Fasciculate Disphyllids (Rugosa) from the Early Givetian Trois-Fontaines Formation in Belgium

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Abstract

Disphyllum caespitosum (GOLDFUSS, 1826), which is the type species of Disphyllum DE FROMENTEL, 1861, D. oekentorpi n. sp. and Coenophyllum groessensi n. gen., n. sp., which is the type species of Coenophyllum n. gen., are described in detail and come from the Early Givetian Trois-Fontaines Formation, on the south side of the Dinant Synclinorium. Both genera are representatives of the family Disphyllidae HILL, 1939. Disphyllum oekentorpi is widely distributed in the upper part of the Trois-Fontaines Formation; it is found at the same level as Argutastrea quadrigemina (GOLDFUSS, 1826) and is locally associated in Hotton with Coenophyllum groessensi. Disphyllum caespitosum has only been collected at the locality of Pondrôme to the east of Givet. In the more eastern area of Marenne and Méné-Favay, the lower part of the Trois-Fontaines Formation is partly composed of silty limestones; however, these detrital deposits have not been observed in the nearby section of Hotton. As a whole, the Trois-Fontaines Formation belongs to the Polygnathus hemiansatus conodont Zone.

Keywords: Rugose corals, Givetian, Taxonomy, Stratigraphy, Belgium.

Introduction

Colonial rugose corals are abundant at the base of the Early Givetian Trois-Fontaines Formation from the south side of the Dinant Synclinorium and have been investigated by COEN-AUBERT (1989, 1990 and 1998). They are still present, but they become more scattered higher in the lithostratigraphic unit. Three species of fasciculate rugose corals coming from these levels are described herein: Disphyllum caespitosum (GOLDFUSS, 1826), D. oekentorpi n. sp. and Coenophyllum groessensi n. gen., n. sp. which is the type species of the new genus Coenophyllum. Moreover, Disphyllum caespitosum is the type species of Disphyllum DE FROMENTEL, 1861 and both genera are representatives of the family Disphyllidae HILL, 1939. These fossils have been collected in two different areas (Fig. 1): firstly the localities of Pondrôme, Wellin and Resteigne located to the east of Givet, then the localities of Marenne, Méné-Favay and Hotton situated in the southeastern part of the Dinant Synclinorium where the facies are slightly different and not very well known.

According to BULTYNCK & DEJONGHE (2002, p. 51) and PREAT & BULTYNCK (2006, p. 15), the Trois-Fontaines Formation belongs to the Polygnathus hemiansatus conodont Zone, above the Eifelian-Givetian boundary. It must also be mentioned that the Givetian on the south side of the Dinant Synclinorium is represented in ascending order, by the upper part of the Hanonet
Formation, the Trois-Fontaines, Terres d’Hars, Mont d’Hars and Fromelennes Formations.

The main part of the material was collected by the author in situ during geological surveys made bed by bed. The types of the new species and the figured specimens are stored in the collections of the Institut royal des Sciences naturelles de Belgique (IRScNB).

Description of the outcrops

RESTEIGNE QUARRY (Wellin MC-1974-95; Fig. 2)

A complete section of the Trois-Fontaines Formation is exposed in the disused and well known quarry of Resteigne investigated among others by BRENNHEIDE et al. (1991, p. 10) and COEN-AUBERT (1998, p. 9 and 2003, p. 12). At the base of the lithostratigraphic unit, there are 10.5 m to 22.5 m of coarsely crinoidal limestones with reefal lenses rich in corals and stromatoporoids. The highly diversified rugose coral fauna of this level has been figured by COEN-AUBERT (1997, fig. 3 and 1998, fig. 2) and includes several colonial forms such as Columnaria intermedia COEN-AUBERT, 1990, Beuignesiastraea kunthi (SCHLÜTER, 1880), Scolopodium elongatum (SCHLÜTER, 1881) and Thamnophyllum occlusum (TSIEN, 1969). A few small corallites of Coenophyllum groessensi have also been collected at the top of this unit. Then occurs a biostrome with massive stromatoporoids which is about 4 m thick and capped by a stringocephalid coquina.

The upper part of the Trois-Fontaines Formation is represented by 73 m of well-bedded and mostly lagoonal limestones, especially close to its top. Below these restricted facies characterized notably by laminites and rare colonies of Argutastrea quadrigemina (GOLDFUSS, 1826), there are several bioclastic intercalations with some massive stromatoporoids, rugose and tabulate corals; a few specimens of Disphyllum oekentorpi have been found 31 m below the base of the Terres d’Hars Formation.

This lithostratigraphic unit has been described in detail by COEN-AUBERT (2003). It starts with a coralliferous biostrome containing numerous colonies of Argutastrea quadrigemina associated with a few coralla of Temnophyllum wellinense COEN-AUBERT, 2003. A bed rich in Disphyllum mcleani COEN-AUBERT, 2003 is present 22.5 m above the base of the Terres d’Hars Formation.

WELLIN FOND DES VAUX EAST AND WEST (Wellin MC-1983-9 and 12; Fig. 2)

To the north of the village of Wellin, there are two active quarries named Fond des Vaux East (Wellin MC-1983-9) and Fond des Vaux West (Wellin MC-1983-12) which have been investigated among others by COEN-AUBERT (1990, 1998 and 2003). At the base of the Trois-Fontaines Formation, four different sections have been described by COEN-AUBERT (1990) and COEN-AUBERT et al. (1991). As in Resteigne, the lithostratigraphic unit starts with coarsely crinoidal limestones which are much more developed at Wellin with a thickness varying between 32 m and
Rugose corals from the Trois-Fontaines Formation (Givetian, Belgium)

Fig. 2 — Comparative logs of the Trois-Fontaines Formation at Pondrôme, Wellin and Resteigne with the distribution of the rugose corals. (For explanation of conventional signs, see Fig. 3).

65.5 m. This level shows also important facies variations and a big reefal lens with abundant massive stromatoporoids was observed in the Fond des Vaux East quarry. With the progress of the quarrying activity, the situation changed and recently another biohermal lens built by corals and stromatoporoids has been studied by MAMET & PREAT (2005) in the Fond des Vaux West quarry. The particular rugose coral fauna of these coarsely crinoidal limestones has been identified by COEN-AUBERT
Fig. 3 — Explanation of conventional signs used in Figs 2 and 5.

BOIS LE BAN QUARRY AT PONDROME (Houyet MC-1983-15; Figs 2 and 4)

In the Bois Le Ban or Malakof quarry located to the northwest of Pondrôme (Fig. 4), the situation is very different from that of Resteigne and Wellin. This old excavation, where the layers are overturned with a dip of 64° to 76° towards the south, has been investigated by Pel (1975, p.85) and also by A. Preat and F. Tourneur during the eighties. In this outcrop, the Trois-Fontaines is represented by:

- 4.5 m: well-bedded and crinoidal limestone with brachiopods present locally and rare fragments of Cystiphylloides;
- 2.2 m: bedded and argillaceous limestone containing crinoids and mostly in the lower part: massive and dendroid stromatoporoids, thamnoporids, scolioporids, aulopo-

(1990) and includes a few specimens of Beugniesastraea kunthi and Columnaria intermedia. Higher occurs as in Resteigne a biostrme with massive stromatoporoids and a stringocephalid coquina. These two units are about 7 m thick.

The upper part of the Trois-Fontaines Formation is characterized by 60 m of lagoonal limestones with again some lamination and colonies of Argutastrea quadrigemina close to its top. Beautiful specimens of Disphyllum oekentorpi have been collected in the Fond des Vaux East and West quarries, respectively 16 m and 24 m below the base of the Terres d’Haux Formation. As mentioned by COEN-AUBERT (2003, p.14), the latter lithostratigraphic unit starts with a coralliferous biostrme rich in Argutastrea quadrigemina and solitary coralla of Temnophyllum wellinense. The bed with Disphyllum mcleani has been observed 21 m above the base of the Terres d’Haux Formation, in the Fond des Vaux West quarry.
rinds, solitary rugose corals and brachiopods; at the base, occurrence of beds with colonies and isolated corallites of *Disphylrum caespitosum*;
- 3.75 m: fine or bioclastic limestone with brachiopods, crinoids and even a small lens composed of massive stromatoporoids;
- 5.0 m: well-bedded and fine limestone;
- 4.3 m: well-bedded and more or less crinoidal limestone showing cross bedding in the lower part;
- 10.8 m: well-bedded and fine limestone locally laminated with layers at the base.

Then the Terres d’Hairs Formation starts with 1.5 m of argillaceous limestones with shaly intercalations and large colonies of *Argustrea* accompanied by *Pachyfavosites* and rare *Alveolites*; these corals form two levels of patch reefs in the upper part of this sequence which is capped by nodular limestones.

This succession is similar to that described by *COEN-AUBERT* (2003, pp. 14-15) in the old quarry of Beauraing (Vencimont MC-1975-4) open in the wood above the road to Winenne and in the Eclaye quarry on Pondrôme (Houyet MC-1975-5) located to the east of Bois Le Ban quarry (Fig. 4). In these three outcrops, the thickness of the lagoonal limestones from the Trois-Fontaines Formation seems to be rather reduced and the crinoidal limestones with some reef building organisms occurring at the base of the Beauraing and Bois Le Ban sections recall already the facies of the coarsely crinoidal limestones observed at the base of the lithostratigraphic unit between Wellin and Resteigne. The discovery of *Disphylrum caespitosum* at Bois Le Ban quarry, unknown elsewhere in Belgium, is probably related to these unusual conditions.

In the three quarries of Bois Le Ban, Eclaye and Beauraing, the Terres d’Hairs Formation starts with two levels of patch reefs rich in *Argustrea quadrigemina*, *Pachyfavosites polymorphus* and *Thamnpora cervicornis*. As mentioned by *COEN-AUBERT* (2003, p. 12), these patch reefs are also present in the Les Limites quarry at Ave-et-Auffe (Wellin MC-1983-14) together with the biostrome that characterizes normally the base of the Terres d’Hairs Formation between Wellin and Resteigne.

**MARENNE QUARRY** (Marche MC-89; Fig. 5) With the progress of the quarrying activity, the Marenne quarry has much changed since the publication of *BARCHY et al.* (2004). At the present time, it shows, in the eastern part of the excavation and to the north of the Marenne Fault, a complete succession from the lower part of the Trois-Fontaines Formation to the base of the Mont d’Hairs Formation.

As mentioned by *BARCHY et al.* (2004, p. 60), the lower part of the Trois-Fontaines Formation is made up of 26.5 m of well-bedded, dark and bioclastic limestones with several silty or crinoidal levels. This particular facies has been assigned to the Marenne Member by *MABILLE et al.* (2008). However, this new lithostratigraphic subdivision is not very well defined as its base and the contact with the Hanonet Formation are not exposed in the Marenne quarry, due to the occurrence of the Marenne Fault. Laterally to the upper part of these more or less silty limestones, a reefal lens crops out along the southwest wall of the quarry. It is characterized by coarsely crinoidal limestones often rich in big massive stromatoporoids, thamnoporids and colonial rugose corals represented by *Columnaria intermedia*, *Beugniesastraea kunthi* and *Sociopentium elongatum*.

These more or less silty limestones are succeeded by:
- 11 m: bioclastic limestone still crinoidal at the base, with a few corals and stromatoporoids in the upper part;
- 23 m: bedded and fine limestone with several beds consisting of brachiopod shells and several intercalations containing corals and brachiopods;
- 3.2 m: bedded and crinoidal limestone very rich in bushes of *Scoliolopora* accompanied by isolated corallites and even colonies of *Disphylrum oekentorpi* as well as by some favositids and thamnoporids. The beautiful collection of spinatrypid and athyrid brachiopods investigated by *GODEFROID & MOTTEQUIN* (2005) comes also from this level which was remarkably exposed along a small fault until 2003;
- 26 m: bedded and fine limestone, locally bioclastic and containing a few corals and stromatoporoids; in the upper part, occurrence of several layers with laminates or leperditid ostracodes.

At the base of the Terres d’Hairs Formation, there are coarsely crinoidal limestones which may reach a thickness of 4.3 m; locally are present numerous branches of *Thamnpora* and *Scoliolopora* associated with some brachiopods, *Pachyfavosites*, *Favosites*, colonies of *Argustrea quadrigemina* and solitary coralla of *Temnothyrella wellinense*. Then the lithostratigraphic unit shows the same succession as that described by *COEN-AUBERT* (2003, p. 13) and *BARCHY et al.* (2004, pp. 64 and 66) at Hampteau close to Hotton. That means that the lower part of the Terres d’Hairs Formation is characterized in the Marenne quarry by fine or bioclastic limestones including several beds with corals, laminates, stringocephalid coquinas or leperditid ostracodes. A few specimens of *Disphylrum meleani* have been found 29 m above the base of the Terres d’Hairs Formation.

**MENIL-FAVAY** (Hotton MC-94; Fig. 6) Two specimens of *Disphylrum oekentorpi* have been collected by M. Coen in the outcrop Hotton MC-94 lying to the north of the village of Ménil-Favay, along the west side of the Agauche stream (Fig. 6). This exposure is situated opposite to the disused quarry of Ménil-Favay investigated by *COEN et al.* (1974, pp. 14-16), whose main part is now filled in with waste. In the discontinuous section of Hotton MC-94, the samples of *D. oekentorpi* come from the upper part of the Trois-Fontaines Formation, below he beds with laminates and leperditid ostracods. These lagoonal limestones overlie silty limestones which characterize the lower part of the lithostratigraphic unit just as in the Marenne quarry.

**HAMPTEAU QUARRY AT HOTTON** (Hotton MC-33; Fig. 5) As stated by *COEN-AUBERT* (2003, p. 15) and *BARCHY et al.* (2004, p. 64), the Hampteau quarry located 1.5 km to the southeast of Hotton is subdivided into two parts by a strongly
Fig. 5 — Comparative logs of the Trois-Fontaines Formation at Marenne and Hampteau close to Hotton with the distribution of the rugose corals. (For explanation of conventional signs, see Fig. 3).
folded and faulted zone. All the Trois-Fontaines Formation crops out in the southern part of the excavation whereas the Terres d’Haurs Formation is exposed in its northern part. Below the Trois-Fontaines Formation, the upper part of the Hanonet Formation is represented at the southwest end of the quarry, along the path climbing in the wood by:

- 15.3 m: fine or bioclastic limestone which may be argillaceous in the lower part; occurrence of three levels with scolioporids, thamnoporids and massive stromatoporoids accompanied locally by Stachyodes, fasciculate rugose corals, crinoids, stringocephalids and also atrypids close to the base;
- 14.9 m: fine or locally bioclastic limestone with several beds of stringocephalid coquinas;
- 9.20 m: fine and dark limestone containing some big brachiopods close to the base;
- 5.80 m: bioclastic limestone with massive stromatoporoids, favositids, thamnoporids, solitary rugose corals, colonies of Coenophyllum groessensi and Argutastrea quadrigemina associated with some crinoids and brachiopods including stringocephalids especially numerous at the top;
- 16.6 m: thin-bedded and fine limestone with shaly interbeds at the top.

The base of the Terres d’Haurs Formation is characterized by:
- 2.75 m: dark limestone first argillaceous with some brachiopods and shales, then bioclastic with massive stromatoporoids, favositids, thamnoporids, scolioporids, solitary coralla of Temnophyllum wellinense and colonies of Argutastrea quadrigemina;
- 3 m: dark argillaceous limestone at the base which becomes bioclastic upwards with some beds containing thamnoporids and hillaeporids in the upper part.

This south section ends against the complicated folded and faulted zone present in the middle of the Hampteau quarry. To the north of this structure, the north section described by COEN-AUBERT (2003, p. 15) shows in particular the more or less reefal level occurring 16.2 m below the top of the Trois-Fontaines Formation; in this part of the outcrop, its rich and diversified rugose coral fauna is represented by Disphyllum oekentorpi, Coenophyllum groessensi, Columnaria intermedia and Argutastrea quadrigemina. As noted by COEN-AUBERT (2003), the base of the Terres d’Haurs Formation is made up of argillaceous limestones with various tabulate corals and A. quadrigemina. Higher in the lithostratigraphic unit, Disphyllum micleani occurs between 28 m and 40 m above the Trois-Fontaines Formation.
Facies variations and stratigraphic distribution of the rugose corals

In the Hamppteau quarry close to Hotton, the Trois-Fontaines Formation is 105 m thick whereas its thickness varies between 85 m and 100 m at Resteigne and between 99 m and 126 m at Wellin. These changes are mainly due to the facies variations affecting the lower part of the lithostratigraphic unit which is characterized by coarsely crinoidal and more or less reefal limestones. Large biohermal lenses with corals and stromatoporoids have been observed in the Fond des Vaux quarries at Wellin, but small ones are also present at Resteigne and Marenne.

In the latter locality as in Ménil-Favay, the lower part of the Trois-Fontaines Formation is partly invaded by silty limestones. However, the sedimentation of this detrital material seems to be rather local as it does not reach the nearby section of Hotton. Among a highly diversified fauna of rugose corals, the occurrence of Columnaria intermedia, Beunignesastraea kunthi, Sociophyllum elongatum and Thamnophyllum ocellatum is typical for the lower part of the Trois-Fontaines Formation. A few corallites of Coenophyllum groessensi have also been collected in Resteigne, at the top of the coarsely crinoidal limestones.

The upper part of the Trois-Fontaines Formation is more uniform in the different outcrops investigated. It is mostly composed of lagoonal limestones with shallower and more restricted facies. However, there are some intercalations with bioclasts and reef building organisms. Disphyllum oekentorpi and to a lesser extent Argutastrea quadrigemina are widely distributed in the upper part of these lagoonal limestones. In the Hamppteau quarry at Hotton occur also at the same level Columnaria intermedia and more especially colonies of Coenophyllum groessensi.

In the Bois Le Ban or Malakof quarry at Pondrôme, the Trois-Fontaines Formation is represented by about 30 m of limestones below the Terres d’Haul Formation. At the base of the section, there are crinoidal limestones capped by a few beds containing Disphyllum caespitosum. This facies is more or less similar to that of the base of the Trois-Fontaines Formation. However, it is not sure whether the thickness of the Trois-Fontaines Formation is so much reduced in the Bois Le Ban quarry as the contact with the Hanonet Formation was not observed.

The base of the Terres d’Haul Formation is marked in all localities by a coralliferous biostrome rich in various tabulate corals and colonies of Argutastrea quadrigemina associated with some solitary coralla of Thamnophyllum wellinense. Small patch reefs with the same corals have been recognized at this level, in the area of Beauring and Pondrôme. Higher in the Terres d’Hauls Formation, Disphyllum oekentorpi is succeeded by D. mcleani.

Systematic palaeontology

Family Disphyllidae Hill, 1939
Genus Disphyllum DE FROMENTEL, 1861

Type species: By subsequent designation of LANG & SMITH (1934, p. 80), Cyathophyllum caespitosum GOLDFUSS, 1826.

Diagnosis

Fasciculate rugose corals. Septa of two orders, occasionally carinate, more or less dilated in the dissepimentarium and thin in the tabularium. Major septa reaching the axis of the corallites or leaving an open space in the centre of the tabularium. Minor septa traversing the entire dissepimentarium. Dissepimentarium composed of several rows of oblate dissepiments, often arranged in horizontal layers in its outer part and inclined towards the axis of the corallites in its inner part. Tabulae usually incomplete or compound.

Disphyllum caespitosum (GOLDFUSS, 1826)
Pl. 1, Figs 1-2, Pl. 2, Figs 7-9, Pl. 3, Figs 7-8

v* p. 1826 --- Cyathophyllum caespitosum nobis - GOLDFUSS, p. 60, pl. 19, fig. 2b (non figs. 2a, 2c-d).

v 1846 --- Cladocora Goldfussii Geinitz. - GEINITZ, p. 569.

v 1934 --- Cyathophyllum caespitosum Goldfuss - LANG & SMITH, p. 80.

v 1935 --- Disphyllum goldfussii (Geinitz) - LANG & SMITH, p. 568, figs. 2-3, 23-24, pl. 35, figs 4-8.


v 1945 --- Disphyllum goldfussi Geinitz - SMITH, p. 21, pl. 8, fig. 8.

non 1947 --- Disphyllum goldfussi (Geinitz) - YU, p. 127, pl. 2, fig. 3.

non 1948 --- Disphyllum cf. goldfussi (Geinitz) - WANG, p. 7, pl. 3, figs 5-6.

non 1961 --- Disphyllum goldfussi (Geinitz)? - LENZ, p. 501, pl. 1, figs. 11-12.

v 1969 --- Cyathophyllum caespitosum Goldfuss, 1826 - BIRENHEIDE, 38, pl. 2, fig. 7, pl. 5, fig. 14.


v non 1970 --- Disphyllum goldfussi (Geinitz), 1846 - TSIEEN, p. 164, figs. 3-4.

v non 1974 --- Disphyllum goldfussi (Geinitz) - COEN-AUBERT, pl. 2, figs. 4-5.

1975 --- Disphyllum goldfussi (Geinitz 1846) - JOSEPH & TSIEEN, p. 193, fig. 5, pl. 2, fig. 2, pl. 6, fig. 4.

v non 1977 --- Disphyllum goldfussi - TSIEEN, fig. 51.

v 1978 --- Disphyllum caespitosum (Goldfuss 1826) -
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non 1978 —  Birenheide, p. 90, fig. 47.

v 1981 —  Disphyllum goldfussii (Geinitz) - Kong & Huang, p. 72, pl. 23, fig. 5.


non 1990 —  Disphyllum sp., aff. caespitosum (Goldfuss 1826) - Birenheide, pl. 3, fig. 9.

1998 —  Disphyllum caespitosum (Goldfuss 1826) - Schröder, p. 41, pl. 5, fig. 35.

? 2004 —  Disphyllum cf. caespitosum caespitosum (Goldfuss, 1826) - Schröder, p. 618.

**Remark**

As there are so many and rather heterogeneous references about Disphyllum caespitosum and D. goldfussii (Geinitz, 1846), this list of synonymy is not complete. It concerns mainly Givetian references which can be used without further revision.

**Lectotype**

Pl. 2, fig. 19b in Goldfuss, 1826, pl. 35, figs 4-6 in Lang & Smith (1935), pl. 2, fig. 7 and pl. 5, fig. 14 in Birenheide (1969) and figs. 169, 2a-d in Hill (1981), chosen by Lang & Smith (1934, p. 80). Specimen GMBo 205 of the Goldfuss collection stored in the Paläontologisches Institut from the University of Bonn in Germany. Probably Givetian of “Bensberg”, Bergisch Gladbach in the Bergisches Land, Germany. Contrary to Birenheide (1969), I have been lucky to investigate recently at Bonn the thin sections of the lectotype figured by Lang & Smith (1935) and Birenheide (1969).

**Material and localities**


**Diagnosis**

A species of Disphyllum with 46 to 52 septa at a diameter of 7 mm to 12 mm. Major and minor septa long. Tabulae incomplete, usually with axial flat-topped parts.

**Description**

The material consists of cylindrical corallites and fragments of fasciculate colonies whose height varies between 2 cm and 10.5 cm; the largest piece reaches an area of 11 x 5 cm. The outer wall is not always very well preserved. It is characterized by a dark median line when the cylindrical corallites are locally in contact and it is occasionally encrusted by thin laminar stromatoporoids. A few lateral and axial offsets occur in some colonies.

The septa are normally non-carinate or bear rarely some small spinose and knobbly carinae. They are dilated in the dissepimentarium and become thin in the tabularium or slightly beyond their entry into it. A weak deposit of stereoplasma is sometimes present between the septa, against the outer wall, on a layer of dissepiments or at the inner margin of the dissepimentarium. In a few corallites, a continuous stereozone invades partly the outer dissepimentarium.

The major septa leave an open space in the centre of the tabularium; in some cases, they nearly reach the axis of the corallites. Sometimes their axial ends are divided into isolated fragments or fusing to form pseudofoossilae. The minor septa traverse the entire dissepimentarium or even enter into the tabularium where they may be contratingent or discontinuous; they are rarely shorter.

The dissepimentarium consists of 1 to 5 or even 0 to 6 rows of small globose dissepiments which are in horizontal layers at the periphery and inclined in its inner part. Locally the dissepiments are obscured by spots of coarse and contiguous trabeculae. The tabulae are incomplete and intersecting laterally; their axial parts are frequently flat-topped.

There are 42 to 48 or even 40 to 50 septa per corallite. The diameter of the corallites ranges from 5.1 mm to 10.5 mm. The width of the tabularium varies commonly between 4 mm and 6.5 mm and more generally between 3.7 mm and 7.1 mm.

**Discussion**

The Belgian Givetian material investigated herein differs from the lectotype of Disphyllum caespitosum in having slightly smaller septal number and diameters of the corallites. Due to these two quantitative data, it is more closely related to the colonies from the Givetian Cürten Formation of the Eifel Hills in Germany assigned to D. caespitosum by Schröder (1998), which show as in my sampling some weak stereoplastic thickenings and axial offsets. As it was already mentioned by Schröder (1998), D. caespitosum resembles the specimen of Disphyllum sp. B described by Lütte & OeKentorp (1988, p. 222) which comes also from the Cürten Formation in the Eifel Hills.

At the Belgian scale, there are some affinities between D. caespitosum and D. semenoffi Coen-Aubert, 2000 from the Mont d’Hau rs Formation in the middle part of the Givetian. However, the latter taxon is distinguished from the former by larger corallites with more numerous and highly attenuated septa as well as by more rows of dissepiments which are often inclined. It is well known since Lang & Smith (1935, p. 569) that D. goldfussi is a junior objective synonym of D. caespitosum. The
Frasnian colony identified as *D. golfussi* by COEN-AUBERT (1974, pl. 2, figs. 4-5) and collected at the base of the Lustin Formation belongs in fact to *D. hilli* TSIEN, 1970 whereas the Belgian Frasnian material ascribed to the first species by TSIEN (1970 and 1977) is separated from *D. caespitosum* by greater size and septal number, thinner septa and broader dissepimentaria.

With the exception of the Pyrenean sampling of JOSEPH & TSIEN (1975), the other Givetian references of *D. caespitosum* and *D. golfussi* outside Germany are excluded from the synonymy list for various reasons:

- smaller corallites with fewer septa for KONG & HUANG (1978);
- a wide open space in the centre of the tabularium for the Middle Devonian colony of YU (1947);
- occurrence of a peripheral stereozone for LE MAÎTRE (1937);
- thicker and sometimes also carinate septa for WANG (1948), LENZ (1961), BRICE (1970) and BIRENHEIDE (1990); additionally, there are more numerous septa in the first two references.

**Geographic and stratigraphic occurrence**

The material collected by the author comes from the Trois-Fontaines Formation at Pondrôme, on the south side of the Dinant Synclinorium.

Outside Belgium, *Disphyllum caespitosum* occurs certainly in the Givetian from the Pyrenees in France, in the Givetian Cürten Formation from the Eifel Hills and in the Givetian from the Bergisches Land, both areas in Germany.

**Disphyllum oekentorpi** n.sp.

Pl. 1, Figs 3-10, Pl. 2, Figs 3-6

v 1991 — *Disphyllum aequiseptatum* (Milne-Edwards & Haime, 1851) - BIRENHEIDE et al., p. 10.

v 2004 — *Disphyllum sp. A* - BARCHY et al., p. 60, fig. 5.

**Derivatio nominis**

The species is dedicated to Klemens Oekentorp, a distinguished German specialist of Palaeozoic corals.

**Holotype**

IRScNB a12467 (= Pl. 1, Figs 3-5). Specimen Wellin MC-1983-12-Z997 collected by M. Coen-Aubert in 1983, 24.5 m below the top of the Trois-Fontaines Formation.

**Locus typicus**

Active quarry Fond des Vaux West at Wellin located in figure 2 of COEN-AUBERT (1999). Map sheet Wellin IGNB 59/6, Lambert coordinates: x = 203.525 and y = 87.2, south side of the Dinant Synclinorium, Belgium.

**Stratum typicum**

Upper part of the Trois-Fontaines Formation, Early Givetian.

**Material and localities**


**Diagnosis**

A species of *Disphyllum* with 46 to 58 septa at a diameter of 7 mm to 17 mm. Major septa slightly dilated in the dissepimentarium and leaving an open space in the centre of the tabularium. Minor septa variable in length, but often long.

**Description**

The material consists of fragments of big fasciculate colonies whose height varies between 3 cm and 18 cm; the largest piece reaches an area of 17 x 9 cm. The corallites are arranged in a parallel manner with growth lines and longitudinal ribs. There are also some isolated cylindrical or even ceratoid corallites. Several colonies of Wellin show some crushed or broken corallites. The outer wall is more or less well preserved. It is characterized by a dark median line when the cylindrical corallites are in lateral contact and it is locally encrusted by thin laminar stromatoporoids or auloporids. Lateral offsets occur in some colonies.

The septa are normally non-carinate or bear rarely a few small spinose or knobbly carinae. They are more or less diluted in the dissepimentarium and leaving an open space in the centre of the tabularium. Minor septa variable in length, but often long.

The septa are normally non-carinate or bear rarely a few small spinose or knobbly carinae. They are more or less diluted in the dissepimentarium and leaving an open space in the centre of the tabularium. Their axial ends are rarely discontinuous. The minor septa are often long, traversing all or nearly all the dissepimentarium; sometimes they are shorter, discontinuous at their inner ends or entering into the
tabularium where they may be contratingent. Some herringbone dissepiments have been observed in a few corallites. The dissepimentarium consists of 1 to 6 rows of small globose dissepiments which are usually in horizontal layers at the periphery and inclined in its inner part. The tabulae are incomplete and intersecting laterally; occasionally, they are horizontal, more or less deeply concave, irregular, wavy or characterized by axial flat-topped parts. In the colonies of Wellin and Marenne, the tabulae are frequently broken.

There are 42 to 62 septa per corallite. The diameter of the corallites ranges from 5.6 mm to 21 mm. The width of the tabularium varies commonly between 5 mm and 10.5 mm and more generally between 4 mm and 12.5 mm.

Discussion

D. oekentorpi is readily separated from D. caespitosum by:
- greater septal number and diameters of corallites and tabularia;
- a wide open space occurring systematically in the centre of the tabularium;
- minor septa which may not traverse the entire dissepimentarium;
- incomplete tabulae of variable patterns.

There are some similarities between Disphyllum oekentorpi and the specimen from the Givetian of West Somerset in Great Britain identified as D. aequiseptatum (Milne-Edwards & Haime, 1851) by Lang & Smith (1935, fig. 27, pl. 35, fig. 14). For the holotype of the latter species coming from the Givetian of the North Devon in Great Britain, only an external view has been given by Milne-Edwards & Haime (1853, pl. 52, fig. 2). According to Lang & Smith (1935, p. 572), the corallites of this colony are much crushed and their internal structures are thoroughly destroyed by recrystallization; moreover, the septa are less numerous in the material described by Milne-Edwards & Haime (1851 and 1853). Several specimens collected in the Givetian Cürten Formation from the Eifel Hills in Germany seem to be closely related to D. oekentorpi. This concerns:
- the sampling assigned to Disphyllum sp. A by Lütte & Oekentorp (1988, p. 220);
- the colony referred to the same Disphyllum sp. A by Schröder (1998, p. 42);

On the contrary, the holotype of D. geinitzi, which comes from the Givetian of the Bergisches Land in Germany and which has been illustrated by Lang & Smith (1935, pl. 36, fig. 1-3) and Birenheide (1969, pl. 3, fig. 8 and pl. 5, fig. 13) is different as it is characterized by a narrow dissepimentarium with inclined and locally lacking dissepiments. It can be remembered that D. geinitzi is the type species of Pantophyllum Lakho, 1982 and that this genus is not well defined and is very likely a synonym of Disphyllum as stated by Schröder (1998, p. 41), Rohart (1999, p. 51) and Coen-Aubert (2003, p. 18).

The material of D. oekentorpi with rather thin septa shows some affinities with D. intermedium Kong, 1978 from the Givetian of the Guizhou Province in China, D. salicis McLaren & Norris, 1964 from the Givetian of the Northwest Territories in Canada and D. panicum (Winchell, 1866) from the Givetian of Michigan in USA. In D. intermedium however, the dissepiments are inclined whereas the major and minor septa are longer than in D. oekentorpi. D. salicis is distinguished from the new taxon by very thin septa throughout their length and by minor septa traversing the entire dissepimentarium. D. panicum investigated by Ehlers & White (1932, p. 93) and Ehlers & Stumm (1949, p. 27) is more different in having weak carinae and slightly smaller corallites.

Geographic and stratigraphic occurrence

The species is only known in the Early Givetian of Belgium. The material collected by the author and M. Coen comes from the upper part of the Trois-Fontaines Formation at Wellin, Resteigne, Marenne, Mênil-Favay and Hotton, on the south side of the Dinant Synclinorium.

Genus Coenophyllum n. gen.

Type species: Coenophyllum groessensi n. gen., n. sp.

Derivatio nominis

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

Diagnosis

Fasciculate rugose corals. Septa of two orders, non-carinate, dilated in the dissepimentarium and thin in the tabularium. Both orders of septa frequently in lateral contact in the dissepimentarium so as to form a wide peripheral stereozone which is complete or partial. Major septa leaving an open space in the centre of the tabularium or reaching the axis of the corallum. Minor septa traversing the entire dissepimentarium. Dissepimentarium composed of a few rows of globose
dissepiments arranged in horizontal layers in its outer part and inclined towards the axis of the corallum in its inner part. Tabulae incomplete, compound or sometimes complete.

Discussion

Coenophyllum forms typical fasciculate colonies like Disphyllum, but differs from this genus by a strong stereozone investing the dissepimentarium and by rather few dissepiments. Due to the first feature, Coenophyllum is closely related to Temnophyllum WALTHER, 1929 whose several species from the Givetian of Belgium and Germany have been described or revised by COEN-AUBERT (2002, 2003 and 2004). But Temnophyllum is mostly represented by solitary rugose corals with much larger coralla and much more small globose dissepiments. Even the size of Alaiophyllum jarushevskyi GORIANOV, 1961 from the Givetian of Tien Shan in Kirghizistan and type species of Alaiophyllum GORIANOV, 1961 is greater than the corallites of Coenophyllum groessensi. It must be mentioned that Alaiophyllum is placed in synonymy with Temnophyllum by COEN-AUBERT (2004, p. 26) though Alaiophyllum jarushevskyi is possibly weakly fasciculate.

The species Disphyllum liumaense YU, 1947 that is ascribed herein to Coenophyllum, was transferred to the genus Temnophylloides KONG & HUANG, 1978 by KONG & HUANG (1978, p. 76). However, this is a nomen nudum as its type species T. devoniana hunanensis KONG & HUANG, 1978 was neither described nor illustrated. According to LIAO & BIRENHEIDE (1989, p. 87) and ZHEN (1995, p. 222), the generic name Temnophylloides was introduced by KONG & HUANG (1978) for fasciculate rugose corals distinguished from Disphyllum by a wide and consistent peripheral stereozone formed by thickened septa. For ZHEN (1995) also, Temnophylloides is a junior synonym of Solominella IVANIA, 1952 whose type species is S. soshkinae IVANIA, 1952 from the Frasnian of the Kuznetsk Basin in Russia. But this species refigured by ZHELTONOGOVA & IVANIA (1960, pl. 30, fig. 3) is separated from Coenophyllum by a narrower stereozone and very few dissepiments.

Species assigned to the genus

In addition to the type species Coenophyllum groessensi from the Early Givetian of Belgium, the following taxa are assigned to the genus Coenophyllum:
- Disphyllum wirbelauense PICKETT, 1967 from the Frasnian of the Lahn Synclinorium in Germany;
- D. wirbelauense regulare ROZKOWSKA & FEDOROWSKI, 1972 from the Upper Givetian of Poland;
- D. wirbelauense bonae ROZKOWSKA & FEDOROWSKI, 1972 from the Upper Givetian and probably the Frasnian of the same areas;
- D. liumaense from the Frasnian of Guangxi in China.

Coenophyllum groessensi n. gen., n.sp.

Pl. 2, Figs 1-2, Pl. 3, Figs 1-6

Derivatio nominis

The species is dedicated to Eric Groessens, a distinguished specialist of Carboniferous conodonts and Belgian marbles.

Holotype

IRScNB a12473 (= Pl. 3, Figs 1-3). Specimen Hotton MC-33-B515 collected by M. Coen-Aubert in 1993, 20 m below the top of the Trois-Fontaines Formation.

Locus typicus

Disused Hampteau quarry lying 1.5 km to the southeast of Hotton and located in figure 6 of COEN-AUBERT (2003). Map sheet Hotton IGNB 55/5, Lambert coordinates: x= 228 and y= 106.1, southeast side of the Dinant Synclinorium, Belgium.

Stratum typicum

Upper part of the Trois-Fontaines Formation, Early Givetian.

Material and localities


Diagnosis

A species of Coenophyllum with 42 to 48 septa at a diameter of 7 mm to 11 mm. Major septa rather long. Tabulae incomplete, usually with axial flat-topped parts.

Description

The material consists of fragments of fasciculate colonies whose height varies between 1.5 cm and 4 cm; the largest piece reaches an area of 14 x 8 cm. There are also a few isolated corallites with longitudinal ribs. The outer wall is often preserved. It is characterized by a dark median line when the cylindrical corallites are in lateral contact and it is locally encrusted by thin laminar
stromatoporoids or auloporids. Axial quadripartite and sometimes tripartite offsets occur in several colonies.

The septa are normally non-carinate though a few small knobby carinae occur in some specimens. The septa are dilated in the dissepimentarium and become thin in the tabularium or beyond their entry into it; they are rarely thick throughout their length. A wide and more or less continuous stereozone, where the septa are contiguous laterally, invests the entire dissepimentarium, its outer part, its inner margin or both of them. However, a few corallites are devoid of these stereoplasmic thickenings or are only affected partly by them.

The major septa reach the axis of the corallites or leave an open space in the centre of the tabularium; sometimes their axial ends are divided into isolated fragments or fusing to form pseudofossulae. The minor septa traverse the entire dissepimentarium or even enter into the tabularium where they may be contranting or discontinuous; they are rarely shorter.

The dissepimentarium consists of 1 to 4 or even 5 rows of globose dissepiments which are in horizontal layers at the periphery and inclined in its inner part. The dissepiments are partly obscured by coarse and contiguous trabeculae which are occasionally subhorizontal or slightly inclined towards the outer wall. The tabulae are incomplete and intersecting laterally; their axial parts are frequently flat-topped and rarely horizontal or convex.

There are 40 to 52 septa per corallite. The diameter of the corallites ranges from 5.5 mm to 11.5 mm. The width of the tabularium varies commonly between 4.3 mm and 7 mm and more generally between 3.3 mm and 7.4 mm.

Discussion

Coenophyllum regulare differs from the new species by major septa hardly projecting into the tabularium and by tabulae frequently complete. The first feature characterizes also C. wirbelauense which is additionally separated from C. groessensi by a narrower dissepimentarium and a broader tabularium. C. bonae is distinguished from C. groessensi by major septa leaving systematically an open space in the centre of the tabularium and by dissepiments poorly developed. In C. liumaense, the major septa reach the axis of the corallites as in the new species, but the dissepimentarium is once more narrower.

C. groessensi shows some affinities with Temnophyllum ramosum Coen-Aubert, 2004 from the Upper Givetian Fromelennes and Le Roux Formations in Belgium. However, the latter taxon which is represented by solitary coralla and small fasciculate colonies, is different from the former in having:
- greater septal number and diameters of the corallites and tabularia;
- minor septa of rather variable length;
- several rows of small inclined dissepiments.

Finally, it must be mentioned that Coenophyllum groessensi has similar quantitative data as Disphyllum caespitosum; but the new species is easily distinguished by the wide stereozone investing the dissepimentarium as well as by larger and slightly fewer dissepiments often obscured by stereoplasma.

Geographic and stratigraphic occurrence

The species is only known in the Early Givetian of Belgium. The material collected by the author comes from the Trois-Fontaines Formation at Resteigne and Hotton, on the south side of the Dinant Synclinorium.

Acknowledgments

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References


Rugose corals from the Trois-Fontaines Formation (Givetian, Belgium) 45


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**Explanation of Plates**

All the specimens are figured at magnification x 3.

**PLATE 1**

*Disphyllum caespitosum* (GOLDFUSS, 1826)

<table>
<thead>
<tr>
<th>Fig.</th>
<th>Specimen</th>
<th>Location</th>
<th>Type of Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IRScNB a12462</td>
<td>Houyet MC-1983-15-B122</td>
<td>Transverse section</td>
</tr>
<tr>
<td>2</td>
<td>IRScNB a12463</td>
<td>Houyet MC-1983-15-B15</td>
<td>Transverse section</td>
</tr>
</tbody>
</table>

*Disphyllum oekentorpi* n. sp.

| Figs 3-5 | Holotype. IRScNB a12467 | Wellin MC-1983-12-Z997 | Transverse and longitudinal sections. |
| Figs 6-7 | Paratype. IRScNB a12468 | Marche MC-89-D445 | Transverse and longitudinal sections. |
| Figs 8-9 | Paratype. IRScNB a12469 | Wellin MC-1983-12-A100 | Transverse and longitudinal sections. |
| Fig. 10 | Paratype. IRScNB a12470 | Marche MC-89-D441 | Transverse section. |

**PLATE 2**

*Coenophyllum groessensi* n.gen., n. sp.

| Figs 1-2 | Paratype. IRScNB a12474 | Hotton MC-33-B509 | Transverse and longitudinal sections. |

*Disphyllum oekentorpi* n. sp.

| Fig. 3 | Paratype. IRScNB a12471 | Wellin MC-1983-9-Z988 | Transverse section. |
| Figs 4-6 | Paratype. IRScNB a12472 | Marche MC-89-D442 | Transverse and longitudinal sections. |

*Disphyllum caespitosum* (GOLDFUSS, 1826)

| Fig. 7 | IRScNB a12464 | Houyet MC-1983-15-B16 | Longitudinal section. |

**PLATE 3**

*Coenophyllum groessensi* n.gen., n. sp.

| Figs 1-3 | Holotype. IRScNB a12473 | Hotton MC-33-B515 | Transverse and longitudinal sections. |
| Figs 4-5 | Paratype. IRScNB a12475 | Hotton MC-33-C223 | Transverse and longitudinal sections. |
| Fig. 6 | Paratype. IRScNB a12476 | Hotton MC-33-B510 | Transverse section. |

*Disphyllum caespitosum* (GOLDFUSS, 1826)

| Figs 7-8 | IRScNB a12466 | Houyet MC-1983-15-B121 | Transverse and longitudinal sections. |
Rugose corals from the Trois-Fontaines Formation (Givetian, Belgium)