comblain-la-Tour on the east side from the same structural unit;
- the base of the Neuville Formation at Gerpinnes, Gourdinne, Lanefte, Barbençon and Neuville in the northwestern and central parts of the Dinant Synclinorium;
- the lower part of the bioherms from the Petit-Mont Member at Neuville and Vodelée in the Philippeville Massif.

***Frechastraea glabra* n. sp.**
(Pl. 2A-D)

v 1979 *Frechastraea carinata* subsp.; Coen-Aubert & Lacroix: 275.
v 2011 *Frechastraea* cf. *borealis* McLean, 1994; Coen-Aubert: 28.

Derivation of name. From *glaber*, *bra*, *brum* (latin)= smooth, referring to the lack of carinae in the new species.

Holotype. IRScNB a12823 (=Pl. 2A-B). Specimen Senzeille MC-1976-4-LB4 collected by M. Coen in 1976, 7 m above the base of the red marble bioherm from Les Bulants quarry at Neuville.

Type locality and horizon. Disused Les Bulants quarry lying about 1 km to the west of Neuville, described and located among others by Boulvain et al. (1999, point 4 of fig. PHV1, pp. 72 and 74). Map sheet Senzeille 57/4, Lambert coordinates: x= 159,975 and y= 95,625, Philippeville Massif. Lower part of the Petit-Mont Member, Neuville Formation, Late Frasnian.

Material. 11 specimens with 19 thin sections. Personal sampling with that of M. Coen: Saint-Georges MC-1978-5-V14, V16 and V19; Senzeille MC-1976-4-LB4 and LB11; Surice MC-1974-133-V10, V13, V29, V32 and A521. Old collection from the Institut royal des Sciences naturelles de Belgique: Sautour 6802-F2i-15568.

Diagnosis. An asteroïd species of *Frechastraea* with 18 to 24 septa at tabularial diameters of 1 mm to 1.6 mm. Septa non-carinate and restricted to the dissepimentarium.

Description. The material consists of platy and sheet-like colonies which are complete or fragmentary. Their height varies between 1 cm and 6 cm whereas the largest piece has an area of 17 cm x 9 cm. The corallites are separated by a zigzagged or rarely straight pseudotheca which is often weak and not very well delimited. Therefore, the shape of the corallites is not regularly polygonal. In a few specimens, the septa are occasionally confluent or forked at the periphery. In longitudinal sections, it can be seen that the growth of some colonies is locally disrupted and followed by rejuvenescence; this is sometimes due to the input of sediments. A few lateral offsets have also been observed.

The septa are normally non-carinate; however, a few poorly developed, spinose and knobby carinae occur in some corallites. The septa of both orders are dilated and usually restricted to the dissepimentarium; sometimes, they show a spindle-shaped thickening at the boundary with the tabularium, but without forming an inner wall. In some specimens, a few major septa become thinner and are extending into the tabularium; they may even reach the axis of the corallites where there are possibly pseudofossulae.

The dissepimentarium consists of 3 to 7 or even 9 rows of globose dissepiments which are arranged in flat layers. In one colony, there are occasionally at the border of the tabularium small specialized dissepiments close to the shape of horseshoes. The tabulae are horizontal, concave or incomplete and intersecting laterally without any trace of septa disrupting them; sometimes, they are convex.

There are 18 to 26 septa per corallite. The width of the tabularium ranges from 0.9 mm to 1.8 mm. The diameter of the corallites varies commonly between 3 mm and 5.5 mm and more generally between 2.5 mm and 6.4 mm.

Discussion. *Frechastraea glabra* is similar to *F. coeni* in its quantitative data and the length of septa which are mostly restricted to the dissepimentarium. The former species is distinguished from the latter by a much weaker asteroïd pseudotheca and by the scarcity to the complete absence of carinae. Subsidiarily, the septa of *F. glabra* may be affected by some thickening at the inner border of the dissepimentarium whereas a few major septa may extend into the tabularium; these two features are rarely present in *F. coeni*.

F. glabra has been identified as *F. cf. borealis* McLean, 1994 by Coen-Aubert (2011). This taxon introduced by McLean (1994, p. 86) in the Late Frasnian from the Northwest Territories in Canada is different in having a rather thamnasterioid aspect

as well as slightly greater septal number and diameter of the tabularium. The tabularia are still wider in *F. whittakeri* (Smith, 1945) from the late Frasnian of the same area. However, one typically asteroïd colony figured and assigned by McLean (1994, pl. 7, figs. 5-6) to *F. whittakeri* resembles more *F. glabra*. It may be discussed whether *F. borealis* and *F. whittakeri* should be better referred to the thamnasterioid genus *Scruttonia* Tcherepnina, 1974 rather than to the genus *Frechastraea* which is normally pseudoceroïd.

F. kaisini (Tsien, 1978) is another species from the Late Frasnian of Belgium which is asteroïd with all the septa restricted to the dissepimentarium. But it is easily separated from *F. glabra* by the occurrence of an inner wall and by much smaller tabularia.

Distribution. The species is only known from the base of the Late Frasnian in Belgium. The colonies from Engis on the south side of the Namur Synclinorium come from the top of the lower limestone level belonging to the Aisemont Formation. The material of Neuville and Vodelée in the Philippeville Massif has been collected in the lower part of the bioherms from the Petit-Mont Member.

***Frechastraea phillipsastraeiformis* (Moenke, 1954)**
(Pl. 2E-F)

* 1954 *Hexagonaria phillipsastraeiformis* n. sp.; Moenke: 476, pl. 1, figs. 7-8.

v p. 1967 *Phillipsastraea goldfussi* (de Verneuil & Haime); Sorauf: 27, figs. 11, 1a-b (non fig. 10)

v 1994 *Frechastraea phillipsastraeiformis* (Moenke, 1954); Coen-Aubert: 38, pl. 4, figs. 5-8, pl. 5, figs. 12-13.

2003 ?*Phillipsastrea phillipsastreiiformis* (Moenke, 1954); Fedorowski: 104, pl. 50, figs. 3, ?4.

Holotype. Specimen Tc 8/2 stored in the Department of Geology from the University of Poznan, Poland. Point 11 of the Psie Gorki quarry at Kielce, Holly Cross Mountains, Poland. Middle to Late Frasnian. Pl. 1, figs. 7-8 in Moenke (1954) and pl. 50, fig. 3 in Fedorowski (2003).

Material. In addition to the 9 colonies listed by Coen-Aubert (1994), 11 specimens with 20 thin sections. Personal sampling with that of M. Coen: Huy MC-1977-8-U53; Saint-Georges MC-1978-5-V2; Chênee MC-1974-77-L15; Nalinnes MC-1975-2-3; Walcourt MC-1974-131-P88; Walcourt MC-1976-6-U28; Surice MC-1974-134-V1. Old collection from the Institut royal des Sciences naturelles de Belgique: Beaumont 6306-F2i-14742; Beaumont 6306a-F2i-14771; Sautour 8302-F2i-15563 and 15566.

Diagnosis. A pseudoceroïd species of *Frechastraea* with 22 to 30 septa at tabularial diameter of 1.3 mm to 2.5 mm. Septa weakly carinate and spindle-shaped dilated at the inner border of the dissepimentarium. Major septa extending into the tabularium.

Description. This description completes that given by Coen-Aubert (1994). Like the two preceding species, these laminar and tabular colonies may be composed of two sheets or show a local disruption in their growth followed by rejuvenescence. The corallites polygonal in shape are separated by a zigzagged or sometimes straight pseudotheca.

The septa bear some weak spinose and knobby carinae and they are dilated in the dissepimentarium. Mostly the major ones are affected by a spindle-shaped thickening which is normally restricted to the boundary with the tabularium, but which is slightly wider in some specimens. The major septa become thin in the tabularium. They are extending to the axis of the corallites or they are leaving a more or less extensive open space in the centre of the tabularium. The minor septa traverse the entire dissepimentarium.

The dissepimentarium consists of 3 to 8 or even 2 to 10 rows of globose dissepiments which are arranged in horizontal layers. In a few colonies, some specialized or inclined dissepiments occur locally at the border of the tabularium. Some symmetrical tight fans of septal trabeculae have been observed

at the inner margin of the dissepimentarium. The tabulae are incomplete and intersecting laterally; occasionally, they are concave or they are characterized by a flat-topped axial part.

There are 20 to 28 septa and even 30 to 32 septa per corallite. The width of the tabularium ranges from 1.1 mm to 2.6 mm with frequent values between 1.3 mm and 2.1 mm. The diameter of the corallites varies commonly between 3.5 mm and 7 mm and more generally between 2.9 mm and 8.5 mm.

Discussion. The Belgian material is very similar to the holotype of *Frechastraea phillipsastraeiformis* which has been figured by Moenke (1954) and Fedorowski (2003) and which is characterized by tabularia and corallites of slightly greater sizes. The other specimen assigned to the species by Fedorowski (2003, pl. 50, fig. 4) is somewhat different as its septa are uniformly and more strongly dilated throughout the dissepimentarium. At the generic level, *F. phillipsastraeiformis* is without doubt pseudoceroid as was already mentioned by Wrzolek (1993, p. 244) and Coen-Aubert (1994). However, it was assigned by McLean (2010, p. 80) to *Kuangxiastraea* Yu & Kuang, 1982 whose type species is *K. elegans* Yu & Kuang, 1982 from the Late Givetian of Guangxi in China. According to Yu (1997), Coen-Aubert (2002) and Brownlaw & Jell (2008, p. 113), this genus is represented by thamnasterioid to astreoid colonies with rather large corallites and septa typically carinate.

Frechastraea phillipsastraeiformis has been identified by Sorauf (1967) as *F. goldfussi* which is considered to be related to *F. pentagona*. There are certainly some affinities between this species and *F. phillipsastraeiformis*. But *F. pentagona* is distinguished by slightly smaller septal number and diameters of the tabularia and corallites, by non-carinate septa and by a short bulbous thickening of the septa which is restricted to the border of the tabularium with possibly the formation of an inner wall.

Distribution. In Belgium, the species occurs at the transition between the Middle and the Late Frasnian. Indeed, the material collected by the author and M. Coen comes from:

- the base of the Aisemont Formation at Huy and Engis on the south side of the Namur Synclinorium and at Chaudfontaine in the Vesdre Massif;

- the base of the Neuville Formation at Gerpennes, Gourdinne and Laneffe in the north-western part of the Dinant Synclinorium, at Neuville, Vodelée and Merlemont in the Philippeville Massif and at Frasnes and Boussu-en-Fagne on the south side of the Dinant Synclinorium.

Outside Belgium, *Frechastraea phillipsastraeiformis* is only known in the Middle to Late Frasnian (*Palmatolepis jamieae* to *P. rhenana* conodont Zones) from the Holy Cross Mountains in Poland.

4. Conclusion

As noted by Coen-Aubert (2011), *Frechastraea coeni* is an excellent marker for the base of the Late Frasnian in Belgium. In some localities, it is associated with *F. glabra* and *F. phillipsastraeiformis*. However, the latter species may be already present at the top of the Middle Frasnian from the Philippeville Massif and the south side of the Dinant Synclinorium, in some of the outcrops described by Coen-Aubert (1994).

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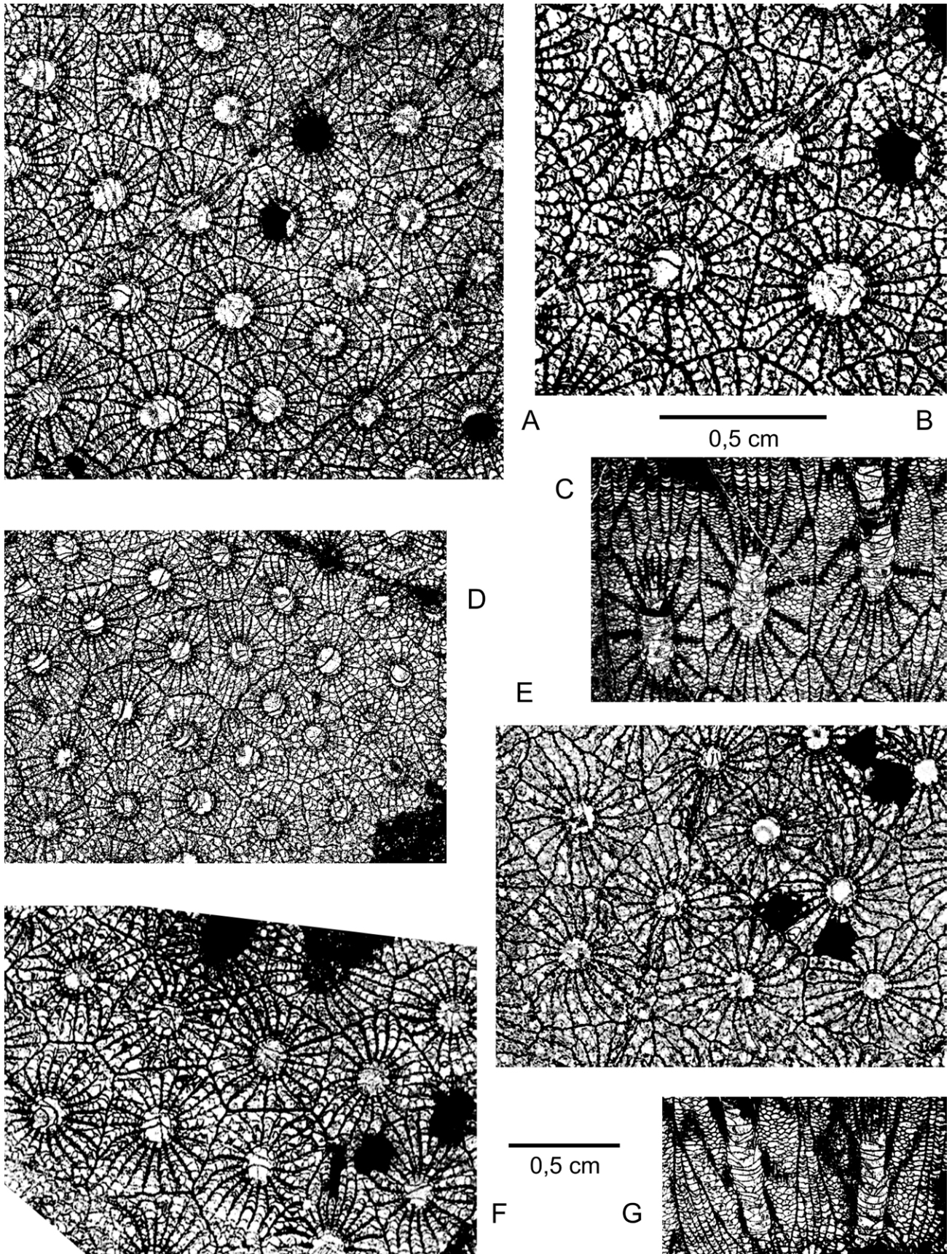


Plate 1. A-G: *Frechastraea coeni* n. sp. A-C: Holotype, IRScNB a12819, Beaumont MC-1979-9-G35; transverse sections and longitudinal section. D: Paratype, IRScNB a12820, Beaumont MC-1979-9-G11; transverse section. E: Paratype, IRScNB a12821, Senzeille MC-1974-106-9; transverse section. F-G: Paratype, IRScNB a12822, Beaumont MC-1979-9-G34; transverse and longitudinal sections. Magnification x 4 except figure B x 6.

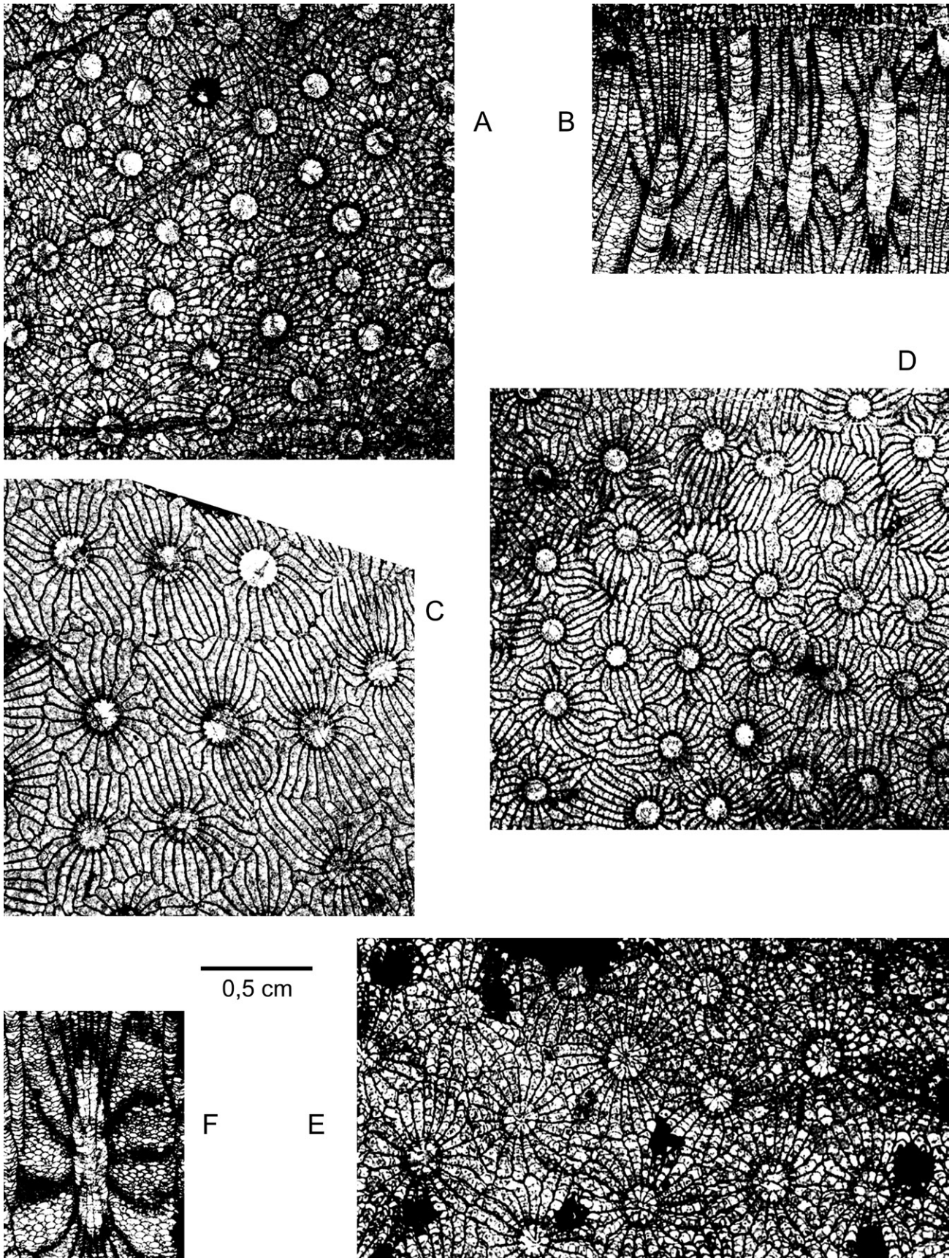


Plate 2. A-D, *Frechastraea glabra* n. sp. A-B: Holotype, IRScNB a12823, Senzeille MC-1976-4-LB4; transverse and longitudinal sections. C: Paratype, IRScNB a12824, Surice MC-1974-133-V32; transverse section. D: Paratype, IRScNB a12825, Saint-Georges MC-1978-5-V19; transverse section. E-F: *Frechastraea phillipsastraeiformis* (Moenke, 1954), IRScNB a12826, Nalinnes MC-1975-2-3; transverse and longitudinal sections. Magnification x 4.