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Fasciculate rugose corals across the Early-Middle Frasnian boundary in Belgium

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Abstract

Disphyllum hilli TSIEN, 1970, *D. grabaui* TSIEN, 1970, *D. rugosum* (WEDEKIND, 1922), *D. preslense* n.sp. and *Peneckiella discreta* n.sp. are described in detail and have been mostly collected in beds rich in fasciculate rugose corals, occurring in various areas of Belgium. The material investigated comes mainly from the *Palmatolepis transitans* and *P. punctata* conodont Zones, at the transition between the Early and the Middle Frasnian. The rugose corals identified herein allow also interesting regional correlations. *Disphyllum hilli, D. grabaui* and *Macgeea rozkowskae* COEN-AUBERT, 1982 are abundant at the base of the Moulin Liénaux Formation on the south side of the Dinant Synclinorium and at the base of the Lustin Formation on the north side of the same structural unit. *Disphyllum preslense* and *D. rugosum* are widely distributed in the middle part of the Bovesse Formation on the north side of the Namur Synclinorium, in the middle of the reefal limestones from the lower part of the Lustin Formation and in the middle part of the Pont de la Folle Formation which characterizes the northwestern part of the Dinant Synclinorium. *Peneckiella discreta* serves locally as basement for the small mounds observed at the top of the Moulin Liénaux Formation. *Hexagonaria mirabilis* MOENKE, 1954 and *Tabulophyllum mcconnelli* (WHITEAVES, 1898) are frequently associated at the base of the overlying Grands Breux Formation, at the top of the Pont de la Folle Formation, at the top of the reefal limestones from the Lustin Formation and at the base of the Huccorgne Formation capping the Bovesse Formation.

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

Résumé

Disphyllum hilli TSIEN, 1970, *D. grabaui* TSIEN, 1970, *D. rugosum* (WEDEKIND, 1922), *D. preslense* n.sp. et *Peneckiella discreta* n.sp. sont décrits en détail et ont surtout été récoltés dans des lits riches en Rugueux fasciculés, présents dans diverses régions de la Belgique. Le matériel étudié provient principalement des Zones à Conodontes à *Palmatolepis transitans* and *P. punctata*, à la transition entre le Frasnien inférieur et moyen. Les Rugueux identifiés dans ce travail permettent aussi de faire d'intéressantes corrélations régionales. *Disphyllum hilli, D. grabaui* et *Macgeea rozkowskae* COEN-AUBERT, 1982 sont abondants à la base de la Formation du Moulin Liénaux au bord sud du Synclinorium de Dinant et à la base de la Formation de Lustin au bord nord de la même unité structurale. *Disphyllum preslense* et *D. rugosum* sont largement répandus dans la partie moyenne de la Formation de Bovesse au bord nord du Synclinorium de Namur, au milieu des calcaires récifaux de la partie inférieure de la Formation de Lustin et dans la partie moyenne de la Formation du Pont de la Folle qui caractérise le Nord-Ouest du Synclinorium de Dinant. *Peneckiella discreta* sert localement de soubassement aux petits monticules observés au sommet de la Formation du Moulin Liénaux. *Hexagonaria mirabilis* MOENKE, 1954 et *Tabulophyllum mcconnelli* (WHITEAVES, 1898) sont fréquemment associés à la base de la Formation sus-jacente des Grands Breux, au sommet de la Formation du Pont de la Folle, au sommet des calcaires récifaux de la Formation de Lustin et à la base de la Formation de Huccorgne recouvrant la Formation de Bovesse.

Mots-clefs: Rugueux, Frasnien, Taxinomie, Stratigraphie, Belgique.

Introduction

The Early-Middle Frasnian transition in Belgium is characterized by several remarkable beds rich in fasciculate rugose corals, which serve as basement for bioherms and biostromes or which overlie levels of massive limestone. The genus *Disphyllum* DE FROMENTEL, 1861 is widely represented in this part of the stage with the species *D. hilli* TSIEN, 1970, *D. grabaui* TSIEN, 1970, *D. rugosum* (WEDEKIND, 1922) and *D. preslense* n. sp. described herein in detail. However, a first species of *Peneckiella* SOSHKINA, 1939, namely *P. discreta* n. sp. occurs already in these layers. Indeed, it must be mentioned that the genus *Peneckiella* is more widespread higher in the Frasnian with several taxa investigated by COEN-AUBERT (1994,

1995 and 1996).

The numerous specimens used for this study have been collected in various localities lying in different areas of Belgium (Fig. 1). On the south side of the Dinant Synclinorium (Fig. 8), the Frasnian is subdivided in ascending order into the Nismes, Moulin Liénaux, Grand Breux, Neuville and Matagne Formations. My material from this part of Belgium comes mainly from the reefal areas of Frasnes and Rochefort where the Moulin Liénaux Formation includes from base to top the Chalon Member, the bioherms of the Arche Member and the La Boverie Member with again small mounds in its upper part. In the non reefal areas from the south side of the Dinant Synclinorium, the Moulin Liénaux Formation starts also with the Chalon Member, but the carbonate sediments of the Arche and La Boverie Members pass laterally into the fine shales of the Ermitage Member. According to BOULVAIN *et al.* (1999), GOUWY & BULTYNCK (2000) and BULTYNCK & DEJONGHE (2002), the base of the Frasnian has been recognized close to the base of the Nismes Formation, in the Early *Mesotaxis falsiovalis* conodont Zone. The *Palmatolepis transitans* Zone occurs from the top of the Nismes Formation to the top of the Chalon Member. It is succeeded first by the *P. punctata* Zone and then by the *P. hassi* Zone close to the top of the Ermitage Member. As pointed out by CASIER & OLEMPSKA (2008, p. 635), the Early-Middle Frasnian boundary has been fixed recently by the Subcommission on Devonian Stratigraphy, at the base of the *P. punctata* Zone.

In the northwestern part of the Philippeville Massif, the Nismes Formation is overlain by the Pont de la Folle and Philippeville Formations and this situation characterizes in fact all the northwestern part of the Dinant Synclinorium (Fig. 9). On the north side of the Dinant Synclinorium, on the south side of the Namur Synclinorium and in the Vesdre Massif, the Nismes Formation or locally the Presles Formation is capped by the Lustin Formation. Some beautiful levels with colonies of *Disphyllum* are observed in the reefal limestones from the lower part of the Lustin Formation. Finally, some samples come from the north side of the Namur Synclinorium and from the bottom of the Wépion borehole drilled in the central part of the same structural area where there are particular facies and different lithostratigraphic units.

The main part of the material was collected by the author *in situ* during geological surveys made bed by bed. This sampling is supplemented by a few old thin sections referred in this paper to the "Old collection from the Institut royal des Sciences naturelles de Belgique". The types of the new species and the figured specimens are also stored in the collections of

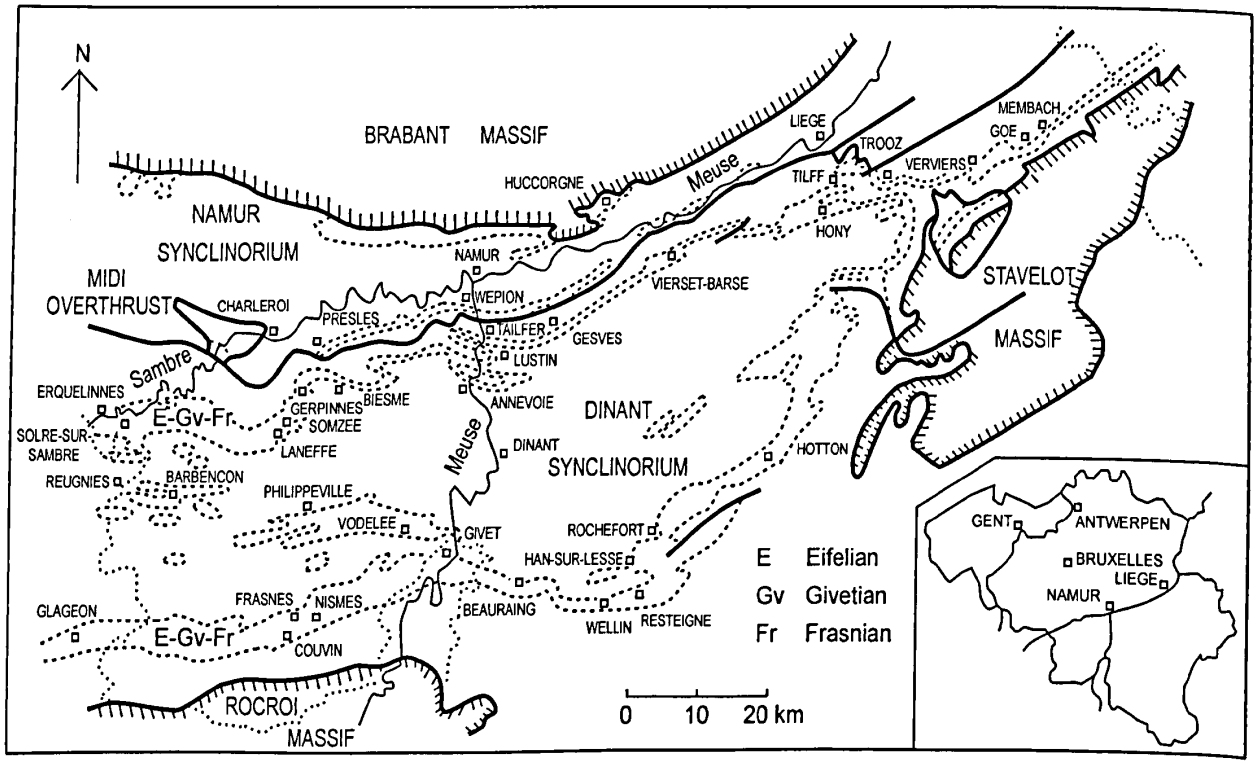

Fig. 1 – Geological setting and locality map in the southern part of Belgium.

the Institut royal des Sciences naturelles de Belgique (IRScNB).

Description of the outcrops

LA BOVERIE QUARRIES AT ROCHEFORT (Figs 2 and 4)

On the south side of the Dinant Synclinorium, the most complete succession for the reefal facies of the Moulin Liénaux Formation is that of La Boverie quarries at Rochefort located and investigated by BOULVAIN *et al.* (2005) and BOULVAIN & COEN-AUBERT (2006). At the base of the southwestern excavation Rochefort MC-53 (Fig. 2) corresponding to sections A and B of these authors, the Chalon Member is represented by 2.9 m of thin-bedded argillaceous limestone with a few colonies and corallites of *Disphyllum grabaui*, alveolitids and thamnoporids. After a lack of outcrop of 4 m, the Chalon Member ends with 1.75 m of argillaceous limestone containing in its upper part numerous alveolitids and representatives of *D. hilli* associated with some specimens of *D. grabaui* and *Macgeea rozkowskae* COEN-AUBERT, 1982, thamnoporids, brachiopods and crinoids. At the base of the Arche Member, colonies of *Disphyllum hilli* are still abundant and accompanied by a few coralla of *Macgeea rozkowskae*, but massive and thick laminar stromatoporoids are also present in a pure and fine limestone. Then the Arche Member is characterized by a total thickness of 95 m and by various facies such as limestones more or less rich in corals, tabular and massive stromatoporoids or even dendroid stromatoporoids; the occurrence at certain levels of numerous brachiopods, stromatactis and zebra structures must also be mentioned. At the top of the southwestern excavation Rochefort MC-53, the La Boverie Member starts with 16 m of thin-bedded argillaceous, bioclastic or fine limestone with locally some rugose corals; *Sinodisphyllum posterum* (IVANIA, 1965) and *Hexagonaria mirabilis* MOENKE, 1954 have been identified among them.

The La Boverie Member (Fig. 4) is completely exposed in the eastern part of the southeast excavation corresponding to the outcrop Rochefort MC-56 and to the sections D, E and F described by BOULVAIN *et al.* (2005) and BOULVAIN & COEN-AUBERT (2006). With the progress of the quarrying activity, new sections showing interesting facies variations have been surveyed by the author in the western part of the southeast excavation lying to the south of section G of BOULVAIN *et al.* (2005) and corresponding to the outcrop Rochefort MC-55.

In the outcrop Rochefort MC-56, the La Boverie Member starts with 3 m of argillaceous limestone with some shaly intercalations and also some tabulate and rugose corals in their lower part; the latter include solitary coralla of *Macgeea boveriensis* BOULVAIN & COEN-AUBERT, 2006, *M. socialis* SOSHKINA, 1939 and *Sinodisphyllum posterum* as well as a few corallites of *Disphyllum rugosum* and *Peneckiella discreta*. The following 21 m are are made up of dark, fine or bioclastic limestones with locally a few gastropods, alveolitids and small colonies of *P. discreta*; these corals become more frequent in the upper part of this sequence together with *Macgeea socialis*, *Hexagonaria mirabilis* and some laminar and massive stromatoporoids. The small buildup characteristic of the top of the La Boverie Member has a thickness of 10 m and consists of light coloured limestone which contains in section D the same various reef building organisms at the base and mostly dendroid stromatoporoids at the top. However, the fauna of this small mound is already less diversified in the western section F illustrated by BOULVAIN *et al.* (2005, fig. 7) as it is restricted to scattered massive and dendroid stromatoporoids. In the lower part of the Grand Breux Formation, the Bieumont Member is then composed of argillaceous and bioclastic limestones often rich in laminar stromatoporoids and diverse corals; among the rugose corals appear the species *Sinodisphyllum kielcense* (ROZKOWSKA, 1979), *Aristophyllum irenae* ROZKOWSKA, 1979 and *Tabulophyllum mcconnelli* (WHITEAVES, 1898) synonym of *Tabulophyllum conspectum* TSIEN, 1977a according to MCLEAN (2007, p. 28).

Changes of facies affect all the La Boverie Member of the Moulin Liénaux Formation to the west of Rochefort MC-56, in the outcrop Rochefort MC-55. Along the western wall of the southeast excavation, the Arche Member ends with massive limestone rich in dendroid stromatoporoids accompanied by a few massive stromatoporoids. At the base of the La Boverie Member, there are argillaceous limestones containing various tabulate and rugose corals, overlain by dark and bioclastic limestones containing the same corals and laminar stromatoporoids; this first sequence is 9 m thick. Further upwards are observed 10 m of dark and fine, thin-bedded limestone with locally some gastropods. The following 9 m of the same limestone show frequent accumulations of fasciculate colonies of *Peneckiella discreta* associated with some solitary rugose corals and numerous scolioporids at the top. Then the small mound starts with 1.75 m of massive and light grey limestone locally rich in dendroid stromatoporoids; it ends with 3.75 m of the same limestone often crinoidal.

Close to this section, another section in the western part of Rochefort MC-55 exposes the top of the levels with beautiful thickets of *Peneckiella discreta*. Then the small buildup belonging to the top of the La Boverie Member is represented by 6 m of massive and light coloured limestone including only dendroid stromatoporoids in its lower part. In both sections of Rochefort MC-55 investigated, the overlying Bieumont Member consists of 10 to 16 m of argillaceous limestones with various corals and laminar stromatoporoids. The succeeding Lion Member starts with massive and light grey limestone which is characterized by stromatactis, diverse ramose tabulate corals, tabular and massive stromatoporoids as well as by some massive rugose corals and dendroid stromatoporoids.

ARCHE AND NORD QUARRIES AT FRASNES (Figs 2 and 4)

The Arche quarry at Frasnes (Couvin MC-1974-97) is the stratotype for the Moulin Liénaux Formation introduced by BOULVAIN *et al.* (1999, p. 38) and summarized by BULTYNCK & DEJONGHE (2002, p. 55). This famous disused quarry has also been described among others by LECOMPTE (1960, p.60), TSIEN (1975, p. 25) and BOULVAIN *et al.* (2004, p. 319).

Along the access path to the quarry (Fig. 2), the Nismes Formation ends with 3.35 m of shales containing several thin beds of fine or crinoidal limestone. The Chalon Member at

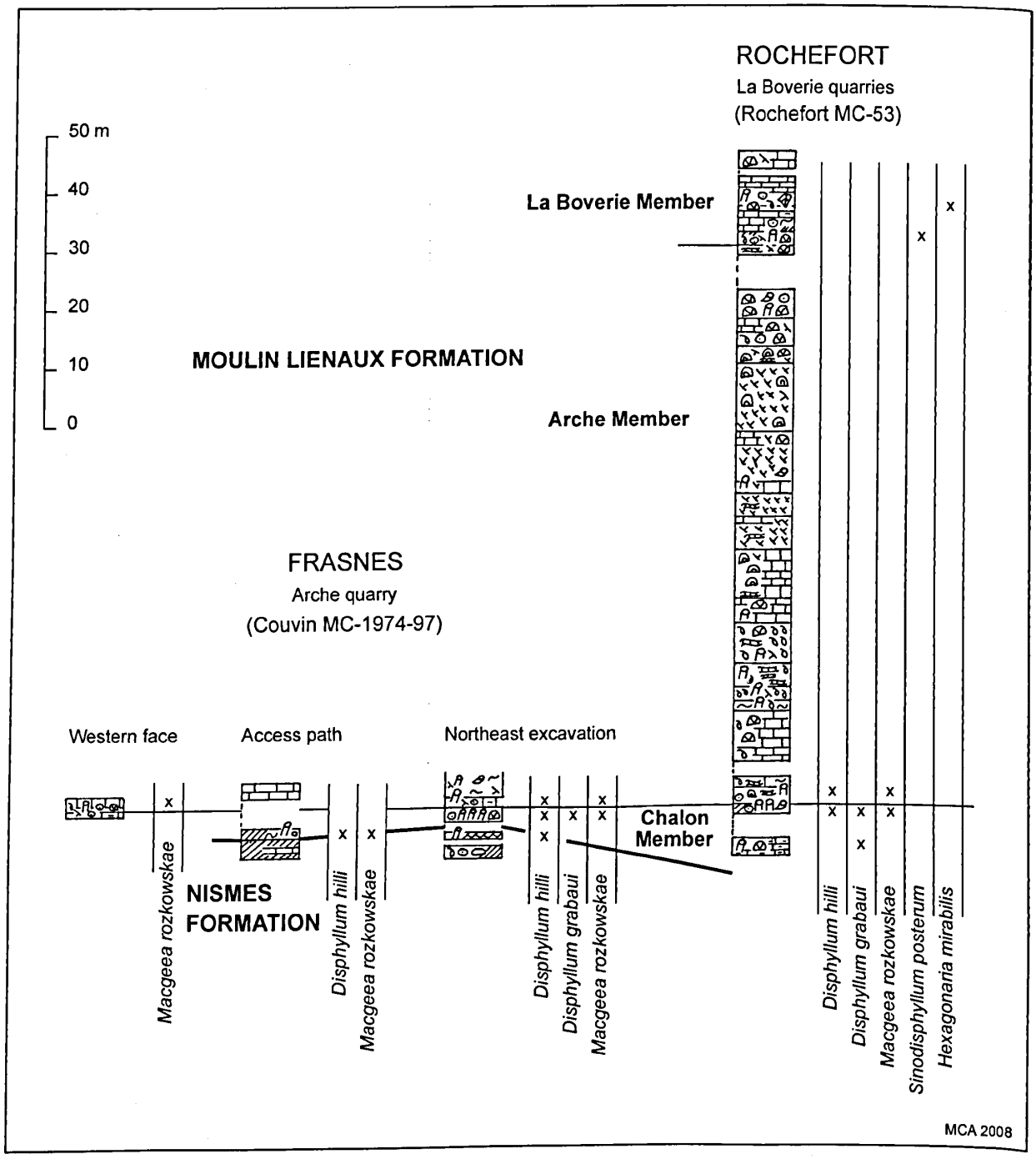

Fig. 2 – Comparative logs from the lower part of the Moulin Liénaux Formation at Frasnes and Rochefort with the distribution of the rugose corals. (For explanation of conventional signs, see Fig. 3).

the base of the Moulin Liénaux Formation is represented by 1.7 m of coralliferous carbonate deposits: crinoidal or argillaceous limestones and shales often with calcareous lenses; the corals include platy alveolitids, thamnoporids, coralla of *Macgeea rozkowskae* and corallites of *Disphyllum hilli*. After a lack of outcrop of 2.5 m is observed the massive and fine red limestone of the Arche Member. The boundary between the Chalon and Arche Members is exposed along the western face of the Arche quarry. However, the most spectacular outcrop for the Chalon Member is located in the northeast excavation open in the wood, but it was not investigated by BOULVAIN *et al.* (1999). In this place, the Nismes Formation is characterized by a discontinuous sequence of 4 m with shales, calcareous shales and nodular limestones containing brachiopods, crinoids and a few corals at the top with among them *D. hilli*. After a gap of 1.85 m, the Chalon Member starts with crinoidal limestone overlain by large accumulations of numerous corallites of *D. hilli* and *D. grabaui* which are broken or oriented in several directions; there are also a few specimens of *Macgeea rozkowskae*, alveolitids and thamnoporids. This level is 2.5 m thick and is succeeded after a hiatus of 0.5 m by 1.2 m of argillaceous or fine limestone, which is still rich in corallites and even colonies of *Disphyllum hilli* in growth position associated with *Macgeea rozkowskae*; this bed belongs to the Arche Member below the red marble.

It must be mentioned that my interpretation for the boundary between the Nismes and Moulin Liénaux Formations in the access path to the Arche quarry follows that of TSIEN (1975) whereas all the succession was assigned to the Chalon Member by BOULVAIN *et al.* (1999). Rugose corals were of course collected by TSIEN (1970 and 1975) in the northeast excavation as well as along the access path to the Arche quarry.

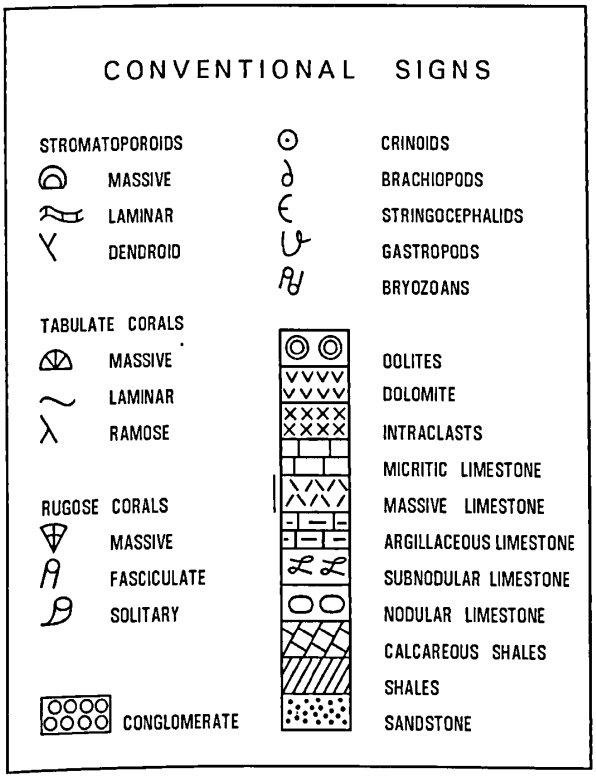

Fig. 3 – Explanation of conventional signs used in Figs 2, 4, 5 and 7.

The active Nord quarry at Frasnes is mostly excavated in the Grands Breux Formation. However, several boreholes drilled in this exposure intersected the upper part of the Moulin Liénaux Formation. These boreholes were described by BOULVAIN & COEN-AUBERT (2006). In the FR2 borehole (Fig. 4), the upper part of the Arche Member was observed between 100 m and 76,35 m. From 76,35 m to 65,3 m, the lower part of the La Boverie Member is mostly characterized by nodular and more or less crinoidal limestones. Fasciculate colonies of *Disphyllum rugosum*, *D. preslense* and *Peneckiella discreta* occur up to 68 m. There are also thamnoporids, massive, platy and ramose alveolitids accompanied by a few massive, laminar and dendroid stromatoporoids. The next unit between 65,3 m and 53 m consists of light grey limestone including dendroid stromatoporoids which are sparse to locally more numerous and associated with some ramose tabulate corals, laminar and massive stromatoporoids. All these reef building organisms are scattered up to the top of the La Boverie Member at 40 m, in a grey limestone which may be red, bioclastic or crinoidal. Then, the Bieumont Member and the lower part of the Lion Member belonging to the Grands Breux Formation show the same facies as those of the La Boverie quarries at Rochefort. In other boreholes drilled in the Nord quarry at Frasnes, BOULVAIN & COEN-AUBERT (2006, p. 40) mentioned the occurrence of *Sinodisphyllum posterum* and *Hexagonaria mirabilis* in the lower part of the La Boverie Member.

OTHER LOCALITIES IN THE SOUTHERN AND CENTRAL PARTS OF THE DINANT SYNCLINORIUM

On the south side of the Dinant Synclinorium, *Disphyllum grabaui* has been collected in the Nismes Formation at Givet in France and Han-sur-Lesse. The first occurrence comes from the Fort de Charlemont at Givet (Agimont MC-1983-7) located on a map by ERRERA *et al.* (1972, fig. 1). The second one is from the place named Le Poteau (Han-sur-Lesse K2) lying 1.2 km to the north of Han-sur-Lesse, along the road to Rochefort. It was found by COEN (1977, p. 43) in a temporary trench for water supply.

In the southeastern part of the Philippeville Massif, *D. hilli* and *D. grabaui* have been observed at Vodelée, in the lower part of the Arche Member from the Moulin Liénaux Formation, 9.5 m above the base of the Moulin Bayot section West or A (Surice MC-40) described respectively by DUMOULIN *et al.* (1998) and BOULVAIN *et al.* (2005). In the northwestern part of the Philippeville Massif, the Moulin Liénaux and Grand Breux Formations pass laterally into the Pont de la Folle and Philippeville Formations as it was stated by DUMOULIN *et al.* (1998).

To the northwest of the Philippeville Massif, different outcrops and boreholes have been investigated by COEN & COEN-AUBERT *in* DUMOULIN (2001, pp. 15-20), in the Pont de la Folle Formation exposed in the vicinity of Barbençon. In the lower part of the lithostratigraphic unit, a massive and

thick level of dolomite characterizes the Brayelles Member. Then the Fontaine Samart Member is 13 m to 32 m thick. It consists of dark and bedded limestones which are often argillaceous, nodular or crinoidal; various corals are abundant in their lower part whereas laminar stromatoporoids are more frequent in their upper part. *Disphyllum preslense* occurs throughout the Fontaine Samart Member (outcrops Beaumont MC-1977-13 and MC-1978-7 and boreholes Bo1 and Bo2); *D. rugosum* and *Peneckiella discreta* have only been found close to its base in the borehole Bo1. The accompanying fauna is represented by *Wapitiphyllum tenue* (COEN-AUBERT, 1980) in the middle part of the member and by *Hexagonaria mirabilis* in its upper part. In the borehole Silenrieux Br1 located 3 km to the west of Barbençon along the road to Boussu-lez-Walcourt, *Disphyllum preslense* is also present at the base of the Machenées Member which is the upper subdivision of the Pont de la Folle Formation. These 15 m of shales and argillaceous limestones are rather rich in rugose corals including additionally *Hexagonaria mirabilis* and *Tabulophyllum mcconnelli.*

To the northwest of Barbençon, *Disphyllum rugosum* has been observed in the Fontaine Samart Member intersected by the borehole Gandrieu R1 drilled at the southwest end of the village of Reugnies in France, close to the Belgian border.

LUSTIN AND OTHER LOCALITIES IN THE MEUSE VALLEY

On the north side of the Dinant Synclinorium, the Middle Frasnian is mostly represented by the Lustin Formation introduced by COEN-AUBERT & COEN (1975) and revised by BOULVAIN *et al.* (1999). The stratotype is the section of

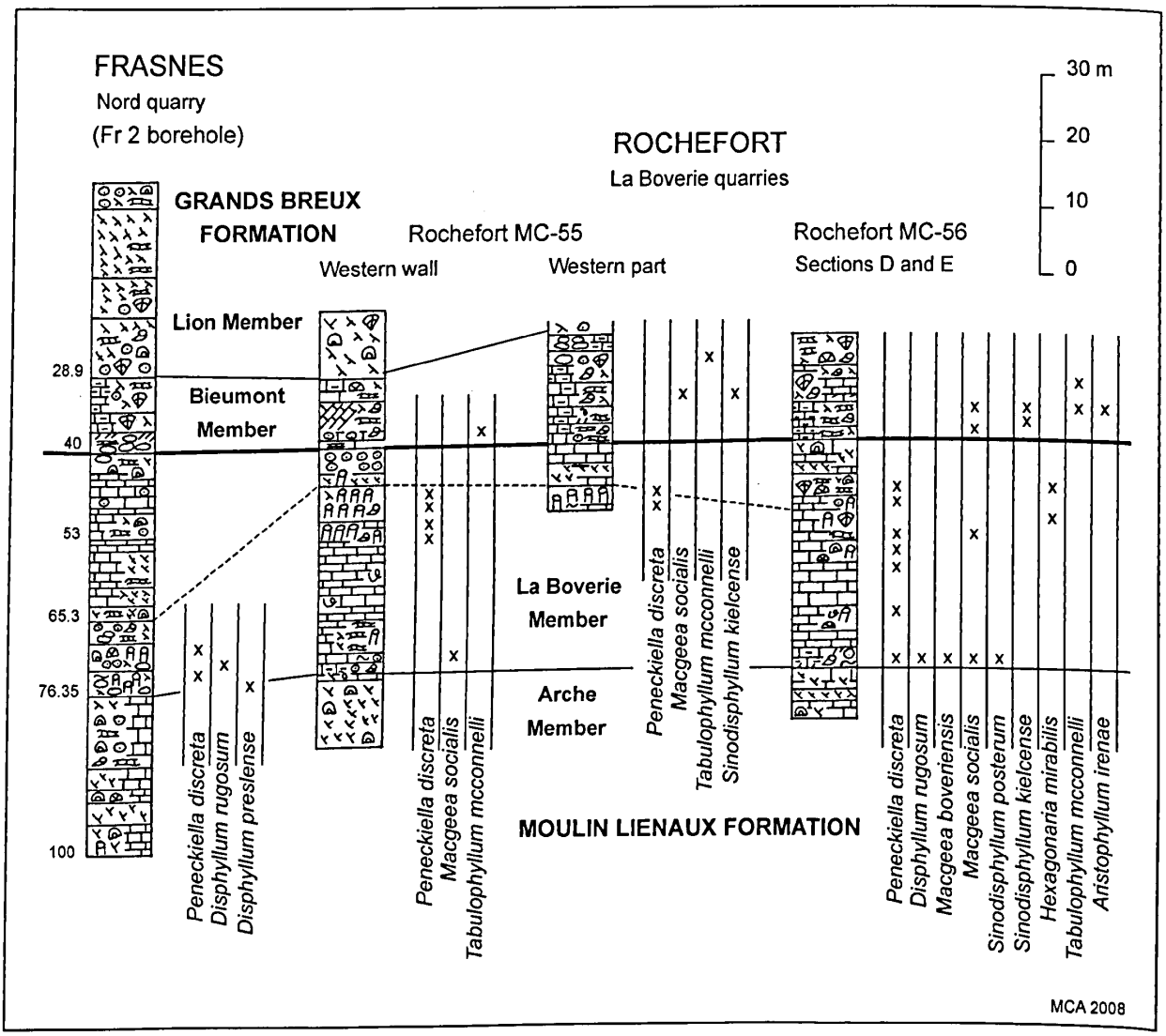

Fig.4 – Comparative logs from the upper part of the Moulin Liénaux Formation at Frasnes and Rochefort with the distribution of the rugose corals. (For explanation of conventional signs, see Fig. 3).

the Rochers de Frênes at Lustin (Naninne MC-1974-115) completed by the nearby cliff and quarry of Tailfer (Naninne MC-1974-113). At Lustin (Fig. 5), the Lustin Formation is 104 m thick and is divided into two parts: 57 m of reefal limestones overlain by 47 m of lagoonal limestones. In continuity with the Presles Formation, the Lustin Formation starts with a first level of massive limestone belonging to the Sainte-Anne Marble (auctores) and capped by argillaceous limestones showing the famous and beautiful thickets of *Disphyllum preslense* associated with a few specimens of *D. rugosum* and *Macgeea boveriensis*. After several layers which may contain diverse reef building organisms, occurs a second level of massive limestone often with various stromatoporoids. *Hexagonaria mirabilis* is present just below this level at Lustin. At Tailfer are observed 2.5 m below this level first a bed with fasciculate colonies of *Disphyllum preslense*, then large colonies of *Wapitiphyllum tenue*. At the top of the reefal limestones from the Lustin Formation, there are bedded limestones rich in laminar stromatoporoids, tabulate and rugose corals including *Hexagonaria mirabilis* and additionally *Tabulophyllum mcconnelli* in the Tailfer section.

Two other species of fasciculate rugose corals have been recognized at Annevoie-Rouillon, in the outcrop 17 of COEN-AUBERT & COEN (1975, fig. 1) corresponding to the Roche aux Corneilles at Hun (Bioul MC-1974-121). In this locality, the Lustin Formation is 125 m thick. *Disphyllum hilli* is present close to its base whereas *Peneckiella discreta*

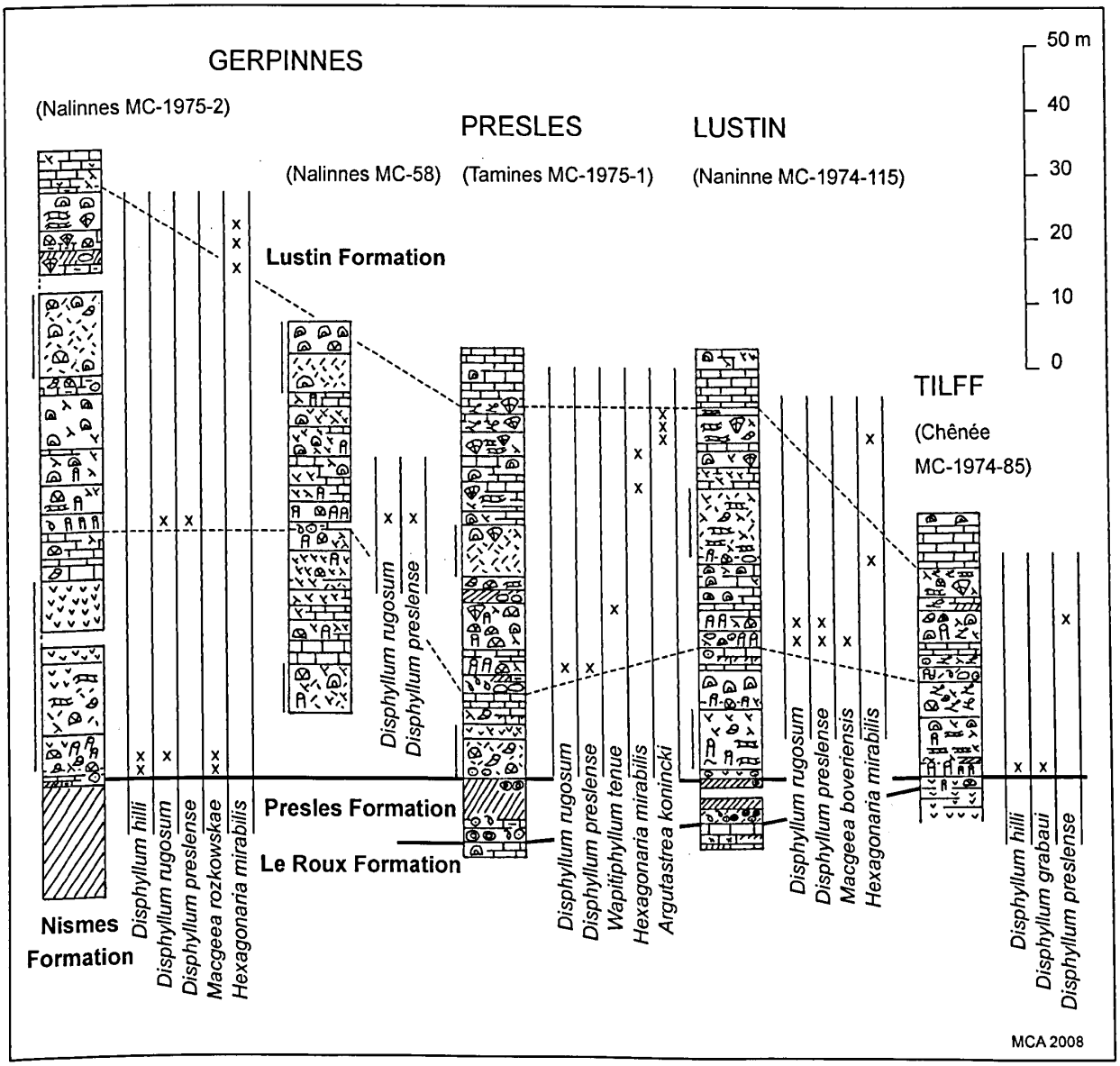

Fig. 5 – Comparative logs from the lower part of the Lustin Formation at Gerpinnes, Presles, Lustin and Tilff with the distribution of the rugose corals. (For explanation of conventional signs, see Fig. 3).

occurs above the level of the Sainte-Anne Marble which is dolomitized in its lower part.

GERPINNES (Figs 5 and 6)

Twenty six kilometres to the west of Lustin and the Meuse valley, the Lustin Formation is nearly completely exposed in the disused railway section of Gerpinnes (outcrop Nalinnes MC-1975-2) whose Givetian part has already been investigated by COEN-AUBERT (2000 and 2004). The Lustin Formation is much thicker in this locality with 91.5 m of reefal limestones and about 73 m of lagoonal limestones. The log of the lower part of the Lustin Formation has already been figured by COEN-AUBERT (1982, fig. 2).

The Nismes Formation is represented by 18 m of shales with thin intercalations of argillaceous or crinoidal limestones only at its top. In continuity, the Lustin Formation starts with 1.7 m of argillaceous limestones first with crinoids and brachiopods, then very rich in corals: alveolitids, thamnoporids and numerous specimens of *Macgeea rozkowskae* and *Disphyllum hilli*. The same corals are present at the base of the Sainte-Anne Marble together with the first corallites of *D. rugosum*. This massive level is 29 m thick; it shows some laminar stromatoporoids in its middle part and it is completely dolomitized in its upper part. The Sainte-Anne Marble is capped by 7.5 m of fine and dark, bedded limestones where a few corals are sparse. Then appear 3 m of argillaceous limestones with remarkable thickets of *D. preslense* and *D. rugosum*. Fasciculate rugose corals are still rather common in the following 4.4 m succeeded by 14 m of limestones which contain massive stromatoporoids accompanied by a few tabulate corals and dendroid stromatoporoids. After 2.7 m of argillaceous limestones with scattered corals occurs a second level of massive and light coloured limestone characterized by massive stromatoporoids sparse to more numerous close to its top and associated with a few corals; its thickness is 13 m. Above a gap of 3 m, there are 1.2 m of argillaceous limestones including some fragments of *Hexagonaria mirabilis* and overlain by 2.4 m of shales with some nodules. The reefal limestones of the Lustin Formation end with 10 m rather rich in laminar and massive stromatoporoids; in their lower part, there are also corals represented by massive and ramose alveolitids as well as by colonies of *H. mirabilis*.

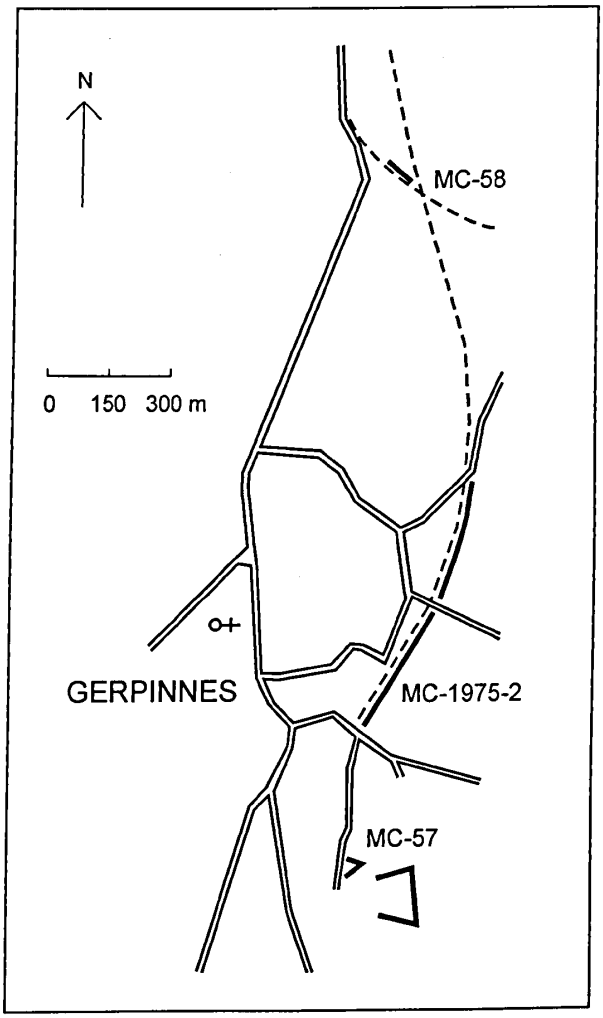

Fig. 6 – Location of the three outcrops investigated at Gerpinnes.

Part of this succession with some facies variations is exposed along another disused railway section lying to the north of Gerpinnes and corresponding to the outcrop Nalinnes MC-58. Indeed, the top of the Sainte-Anne Marble is overlain by 20.5 m of dark and fine limestones often rich in dendroid stromatoporoids accompanied by some rugose and tabulate corals. Then, the marker level with *D. preslense* and rather rare *D. rugosum* is 4.25 m thick and shows colonies in growth position, surrounded by corallites broken in various directions or oriented along the stratification. The following sequence below the second level of massive limestone has a thickness of 16.5 m and contains different reef building organisms including again rather abundant dendroid stromatoporoids.

Finally, several beautiful specimens of *D. preslense* characterizing the same marker level have been collected at the northern end of the disused Evrard quarry located to the south of Gerpinnes and corresponding to the outcrop Nalinnes MC-57. A complete section of this exposure has been illustrated by DELCAMBRE & PINGOT (2000, fig. 29). The reefal limestones of this locality corresponding to the lower part of the Lustin Formation have been assigned to the Hymiée Member by DELCAMBRE & PINGOT (2000). Indeed, they are capped by about 8 m of shales and nodular limestones containing some massive and ramose tabulate corals as well as some massive and solitary rugose corals represented by *Sinodisphyllum kielcense*, *Tabulophyllum mcconnelli* and *Hexagonaria mirabilis*. The same corals are present in the succeeding nodular limestones below the Philippeville Formation. So as stated by DELCAMBRE & PINGOT (2000), the transition from the Lustin Formation to the Pont de la Folle and Philippeville Formation is observed to the south of Gerpinnes.

OTHER LOCALITIES ON THE NORTH SIDE OF THE DINANT SYNCLINORIUM

Six kilometres to the east of Gerpinnes, *Disphyllum hilli* has been found together with *Macgeea rozkowskae* and *M. multizonata* (REED, 1922) at the base of the Lustin Formation from two disused quarries of Biesme (Biesme MC-1976-1 and 2). The logs of these two exposures have been figured by COEN-AUBERT (1982, fig. 2). A complete section of the second one has also been investigated by COEN-AUBERT *in* DELCAMBRE & PINGOT (2004, figs. 11 and 12).

To the south of Gerpinnes, *Disphyllum rugosum* occurs in Somzée and Laneffe, at the top of the Machenées Member from the Pont de la Folle Formation where it is associated with *Tabulophyllum mcconnelli*, *Hexagonaria mirabilis* and rare specimens of *Peneckiella discreta*. The first outcrop (Nalinnes MC-1977-3) mentioned by DELCAMBRE & PINGOT (2000, p. 39) is situated along the road Charleroi-Philippeville, to the south of the intersection of Somzée. The second one (Walcourt MC 1977-2) studied by DUMOULIN & MARION (1997, p. 18 and fig. 7) lies along the road N978 from Somzée to Chastres, south of the place named Pont du Diable.

In the western part from the north side of the Dinant Synclinorium, *Disphyllum rugosum* has also been observed in the Fontaine Samart Member of the Pont de la Folle Formation, about 24 m above the level of the Sainte-Anne Marble excavated by the active Thure quarry (Merbes-le-Château MC-1978-16). This exposure is located 2.5 km to the south of Solre-sur-Sambre, along the road to Bersilies-l'Abbaye, close to the French border.

To the east of Lustin and the Meuse valley, the Lustin Formation has been investigated between the area of Tilff and Hony in the Ourthe valley and the area of Gesves in the Samson valley. *Disphyllum grabaui* and *D. hilli* are present at the base of the Lustin Formation completely exposed in the outcrop Chênée MC-1974-85 of Tilff (Fig. 5) which corresponds to point 3 described by COEN-AUBERT (1974, p. 105); the bed rich in *Disphyllum* lies in the core of the famous anticline. Higher in this section, *D. preslense* has been found 3.5 m below the limestones with laminar stromatoporoids characteristic of the top of the reefal limestones from the Lustin Formation. *D. preslense* occurs also at the top of the argillaceous level overlying the Sainte-Anne Marble in Hony and Vierset-Barse. The first locality (Esneux MC-1974-88) corresponds to point 5 studied by COEN-AUBERT (1974, p. 109); the second one (Huy MC-1974-104) corresponds to point Huy 146W/173 surveyed by COEN-AUBERT (1973, p. 5). In both localities, the species has been identified as *D. goldfussi* (GEINITZ, 1846) by COEN-AUBERT (1973 and 1974). Finally, *D. preslense* has been observed 6 m below the second level of massive limestone from the Lustin Formation, in the disused quarries of Les Forges (Gesves MC-1978-6) which is a place situated at Gesves, in the Samson valley, along the road to Faux-les-Tombes.

VESDRE MASSIF

Disphyllum grabaui occurs at the base of the Nismes Formation in the borehole Membach 3 investigated by COEN-AUBERT *et al.* (1986) and in the outcrop Limbourg MC-1974-32 which corresponds to point 8 of Goé mentioned by COEN-AUBERT (1974, fig. 18). The species is also present at the base of the Lustin Formation, in the borehole Membach 3 and in section 1 of Trooz (Fléron MC-1974-4) described by COEN-AUBERT (1974, fig. 10). *D. hilli* has been found at the base of the Lustin Formation, in one exposure of the locality Les Surdents situated to the east of Verviers (Limbourg MC-1974-43) which corresponds to point 9 of COEN-AUBERT (1974, fig. 17).

NAMUR SYNCLINORIUM

On the south side of the Namur Synclinorium, there is a nearly complete section of the Frasnian at Presles, along the road Namur-Charleroi. This is the type locality for the Presles Formation introduced by COEN-AUBERT *et al.* (1986, p. 8) and revised by BOULVAIN *et al.* (1999, p. 83). The Lustin Formation has been described by COEN (1976, p. 70) at Presles where the succession of the reefal limestones characteristic of its lower part (Fig. 5) is more or less similar to that of Lustin. Beautiful colonies of *Disphyllum preslense* with a few corallites of *D. rugosum* occur above the argillaceous limestones overlying the Sainte-Anne Marble. As it is the case in Tailfer, *Wapitiphyllum tenue* is present below the second level of massive limestone. At the top of the reefal limestones from the Lustin Formation appear first *Hexagonaria mirabilis* and then *Argutastrea konincki* (ROEMER, 1855) which is normally typical of the lagoonal limestones from its upper part. However, the thickness of these lagoonal limestones is only 23 m at Presles and is much more reduced than at Tailfer and Lustin.

A few colonies of fasciculate rugose corals identified in this paper come from the Wépion borehole investigated by GRAULICH (1961) and COEN-AUBERT (1988). In fact, the Frasnian has been intersected twice in this drillhole. In its upper part, only the Presles Formation and the base of the Lustin Formation are observed below a fault, between 698.9 and 711.9 m; this sequence belongs to the south side of the Namur Synclinorium. In the bottom of the borehole, the situation is very different. The Frasnian is much thicker and characterized between 2156.25 m and 1984.5 m by the succession in ascending order of the Presles Formation, the local Su Wary and La Marlagne Formations and finally the Aisemont Formation. *Disphyllum grabaui* has been found at 2155.95 m, at the base of the Presles Formation. The Su Wary Formation intersected between 2139.1 m and 2069.2 m is 67.5 m thick and is represented by an alternation of shales and limestones often argillaceous and containing occasionally diverse stromatoporoids and corals; among them, *D. rugosum* is present at 2124.20 m and *Peneckiella discreta* at 2095.55 m. The overlying La Marlagne Formation consists mainly of dolomites.

On the north side of the Namur Synclinorium, several beds rich in fasciculate rugose corals occur at Huccorgne, in the lower part of the Bovesse Formation, which was well exposed in the outcrop Braives MC-1979-1 corresponding

to point 1 described by COEN-AUBERT & LACROIX (1985, fig. 2). The Bovesse Formation has also been revised by BOULVAIN *et al.* (1999, p. 101); but contrary to this paper, I prefer to exclude from it the terrigenous deposits overlying the Silurian. In fact, the Bovesse Formation consists of an alternation of dolomites, limestones and shales. In the outcrop Braives MC-1979-1 (Fig. 7), 6.5 m of dolomites are capped by 0.85 m of limestones and dolomites with numerous laminar stromatoporoids, tabulate and rugose corals including *Macgeea rozkowskae*, *Peneckiella discreta*, *Disphyllum rugosum* and *D. preslense*. After 4.7 m of dark and fine limestones with a few corals, there are 2 m of black and argillaceous limestones with two beds consisting of beautiful colonies of *Disphyllum* at the base and at the top; one corallum of *Macgeea socialis* has been found in this unit. The following 6.3 m are composed again of fine and dark limestones with some corals. *Disphyllum preslense* and *D. rugosum* are present in these three last levels, which are repeated twice by faults and overlain by shales. The top of these shales is observed in the outcrop Braives MC-1979-5 corresponding to point 3 of COEN-AUBERT & LACROIX (1985) where the upper part of the Bovesse Formation consists of a second level of dolomites capped by a second level of shales. The succeeding Huccorgne Formation starts with bioclastic and coralliferous limestones showing a different rugose coral fauna with *Hexagonaria mirabilis*, *Tabulophyllum mcconnelli*, *Wapitiphyllum irregulare* (KONG, 1978) and *W. mahaniense* COEN-AUBERT, 1987. One specimen of *Disphyllum rugosum* comes from the outcrop Braives MC-1979-6 corresponding to point 2 of COEN-AUBERT & LACROIX (1985) and exposing partly the lower part of the Bovesse Formation.

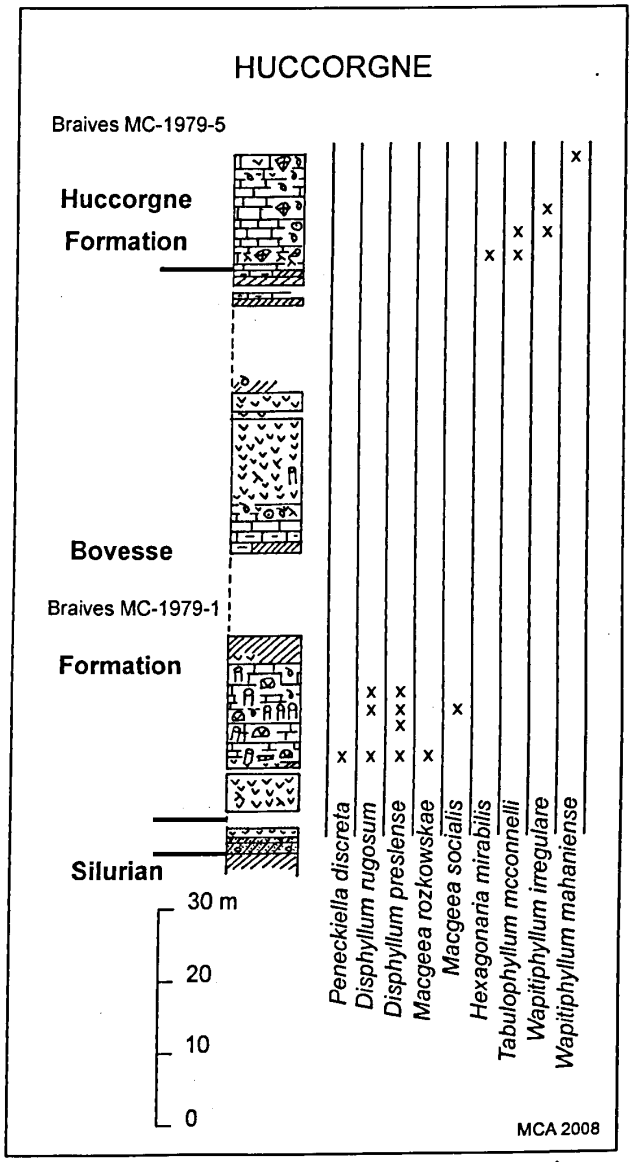

Fig. 7 — Schematic log of the Bovesse Formation at Huccorgne with the distribution of the rugose corals. (For explanation of conventional signs, see Fig. 3).

Stratigraphic distribution of the rugose corals

On the south side of the Dinant Synclinorium (Fig. 8), *Disphyllum grabaui* has been found very locally in the Nismes Formation, at Givet and Han-sur-Lesse. *D. grabaui*, *D. hilli* and *Macgeea rozkowskae* are very abundant in the Chalon Member of the Moulin Liénaux Formation which serves as basement for the reefal mounds of the Arche Member at Frasnes and Rochefort. There are also numerous specimens of the two latter species at the base of the Arche Member. In the La Boverie Member, the situation is changing as the rugose coral fauna is becoming more diversified. Solitary coralla of *M. boveriensis*, *M. socialis* and *Sinodisphyllum posterum* are present at the base of this lithostratigraphic unit together with a few colonies of *Disphyllum rugosum*, *D. preslense* and *Peneckiella discreta*. *Hexagonaria mirabilis* appears rather low in the member. Accumulations of thickets of *Peneckiella discreta* are locally much developed in the La Boverie quarries, just below the small mound, which characterizes the top of the La Boverie Member. In the Bieumont Member of the Grand Breux Formation, *Hexagonaria mirabilis* is associated with various taxa mentioned by BOULVAIN & COEN-AUBERT (2006, p. 40) such as *Tabulophyllum mcconnelli*, *Sinodisphyllum kielcense*, *Aristophyllum irenae* and *Macgeea socialis*. Several of these species still occur in the lower part of the Lion Member and at the base of the overlying Boussu-en-Fagne Member.

In the northwestern part of the Philippeville Massif, the Moulin Liénaux and Grand Breux Formations pass laterally into the Pont de la Folle and Philippeville

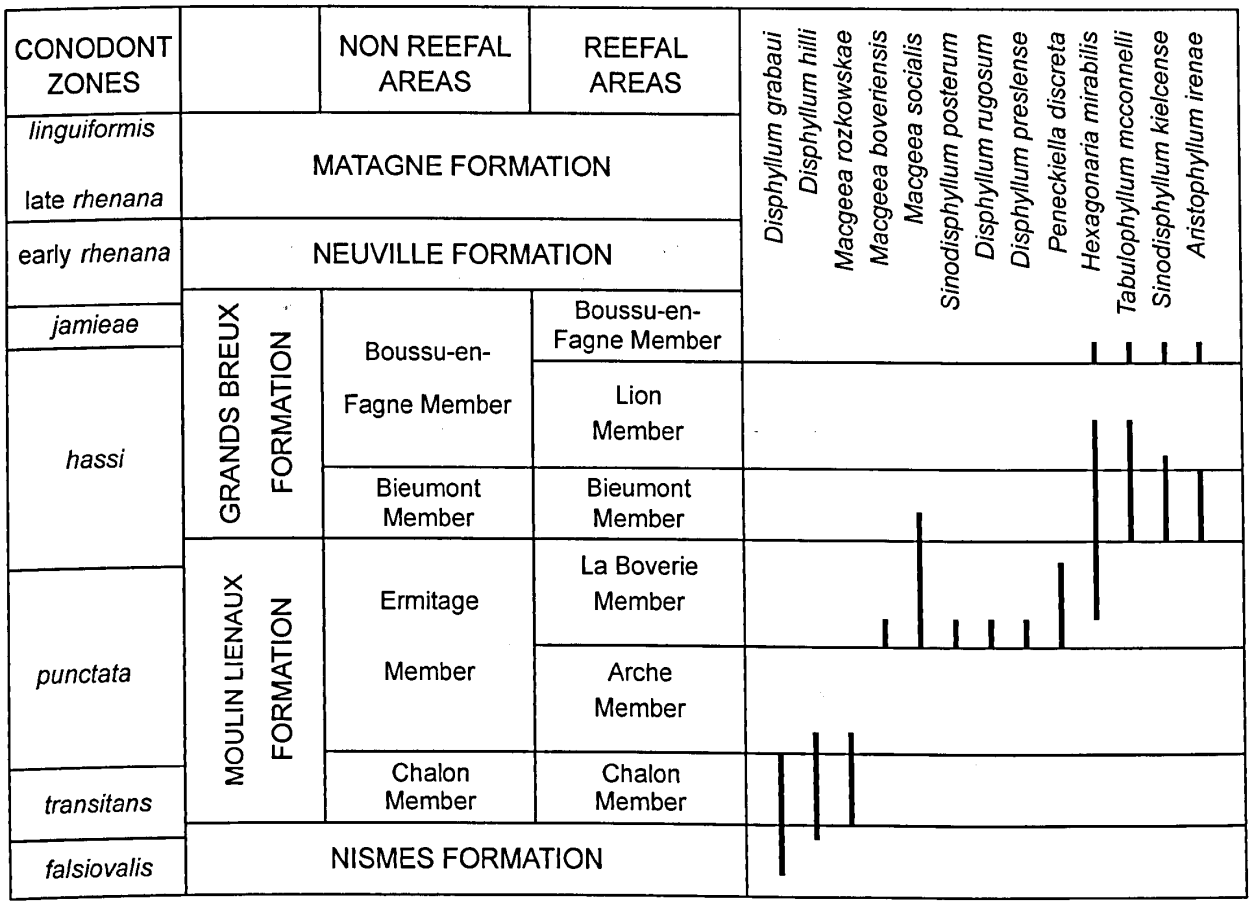

Fig. 8 — Lithostratigraphic units, conodont Zones and stratigraphic distribution of the rugose coral species mentioned herein in the Frasnian from the south side of the Dinant Synclinorium.

Formations. These two lithostratigraphic units characterize all the northwestern part of the Dinant Synclinorium, that is to say even its north side between the French border and Gerpinnes (Fig. 9). *M. rozkowskae* and *M. multizonata* have been found by COEN-AUBERT (1982, p. 6), at the top of the Nismes Formation from the section of Philippeville. These two taxa have also been collected by the author at the base of the Pont de la Folle Formation, just below the Sainte-Anne Marble exposed in the Thure quarry lying to the south of Solre-sur-Sambre. When this level of massive limestone is completely dolomitized, it constitutes the Brayelles Member. *Disphyllum preslense* occurs throughout the overlying Fontaine Samart Member and it is still present at the base of the Machenées Member. Moreover, it is accompanied by *D. rugosum* and *Peneckiella discreta* in the lower part of the Fontaine Samart Member, by *Wapitiphyllum tenue* in its middle part and by *Hexagonaria mirabilis* in its upper part. *H. mirabilis* and *Tabulophyllum mcconnelli* are frequent in the Machenées Member and in the lower part of the Philippeville Formation. They are locally associated with *Disphyllum rugosum*, *Peneckiella discreta* and *Sinodisphyllum kielcense* at the top of the Machenées Member. Finally, it must be mentioned that *Argutastrea konincki* is the typical species for the upper part of the Philippeville Formation whereas *Tabulophyllum mcconnelli*, *Sinodisphyllum kielcense* and *Aristophyllum irenae* are also observed at the very base of the Neuville Formation.

The lateral transition from the Pont de la Folle and Philippeville Formations to the Lustin Formation has been recognized in the area of Gerpinnes by DELCAMBRE & PINGOT (2000). So the Lustin Formation is exposed on the north side of the Dinant Synclinorium between Gerpinnes and Tilff, on the south side of the Namur Synclinorium and in the Vesdre Massif (Fig. 9). *Disphyllum grabaui* is locally present at the base of the Nismes Formation, in the Vesdre Massif. *D. grabaui*, *D. hilli*, *Macgeea rozkowskae* and *M. multizonata*

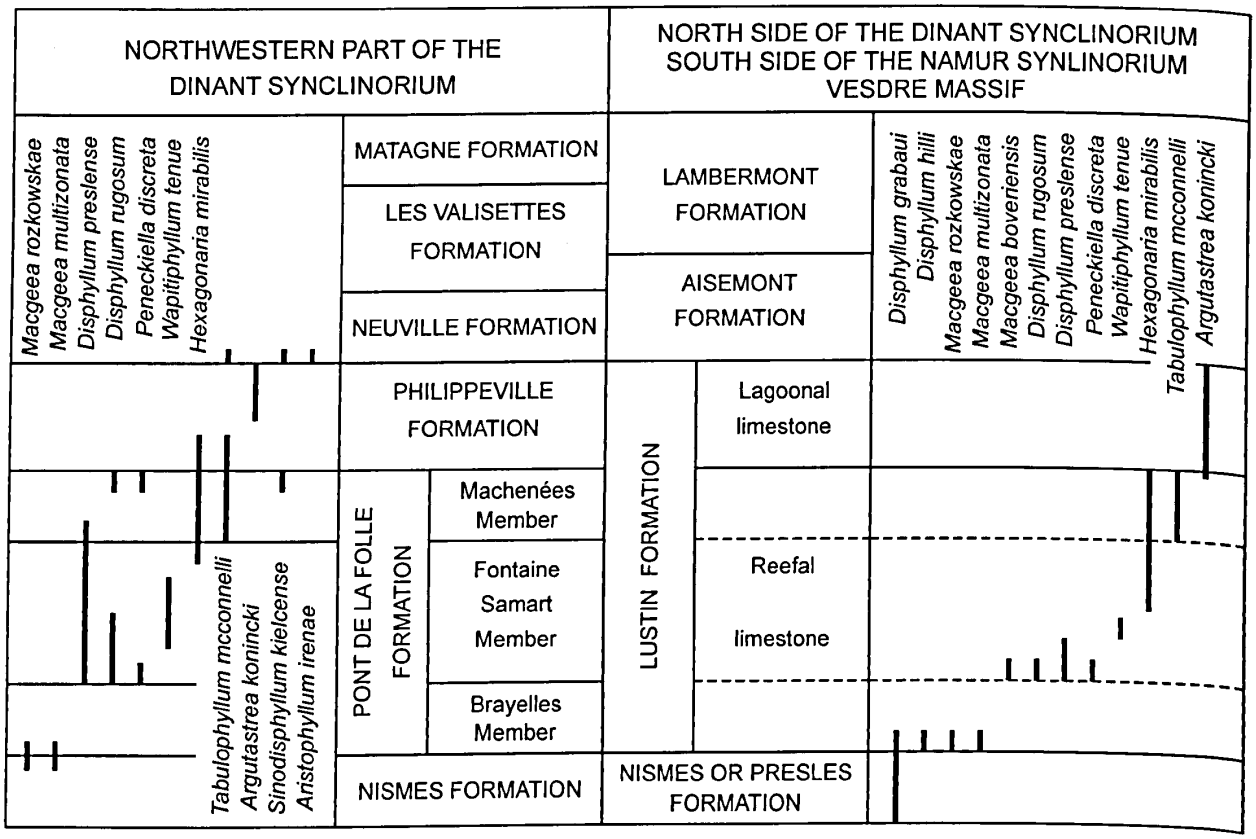

Fig. 9 — Lithostratigraphic units and stratigraphic distribution of the rugose coral species mentioned herein in the Frasnian from the northwestern part of the Dinant Synclinorium as well as from the north side of the same structural area, the south side of the Namur Synclinorium and the Vesdre Massif.

are frequent at the base of the Lustin Formation from several localities. At Gerpinnes, a few specimens of *Disphyllum rugosum* have been found rather low in the Lustin Formation. *D. preslense* is abundant in the coralliferous beds overlying the Sainte-Anne Marble; it is normally accompanied by *D. rugosum* and rarely by *Macgeea boveriensis* and *Peneckiella discreta*. Below the second level of massive limestone from the Lustin Formation appear first *Wapitiphyllum tenue* and then *Hexagonaria mirabilis*. *H. mirabilis* and *Tabulophyllum mcconnelli* are often observed in the bedded limestones with laminar stromatoporoids occurring at the top of the reefal limestones from the Lustin Formation. *Argutastrea koninckl* characterizes mainly the lagoonal limestones which constitute the upper part of the Lustin Formation.

On the north side of the Namur Synclinorium, only the section of Huccorgne has been investigated. *Disphyllum preslense* and *D. rugosum* are very well represented in the different coralliferous beds which succeed to the first level of dolomites present in the Bovesse Formation. They are accompanied by *Peneckiella discreta* at the base and by a few specimens of *M. rozkowskae* and *M. socialis*. *Hexagonaria mirabilis* and *Tabulophyllum mcconnelli* have been found at the base of the overlying Huccorgne Formation; they are quickly followed by a particular fauna composed of *Wapitiphyllum irregulare* and *W. mahaniense*.

The Frasnian intersected in the bottom of the Wépion borehole belongs probably to the central part of the Namur Synclinorium. The fasciculate rugose corals identified herein are the first biostratigraphic data to date these unusual deposits not known as outcrops. *Disphyllum grabaui* occurs at the base of the Presles Formation characteristic of the base of the stage whereas *D. rugosum* and *Peneckiella discreta* have been observed locally in the middle part of the overlying Su Wary Formation.

Regional correlations

As a general conclusion of this study, it appears that the rugose coral fauna is restricted to the genera *Disphyllum* and *Macgeea* WEBSTER, 1889 at the beginning of the Frasnian and that it becomes progressively more diversified higher in the stage. Moreover, three marker levels based on rugose corals result from these investigations at the Early-Middle Frasnian transition, in various areas of Belgium and allow precise stratigraphic correlations between them.

Firstly, *Disphyllum hilli*, *D. grabaui* and *Macgeea rozkowskae* are abundant in the Chalon Member and at the base of the Arche Member on the south side of the Dinant Synclinorium as well as at the base of the Lustin Formation on the north side of the same structural unit. Secondly, *Disphyllum preslense* and *D. rugosum* are widely distributed above the first level of dolomites from the Bovesse Formation on the north side of the Namur Synclinorium, above the Sainte-Anne Marble of the Lustin Formation on the north side of the Dinant Synclinorium and the south side of the Namur Synclinorium and above the Brayelles Member of the Pont de la Folle Formation in the northwestern part of the Dinant Synclinorium; these two species are also present sparsely above the Arche Member on the south side of the Dinant Synclinorium. Thirdly, *Hexagonaria mirabilis* and *Tabulophyllum mcconnelli* are frequently associated in the Bieumont Member on the south side of the Dinant Synclinorium, in the Machenées Member from the northwestern part of the same structural unit, at the top of the reefal limestones from the Lustin Formation on the north side of the Dinant Synclinorium and finally at the base of the Huccorgne Formation on the north side of the Namur Synclinorium. This third occurrence confirms an important correlation emphasized by GOUWY & BULTYNCK (2000, p. 33). Indeed, according to these authors, the base of the Bieumont Member is older than the base of the Philippeville Formation in the northwestern part of the Dinant Synclinorium and the base of the lagoonal limestones from the Lustin Formation. On the contrary, it has about the same age as the base of the Huccorgne Formation on the north side of the Namur Synclinorium.

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 globose 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 hilli TSIEN, 1970
Pl. 1, Figs 1-10, Pl. 5, Figs 9-10

* 1970 — *Disphyllum hilli* nov. sp.- TSIEN, p. 174, figs 16-18.
v 1974 — *Disphyllum goldfussi* (GEINITZ) - COEN-AUBERT, pl. 2, figs 4-5.
1975 — *Disphyllum hill* (sic) - TSIEN, fig. 19a.
1977 — *Disphyllum hilli* - TSIEN, figs 5i-k.

Holotype
Figs. 17A and B *in* TSIEN (1970) and figs. 5i and j *in* TSIEN (1977b). Specimen n° 283 and thin sections 283A and B formerly stored in the Laboratory of Palaeontology from the Catholic University of Louvain at Louvain-la-Neuve, Belgium. Arche quarry at Frasnes, south side of the Dinant Synclinorium, Belgium. Chalon Member of the Moulin Liénaux Formation, close to the Early-Middle Frasnian boundary.

Material and localities
One hundred and one specimens with 180 thin sections. Personal sampling: Limbourg MC-1974-43-855; Chênée MC-1974-85-553B, 553F and 553L; Bioul MC-1974-121-L94; Biesme MC-1976-1-6; Biesme MC-1976-2-U12, U14, U15, U16, U17 and U18; Nalinnes MC-1975-2-12, 15, 16, 18, 20, 21, 22, 25, 28, 32, 38, 39, 41, 43, 46, 47, 47A, 54, 55, 58 and 72; Surice MC-40-B751; Couvin MC-1974-97-T661, T667, T6613, T678, T6715, T684, T6811, C525, C535, C536, C537, C539, C540, C542, C575, C577, C578, C584, C585, C589, C590, C796 and C813; Rochefort MC-53-C102, C103, C104A, C104B, C104C, C104D, C104E, C104F, C104G, C104I, C104J, C104L, C105F, C105H, C105I, C105J, C105L, C107, C108, C205, C207, C208, C209, C210, C211, C213, C214, C215,

C216, C217, C218, C219, C235, C236, C237 and C238; Rochefort MC-54-C128. Old collection from the Institut royal des Sciences naturelles de Belgique: Couvin 6149a-F2c-13591 and 13598; Couvin 6149b-F2c-13427, 13428, 13444, 13455 and 13493 (Couvin 6149a and b= Couvin MC-1974-97).

Diagnosis

A species of *Disphyllum* with 40 to 50 septa at a diameter of 7 to 14 mm. Septa dilated in the dissepimentarium and typically thinning a long way beyond their entry into the tabularium. Major and minor septa more or less long. Tabulae often compound with flat-topped parts.

Description

The material consists of fragments of big fasciculate colonies whose largest piece has an area of 17 cm x 25 cm and a height of 15 cm; however, one colony has a length of 60 cm and a height of 30 cm. There are also numerous cylindrical corallites which are sometimes twisted, conical, trochoid or ceratoid. Their height varies between 1 cm and 4.5 cm or even 6.5 cm. Longitudinal ribs and growth lines are occasionally present. The outer wall is more or less well preserved. It may be characterized by a dark median line when the cylindrical corallites are in lateral contact. In a few specimens, the outer wall is locally encrusted by thin laminar stromatoporoids, alveolitids, auloporids or fistuliporids. Several lateral offsets have been observed.

The septa are more or less carinate and bear spinose, knobbly and rarely yardarm carinae; some specimens are nearly devoid of these carinae. The septa are dilated in the dissepimentarium and become thin a long way beyond their entry into the tabularium. In a few corallites, they are less thick or they remain dilated in the tabularium; in other ones, they are sometimes slender or even discontinuous at the periphery. In several samples, a stereoplasmic thickening is locally present on an inner layer of dissepiments or between the septa, in the inner dissepimentarium; in rare corallites, a more or less complete inner wall occurs at the border of the tabularium. In very few colonies also, the septa are occasionally contiguous or the deposit of stereoplasma between them is more abundant.

The major septa leave a more or less extensive open space in the centre of the tabularium or reach the axis of the corallites. Sometimes, their axial ends are rhopaloid, wavy, curved, twisted, divided into isolated fragments or fusing to form pseudofossulae. The minor septa are usually long, traversing all or nearly all the dissepimentarium or even entering into the tabularium where they may be contratingent. But they are occasionally less developed, especially in the colonies coming from the base of the bioherms of the Arche Member in the Moulin Liénaux Formation; in that case, they may be shorter, reduced to spines, lacking or discontinuous particularly at their inner ends.

The dissepimentarium consists of 2 to 6 or even 1 to 7 rows of globose dissepiments which are in horizontal layers in its outer part and inclined in its inner part; in rare specimens, a few more or less peneckielloid dissepiments occur at the periphery. The tabulae are frequently compound with broad flat-topped axial parts; they are also incomplete and intersecting laterally.

There are 38 to 52 septa per corallite. The diameter of the corallites ranges from 5.5 mm to 16 mm. The width of the tabularium varies commonly between 4.5 mm and 8.5 mm and more generally between 2.3 mm and 10.5 mm.

Discussion

Disphyllum hilli is widespread in various areas of Belgium, close to the Early-Middle Frasnian boundary. The species is highly characteristic due to its major septa thinning a long way beyond their entry into the tabularium and its mesa-shaped tabulae. It shows also a wide variability concerning as well the dilation and the carination of the septa in the dissepimentarium, the length of the minor septa and the local occurrence of some stereoplasmic thickenings. The colony of the Vesdre Massif figured by COEN-AUBERT (1974) has been wrongly assigned to *D. goldfussi*, a taxon discussed below, in comparison with *D. preslense*.

The corallite identified by TSIEN (1970, fig. 10) as *D. rugosum* and collected in the Arche quarry of Frasnes, at the base of the Arche Member of the Moulin Liénaux Formation, belongs very likely to *D. hilli*. This is also the case for the sample referred to *D. rugosum* by ROHART (1988, pl. 30, fig. 5), which comes from the Noces Member of the Frasnian Beaulieu Formation in the Boulonnais, France. In both of these occurrences, the septa become thinner well beyond their entry into the tabularium, which is a rather rare feature among the species of the genus *Disphyllum*. It is more or less present in the specimen illustrated by BIRENHEIDE (1990, p. 264 and pl. 3, fig. 9) as *D.* sp. aff. *caespitosum* (GOLDFUSS, 1826) and recorded according to this author close to the Givetian-Frasnian boundary, in the quarry "Schmalzgrube" of Bergisch Gladbach in the Bergisches Land, Germany. However, the same outcrop was recently reported to the Frasnian *Palmatolepis punctata* conodont Zone by SCHRÖDER (2005, p. 57). As for *D. caespitosum*, it is the genotype of *Disphyllum*

and it was described by COEN-AUBERT (2008) in the Early Givetian Trois-Fontaines Formation from the south side of the Dinant Synclinorium. It is mainly distinguished from *D.hilli* by the weaker dilation of the septa restricted to the dissepimentarium.

D. jiangzhaiense (KONG, 1978) from the Givetian of the Guizhou Province in China resembles the more carinate forms of *D. hilli*, but differs from them by vesicular tabulae. It was chosen as type species of the genus *Pseudodisphyllum* KONG, 1978 by KONG & HUANG (1978, p. 79). *Pseudodisphyllum* is probably a synonym of *Disphyllum* according to HILL (1981, p. F264) whereas it is considered as a subgenus of *Disphyllum* by BIRENHEIDE (1990) and ZHEN (1995, p. 222).

Geographic and stratigraphic occurrence

The species is only known in different areas of Belgium, close to the Early-Middle Frasnian boundary. In fact, the material collected by the author comes from:

- the base of the Lustin Formation at Les Surdents, in the Vesdre Massif as well as at Tilff, Annevoie-Rouillon, Biesme and Gerpinnes, on the north side of the Dinant Synclinorium:
- the lower part of the Arche Member from the Moulin Liénaux Formation at Vodelée, in the Philippeville Massif;
- the Chalon Member and the base of the Arche Member from the Moulin Liénaux Formation and rarely the top of the Nismes Formation, at Frasnes and Rochefort, on the south side of the Dinant Synclinorium.

Disphyllum grabaui TSIEN, 1970
Pl. 2, Figs 1-10

v * 1970 — *Disphyllum grabaui* nov. sp.- TSIEN, p. 177, figs 20A-C.
1975 — *Disphyllum grabaui* - TSIEN, fig. 19b.
v 1977 — *Disphyllum grabaui* - TSIEN, figs 5a-e.
v ? 1988 — *Disphyllum grabaui* Tsien 1970 - ROHART, p. 257, pl. 30, fig. 8.

Holotype

Fig. 20B *in* TSIEN (1970) and figs. 5b-d *in* TSIEN (1977b). Specimen n° 285 and thin sections 285A-C formerly stored in the Laboratory of Palaeontology from the Catholic University of Louvain at Louvain-la-Neuve, Belgium. Arche quarry at Frasnes, south side of the Dinant Synclinorium, Belgium. Chalon Member or base of the Arche Member from the Moulin Liénaux Formation, close to the Early-Middle Frasnian boundary.

Material and localities

Forty-six specimens with 94 thin sections. Personal sampling with that of M. Coen and J.M. Graulich: Malonne Wépion borehole at 2155.95 m; Limbourg Membach 3 borehole at 63.8 m and 70.7 m; Limbourg MC-1974-32-L48 and L49; Fléron MC-1974-4-104 and 105; Chênée MC-1974-85-553A, 553C, 553D, 553E, 553G, 553H, 553I, 553K, 553N and 556; Surice MC-40-B750; Couvin MC-1974-97-C570, C576 and C579; Agimont MC-1983-7-Z803; Han-sur-Lesse K2-1, 2, 3, 4, 5, 6, 8, 9, 10 and 11; Rochefort MC-53-C87, C95, C96, C97, C98, C99, C100, C101, C104K, C105E, C105G and C206. Old collection from the Institut royal des Sciences naturelles de Belgique: Couvin 6149b (= Couvin MC-1974-97)-F2c-13472 and 13483.

Diagnosis

A species of *Disphyllum* with 40 to 48 septa at a diameter of 6.5 mm to 14 mm. Septa slightly dilated in the dissepimentarium. Major septa often leaving an open space in the centre of the tabularium. Minor septa variable in length. Tabulae incomplete, rather frequently with flat-topped or concave axial parts.

Description

The material consists of cylindrical corallites, which may be curved and rarely conical at the tip. Their height varies between 1.5 cm and 7 cm, but reaches 12 cm to 18 cm in one sample. Longitudinal ribs and growth lines are sometimes present. There are also fragments of fasciculate colonies; the largest piece has an area of 14 cm x 8 cm and a height of 9 cm. In one specimen, the excavated calices are bordered by steep sides. The outer wall is not often well preserved. It is characterized by a dark median line when the cylindrical corallites are locally in contact. In a few colonies, the outer wall is occasionally encrusted by laminar stromatoporoids, alveolitids, fistuliporids or algae. Several laeral offsets have been observed.

The septa are non-carinate or bear a few poor carinae. They are faintly dilated in the dissepimentarium and become thin in the tabularium or slightly beyond their entry into it. In some corallites, the septa are rather slender in the dissepimentarium or at the periphery whereas in a few other ones, there is locally a deposit of stereoplasma on an inner layer of dissepiments.

The major septa leave a more or less extensive open space in the centre of the tabularium; sometimes, they nearly reach the axis of the corallites. In rare colonies, their axial ends are wavy, divided into isolated fragments or fusing to form pseudofossulae. The minor septa are highly variable in length, traversing all, nearly all or

half the dissepimentarium or even entering into the tabularium where they are occasionally contratingent. They may also be shorter, reduced to spines, lacking or discontinuous at their inner ends.

The dissepimentarium consists of 2 to 5 or even 1 to 6 rows of globose dissepiments, which are in horizontal layers in its outer part and inclined in its inner part. The tabulae are incomplete and intersecting laterally; their axial parts are rather often flat-topped or more or less deeply concave. Some horizontal and concave tabulae are also present.

There are 36 to 50 septa per corallite. The diameter of the corallites ranges from 5.3 mm to 17 mm. The width of the tabularium varies commonly between 4 mm and 9 mm and more generally between 3.5 mm and 10.5 mm.

Discussion

The Belgian material investigated herein shows some variability at the level of the septal thickening : from septa faintly dilated in the dissepimentarium to septa rather slender. The latter alternative is more characteristic of the specimens figured by TSIEN (1970, 1975 and 1977b). It occurs also in the corallite illustrated by ROHART (1988), which has additionally more numerous dissepiments. *Disphyllum grabaui* is easily distinguished from *D. hilli* by the weaker dilation of the septa restricted to the dissepimentarium, by rather rare carinae and by a more variable tabularium.

The affinities of *D. grabaui* with other species of the genus *Disphyllum* are not very clear. There are some similarities with *D. pashiense* (SOSHKINA, 1939) which comes from the Frasnian of the Urals in Russia and which is the type species of *Megaphyllum* SOSHKINA, 1939 regarded as a synonym of *Disphyllum* according among others to HILL (1981, p. F264). However, *D. pashiense* is separated from *D. grabaui* by very thin septa and by slightly larger corallites with more septa. *D. curtum* HILL, 1954 from the Frasnian of the Canning Basin in Western Australia, which has been redescribed by HILL & JELL (1970, p. 42), resembles *D. grabaui*, but has minor septa traversing systematically the entire dissepimentarium.

Geographic and stratigraphic occurrence

The material collected by the author, M. Coen and J.M. Graulich occurs rather low in the Frasnian from various areas of Belgium and locally of France. In fact, the species is present:

- at the base of the Presles Formation intersected in the bottom of the Wépion borehole located in the Namur Synclinorium;
- at the base of the Nismes and Lustin Formations at Membach, Goé and Trooz in the Vesdre Massif as well as at Tilff, on the north side of the Dinant Synclinorium;
- in the lower part of the Arche Member from the Moulin Liénaux Formation at Vodelée in the Philippeville Massif;
- in the Nismes Formation and the Chalon Member from the Moulin Liénaux Formation at Frasnes, Givet (France), Han-sur-Lesse and Rochefort, on the south side of the Dinant Synclinorium.

Outside Belgium and Givet in France, *Disphyllum grabaui* is possibly known in the Bois Member of the Ferques Formation belonging to the Middle Frasnian of the Boulonnais in France.

Disphyllum rugosum (WEDEKIND, 1922)
Pl. 3, Figs 3-11

* 1922 — *Schlüteria rugosa* Wdkd - WEDEKIND, p. 5, figs 3-4.
p. 1941 — *Schlüteria rugosa* Wedekind - BULVANKER, p. 134, pl. 1, figs. 4-5 (non fig. 1, pl. 1, figs 1-3).
non 1961 — *Disphyllum rugosum* (Wedekind 1922) - SEMENOFF-TIAN-CHANSKY, p. 297, texte-pl. 1, figs 9-11.
v *non* 1970 — *Disphyllum rugosum* (Wedekind), 1922 - TSIEN, p. 169, figs 9-10.
v *non* 1977 — *Disphyllum rugosum* - TSIEN, figs 5f-h.
v p. 1985 — *Disphyllum kostetskae* (Soshkina, E.D., 1949) - COEN-AUBERT & LACROIX, pp. 118, 124, fig. 6.
non 1988 — *Disphyllum rugosum* (Wedekind 1922) - ROHART, p. 252, pl. 30, figs 4-5.
2005 — *Disphyllum rugosum* (Wedekind, 1922) - SCHRÖDER, p. 92, pl. 14, figs 3-4.

Lectotype

Figs. 3-4 *in* WEDEKIND (1922) and pl. 1, figs. 4-5 *in* BULVANKER (1941), chosen by BULVANKER (1941) according to ROHART (1988). Specimen of the Wedekind collection stored in the Forschungsinstitut Senckenberg at Frankfurt am Main, Germany. Probably Frasnian of Refrath in the Bergisches Land, Germany.

Material and localities

Fifty-nine specimens with 98 thin sections. Personal sampling with that of D. Lacroix and J.M. Graulich: Braives MC-1979-1-W531, W5411, W5416, W5417, W552, W561, W791, W793, W798, W802, W806, W831, W833, W835, W841, W842, W843, W844, 1.20 and 1.21; Braives MC-1979-6-W962; Malonne Wépion borehole at 2124.2 m-18203 and 18204; Tamines MC-1975-1-23B; Naninne MC-1974-115-R10A, C6847, C702, and C705I; Nalinnes MC-1975-

2-44, 45, 63B, 63C, 63D, 63E, 63F and 63G; Nalinnes MC-58-C344 and C371; Nalinnes MC-1977-3-V721, V722, V73T, V73W, V73Z, V73AD, V73AF, V73AI, V73AK, V73AN and V73AO; Walcourt MC-1977-2-V602 and V618; Merbes-le-Château MC-1978-16-D752 and D753; Beaumont Bo1 borehole of Barbençon at 155 m and 159.5 m; Gandrieu Reugnies R1 borehole in France at 76 m; Couvin FR2 borehole in the Nord quarry of Frasnes at 70.8 m; Rochefort MC-56-C264 and C288.

Diagnosis

A species of *Disphyllum* with 42 to 52 septa at a diameter of 7 mm to 13 mm. Septa carinate and dilated in the dissepimentarium, thin in the tabularium. Major and minor septa rather long. Tabulae incomplete, frequently with flat-topped axial parts.

Description

The material consists of cylindrical corallites which may be twisted and are rarely conical or ceratoid. Their height varies between 1 cm and 7 cm whereas longitudinal ribs and growth lines are occasionally present. There are also fragments of fasciculate colonies; the largest piece reaches a diameter of 12.5 cm. The outer wall is more or less preserved. It is characterized by a dark median line when the cylindrical corallites are locally in contact. A few lateral offsets occur in some samples.

The septa bear small spinose, knobbly and rarely yardarm carinae. They are more or less dilated in the dissepimentarium and become thin in the tabularium or sometimes slightly beyond their entry into it. In a few corallites, the septa are less thick in the tabularium; in other ones, they are slender at the periphery. A deposit of stereoplasma is occasionally present at the inner margin of the dissepimentarium or on an inner layer of dissepiments.

The major septa leave a more or less extensive open space in the centre of the tabularium or reach the axis of the corallites. Sometimes, their axial ends are rhopaloid, wavy, curved, twisted, 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 contratingent or discontinuous. In some cases, they are shorter or divided into segments especially in the inner dissepimentarium.

The dissepimentarium consists of 2 to 6 or even 1 to 7 rows of small globose dissepiments which are in horizontal layers in its outer part and inclined in its inner part. Locally, peripheral dissepiments are more or less peneckielloid in two specimens. The tabulae are incomplete and intersecting laterally; their axial parts are frequently flat-topped and occasionally horizontal or convex. Rare horizontal tabulae are also present.

There are 40 to 54 septa per corallite. The diameter of the corallites ranges from 6 mm to 16.5 mm. The width of the tabularium varies commonly between 4.5 mm and 7.5 mm and more generally between 3.6 mm and 9.8 mm.

Discussion

Disphyllum rugosum is widely distributed in the Frasnian of Belgium and is a very typical species. My sampling is similar to that from the Frasnian of the Bergisches Land in Germany investigated by WEDEKIND (1922) and SCHRÖDER (2005). It differs for various reasons from the Frasnian material of Belgium illustrated by TSIEN (1970 and 1977b):

- the corallite of fig. 10 *in* TSIEN (1970) belongs very likely to *D. hilli* as stated above. In fact, *D. rugosum* is easily distinguished from *D. hilli* by the regular occurrence of carinae, by the dilation of the septa restricted to the dissepimentarium and by minor septa traversing systematically the entire dissepimentarium.
- the corallite of fig. 5f *in* TSIEN (1977b) corresponding to Senzeille 7043-F2i-15879 is identified herein as *Peneckiella szulczewskii* ROZKOWSKA, 1979. This species collected by COEN-AUBERT (1994, p. 41) in the Boussu-en-Fagne Member of the Grand Breux Formation, on the south side of the Dinant Synclinorium, is characterized in transverse section, by smaller corallites with only a few carinae.
- the corallite of fig. 9 *in* TSIEN (1970) and fig. 5g *in* TSIEN (1977b) corresponding to Sautour 6807-F2g-15539 is separated from *Disphyllum rugosum* by rather thin septa without carinae.

Concerning the other references of the synonymy list, one of the specimens figured by ROHART (1988, pl. 30, fig. 5) is probably also a representative of *D. hilli* whereas the other corallite illustrated by this author (Pl. 30, fig. 4) seems to belong to *Disphyllum preslense*. The material of SEMENOFF-TIAN-CHANSKY (1961) collected close to the Givetian-Frasnian boundary, in the north of Algeria, is again excluded from *D. rugosum* as its septa are thinning well beyond their entry into the tabularium. The Russian colonies from an area located to the west of Saint Petersburg and studied by BULVANKER (1941) have nearly no carinae and minor septa of variable length.

Moreover, it must be added that the carinate corallite coming from the middle part of the Lustin Formation at Gerpinnes and identified by TSIEN (1970, fig. 12B) as *D. kostetskae* (SOSHKINA, 1949) can probably be assigned to *D. rugosum*. As for *D. kostetskae* from the Frasnian of the Urals in Russia, it differs from *D.*

rugosum by rather small corallites and septal number and by few carinae. The carinate specimen figured by ROHART (1988, pl. 30, fig. 7) and collected in the Pâtures Member of the Beaulieu Formation in the Boulonnais resembles also *D. rugosum*; however, it was referred to *D. gradatum* TSIEN, 1970 by ROHART (1988). This taxon from the Middle Frasnian from the south side of the Dinant Synclinorium is characterized by corallites of small size devoid of carinae. Finally, SCHRÖDER (2005) considers that *Disphyllum* sp. 2 figured by TSIEN (1970, fig. 23) is probably a synonym of *D. rugosum*. This is quite possible, but the thin section 13210 mentioned by TSIEN (1970) corresponds to a corallite of *D. virgatum* (HINDE, 1890) coming from the top of the Fromelennes Formation in the Vaucelle quarry at Frasnes (Couvin 6150-F1c).

In transverse section, there are some similarities between *D. rugosum* and *Peneckiella fascicularis* (SOSHKINA, 1939) found by COEN-AUBERT (1995, p. 41) in the lower part of the Grand Breux Formation, on the south side of the Dinant Synclinorium and in the lower part of the Philippeville Formation, in the Philippeville Massif. However, the latter species is distinguished from the former by slightly smaller septal number and diameter of corallites, by the strong thickening of the septa in the dissepimentarium and by major septa mostly reaching the centre of the tabularium.

By the carination and the dilation of the septa in the dissepimentarium, *D. yakovlevi* (BULVANKER, 1958) from the Frasnian of the Kuznetsk Basin in Russia and *D. longiseptatum* YOH, 1957 from the Frasnian of the Guizhou Province in China are closely related to *D. rugosum*, but are separated from it by the smaller size of their corallites with less numerous septa. *D. yakovlevi* has been attributed to the genus *Hexagonaria* GÜRICH, 1896 by BULVANKER (1958, p. 183) whereas the holotype of *Disphyllum longiseptatum* has been reillustrated by CHEN (1959, pl. 5, fig. 1). *D. breviseptatum* YOH, 1937 from the Givetian of Guangxi in China is more different in having larger corallites, a stronger carination and a wide open space in the centre of the tabularium.

Geographic and stratigraphic occurrence

The material collected by the author, D. Lacroix and J.M. Graulich occurs in the Middle Frasnian from various areas of Belgium and locally of France. In fact, the species is present:

- in the middle part of the Bovesse Formation at Huccorgne, on the north side of the Namur Synclinorium;
- in the lower part of the Su Wary Formation intersected in the bottom of the Wépion borehole located in the Namur Synclinorium;
- in the middle part and occasionally the lower part of the reefal limestones characteristic of the lower part of the Lustin Formation at Presles, on the south side of the Namur Synclinorium as well as at Lustin and Gerpinnes, on the north side of the Dinant Synclinorium;
- at the top of the Machenées Member from the Pont de la Folle Formation at Somzée and Laneffe, on the north side of the Dinant Synclinorium;
- in the Fontaine Samart Member of the Pont de la Folle Formation at Solre-sur-Sambre, on the north side of the Dinant Synclinorium as well as at Barbençon and Reugnies (France), south of this area;
- at the base of the La Boverie Member from the Moulin Liénaux Formation at Frasnes and Rochefort, on the south side of the Dinant Synclinorium.

Outside Belgium and Reugnies in France, *Disphyllum rugosum* is known only in the Frasnian from the Bergisches Land in Germany; more precisely, the specimens investigated by SCHRÖDER (2005, p. 57) come from the Refrath Formation, in the *Palmatolepis punctata* conodont Zone.

Disphyllum preslense n. sp.

Pl. 2, Figs 11-12, Pl. 3, Figs 1-2, Pl. 4, Figs 1-10

v 1970 — *Disphyllum goldfussi* (Geinitz), 1846- TSIEN, p. 164, figs. 3-4.
v 1971 — *Disphyllum goldfussi* (Geinitz)- TSIEN, fig. 32, 3a-b.
v *non* 1974 — *Disphyllum goldfussi* (Geinitz)- COEN-AUBERT, pl. 2, figs. 4-5.
v 1977 — *Disphyllum goldfussi* - TSIEN, fig. 5l.
v 1977 — *Disphyllum goldfussi* - TSIEN, pl. 49, fig. 1A.
v 1980 — *Disphyllum goldfussi* - TSIEN, pl. 1, fig. 3.
v 1985 — *Disphyllum* sp. - COEN-AUBERT & LACROIX, pp. 118, 124, fig. 6.

Derivatio nominis

Latin adjective: *preslensis, e* referring to Presles, the type locality of the new species.

Holotype

IRScNB a12641 (= Pl. 2, Figs. 11-12). Specimen Tamines MC-1975-1-26 collected by M. Coen-Aubert in 1975, 16 m above the base of the Lustin Formation.

Locus typicus

Section along the road Namur-Charleroi lying to the south of Presles and located in figure PRE1 of BOULVAIN *et al.* (1999, p. 85). Map sheet Tamines IGNB 47/5, Lambert coordinates: x= 164.85 and

y= 119.35, south side of the Namur Synclinorium, Belgium.

Stratum typicum
Lower part of the Lustin Formation, Middle Frasnian.

Material and localities
One hundred and nineteen specimens with 233 thin sections. Personal sampling with that of M. Coen: Braives MC-1979-1-W44, W541, W542, W543, W545, W547, W551, W555, W563, W5610, W5614, W5615, W772, W773, W782, W785, W786, W788, W818, W819, W8110, W823, W824 and W85; Tamines MC-1975-1-23A, 23C, 24, 25, 26 and 27; Chênée MC-1974-85-586 and 587; Esneux MC-1974-88-L65I and L65II; Huy MC-1974-104-N6; Gesves MC-1978-6-V34 and V36; Naninne MC-1974-113-C131, C132, C133, C134, C135 and C137; Naninne MC-1974-115-R10B, R10C, R10D, R10E, R10F, R16, R17, C683, C6841, C6842, C6843, C6844, C6845, C6846, C6848, C6849, C687, C703A, C703B, C703C, C703D, C703E, C703F, C703G, C703H, C703I, C703J, C704, C705C and C708; Nalinnes MC-1975-2-63A, 63H, 63I, 64, 65 and 66; Nalinnes MC-57-C422, C423, C424, C426, C431, C435, C438, C440, C443, C444, C445, C446, C447, C450 and C451; Nalinnes MC-58-C330, C332, C333, C336, C342, C353, C357, C364, C365, C370, C374, C376, C377, C379 and C380; Beaumont MC-1977-13-768; Beaumont MC-1978-7-774A and 774B; boreholes of Barbençon: Beaumont Bo1 at 114.9 m, 117 m, 119 m and 134 m, Beaumont Bo2 at 59.1 m and Silenrieux Br1 at 38.8 m; Couvin FR2 borehole in the Nord quarry of Frasnes at 74 m.

Diagnosis
A species of *Disphyllum* with 42 to 54 septa at a diameter of 8 mm to 15 mm. Septa rarely carinate and more or less dilated in the dissepimentarium. Major septa often leaving an open space in the centre of the tabularium. Minor septa long. Tabulae incomplete, rather frequently with flat-topped axial parts.

Description
The material consists of fragments of big fasciculate colonies whose largest piece has an area of 13 cm x 8 cm and a height of 12 cm; in some samples, the corallites are oriented in various directions. There are also numerous cylindrical corallites which are rarely twisted, conical or ceratoid. Their height varies between 1 cm and 8 cm, but may reach 11 cm. Longitudinal ribs and growth lines are occasionally present. The outer wall is usually thin and not very well preserved. It is characterized by a dark median line when the cylindrical corallites are locally in contact. Some lateral offsets have been observed.

The septa are non-carinate or bear a few small spinose and knobbly carinae. They are faintly dilated in the dissepimentarium and become thin in the tabularium or sometimes slightly beyond their entry into it. Occasionally they are more dilated in the dissepimentarium or they remain slender or rather thick throughout their length. In a few colonies, there is locally a deposit of stereoplasma or a ring of stereoplasmic thickening on an inner layer of dissepiments. In some offsets, stereoplasma is also present against the outer wall.

The major septa leave a more or less extensive open space in the centre of the tabularium. In some cases, they nearly reach the axis of the corallites. Their axial ends may be rhopaloid, wavy, curved, divided into isolated fragments or fusing to form pseudofossulae. The minor septa traverse the entire dissepimentarium or even enter into the tabularium where they are sometimes contratingent or discontinuous. In some corallites, they are shorter or divided into segments especially in the inner dissepimentarium.

The dissepimentarium consists of 2 to 7 or even 1 to 9 rows of globose dissepiments which are in horizontal layers in its outer part and inclined in its inner part. In a few colonies, peripheral dissepiments are locally larger or more or less peneckielloid. The tabulae are incomplete and intersecting laterally; their axial parts are rather often flat-topped and occasionally horizontal, concave or convex. Rare horizontal and concave tabulae are also present.

There are 38 to 60 septa per corallite. The diameter of the corallites ranges from 6 mm to 18 mm. The width of the tabularium varies commonly between 5 mm and 8.8 mm and more generally between 3.5 mm and 10.5 mm.

Discussion
Disphyllum preslense shows a wide variability concerning the thickening of the septa in the dissepimentarium: from septa rather thin throughout their length to septa typically dilated in the dissepimentarium. These variations are well represented among the material of Presles where the holotype has been chosen. *D. preslense* is similar to the specimens from the Middle Frasnian of Belgium assigned by TSIEN (1970 and 1977b) to *D. goldfussi*. Moreover, the double level rich in *D. preslense* from the section Rochers de Frênes at Lustin has been illustrated several times by TSIEN (1971, 1977c and 1980). As mentioned

by COEN-AUBERT (2008, p. 39), it is well known since LANG & SMITH (1935, p. 569) that *D. goldfussi* is a junior objective synonym of *D. caespitosum*, genotype of *Disphyllum*. However, the latter species revised by COEN-AUBERT (2008) and present in the Early Givetian Trois-Fontaines Formation, from the south side of the Dinant Synclinorium, differs from *D. preslense* by slightly smaller corallites characterized by the same number of septa and by longer major septa often reaching the centre of the tabularium. The colony identified by COEN-AUBERT (1974) as *D. goldfussi* is referred herein to *D. hilli*. At the Belgian scale, there are also some affinities between *D. preslense* and *D. semenoffi* COEN-AUBERT, 2000 from the Mont d'Haurs Formation, in the middle part of the Givetian. But the latter taxon has a few more carinae and mostly inclined dissepiments.

One of the specimens determined by ROHART (1988, pl. 30, fig. 4) as *D. rugosum*, which comes from the Noces Member of the Frasnian Beaulieu Formation, in the Boulonnais, France, resembles the corallites of *D. preslense* with septa rather thick in the dissepimentarium. In the Belgian Frasnian, the two taxa are frequently associated and the new species is easily distinguished from *D. rugosum* by:
- slightly greater septal number and diameters of the corallites and tabularia;
- usually thinner septa with carinae poorly developed;
- a few more rows of dissepiments;
- tabulae incomplete or compound.

D. caespitosum (SOSHKINA, 1939) and *D. kostetskae* from the Frasnian of the Urals are two Russian species related to *D. preslense*. *D. caespitosum* (SOSHKINA) is in fact the type species of the genus *Pseudostringophyllum* SOSHKINA, 1939 considered now as synonym of *Disphyllum* even by Russian authors such as IVANOVSKI (1984, p. 13). *D. caespitosum* (SOSHKINA) exhibits the same variability at the level of the septal dilation in the dissepimentarium as *D. preslense*, but differs from it by a narrower dissepimentarium with only 1 to 3 rows of dissepiments. IVANOVSKI & SHURIGINA (1980, p. 21) synonymized *D. caespitosum* (SOSHKINA) with *D. pashiense* which is different in having shorter minor septa and has therefore been compared to *D. grabaui*. As for *D. kostetskae*, it is separated from *D. preslense* by smaller corallites with slightly fewer septa, by septa systematically dilated in the dissepimentarium and by longer major septa often reaching the centre of the tabularium. One of the specimens collected in the middle part of the Lustin Formation at Gerpinnes and ascribed by TSIEN (1970, fig. 12A) to *D. kostetskae* belongs probably to *D. preslense*.

Finally, there are some affinities between *D. multiseptatum* CHEN, 1959 from the Frasnian of the Guizhou Province in China and the colonies of *D. preslense* with thick septa in the dissepimentarium. But the Chinese taxon is characterized by slightly more numerous septa, a wide open space in the centre of the tabularium and frequently inclined dissepiments.

Geographic and stratigraphic occurrence
The species is only known in the Middle Frasnian from various areas of Belgium. The material sampled by the author and M. Coen comes from:
- the middle part of the Bovesse Formation at Huccorgne, on the north side of the Namur Synclinorium;
- the middle part of the reefal limestones characteristic of the lower part of the Lustin Formation at Presles, on the south side of the Namur Synclinorium as well as at Tilff, Hony, Vierset-Barse, Gesves, Tailfer, Lustin and Gerpinnes, on the north side of the Dinant Synclinorium;
- the Fontaine Samart Member and the base of the Machenées Member of the Pont de la Folle Formation, in the area of Barbençon.
- the base of the La Boverie Member from the Moulin Liénaux Formation at Frasnes, on the south side of the Dinant Synclinorium.

Moreover, the corallite figured by TSIEN (1977b) has been found in the Middle Frasnian from the Philippeville Massif.

Family Phillipsastreidae ROEMER, 1883
Genus *Peneckiella* SOSHKINA, 1939

= *Sudetia* ROZKOWSKA, 1960

Type species: By original designation, *Diphyphyllum minus* ROEMER, 1855

Diagnosis
Fasciculate rugose corals. Septa of two orders, carinate or non-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, sometimes also shorter. Narrow dissepimentarium composed of a few rows of globose vesicles with peneckielloid dissepiments at the periphery; occasionally occurrence of horseshoe dissepiments. Tabulae complete, incomplete or compound.

Peneckiella discreta n. sp.
Pl. 1, Figs 11-12, Pl. 4, Figs 11-13, Pl. 5, Figs 1-8

Derivatio nominis
From *discretus* (latin) = discreet, referring to the marginal position of the new species in the genus *Peneckiella.*

Holotype
IRScNB a12648 (= Pl. 4, Figs. 11-13). Specimen Rochefort MC-55-C644 collected by M. Coen-Aubert in 1998, 8 m below the top of the La Boverie Member of the Moulin Liénaux Formation.

Locus typicus
Western part of the southeast excavation lying to the south of section G (Rochefort MC-55) described and located by BOULVAIN *et al.* (2005, fig. 3); this section in the La Boverie quarries is lying 3 km to the north of Rochefort. Map sheet Rochefort 59/3, Lambert coordinates: x= 211,625 and y= 97,50, south side of the Dinant Synclinorium, Belgium.

Stratum typicum
La Boverie Member of the Moulin Liénaux Formation, Middle Frasnian.

Material and localities
Forty four specimens with 79 thin sections. Personal sampling with that of J.M. Graulich: Braives MC-1979-1-W45, W546, W548, W5412 and W5420; Malonne Wépion borehole at 2095,55 m; Bioul MC-1974-121-L97 and L99; Nalinnes MC-1977-3-V73B; Beaumont Bol borehole of Barbençon at 166 m; Couvin FR2 borehole in the Nord quarry of Frasnes at 69 m and 72,9 m; Rochefort MC-55-C491, C492, C493, C494, C643, C644, C645, C659, C660, C661, C662, C663, C664, C665, C666, C667, C668, C669 , C670 and C671; Rochefort MC-56-C247, C249, C268, C270, C271, C275, C276, C277, C283, C640 and C641.

Diagnosis
A species of *Peneckiella* with 42 to 56 septa at a diameter of 6 to 13 mm. Occurrence of a complete or partial inner wall at the border of the tabularium. Major septa reaching the axis of the corallites or leaving an open space in the centre of the tabularium. Dissepimentarium composed of several rows of globose dissepiments with some peneckielloid dissepiments at the periphery.

Description
The material consists of fragments of big fasciculate colonies whose largest piece reaches an area of 13.5 cm x 12 cm and a height of 6 cm; in some samples, the corallites are oriented in various directions. There are also some isolated cylindrical corallites with a height varying between 1.5 cm and 4.5 cm. The outer wall is often well preserved. It may be characterized by a dark median line when the cylindrical corallites are in lateral contact. In some specimens, the outer wall is encrusted occasionally by thin laminar stromatoporoids and rarely by alveolitids, thamnoporids or thecostegitids. Lateral offsets occur in some colonies

The septa are non-carinate or bear a few small spinose, knobbly or even yardarm carinae. They are typically dilated in the dissepimentarium and become thin in the tabularium or slightly beyond their entry into it; in very few corallites, the septa remain rather thick in the tabularium. A partial or complete inner wall is frequently present at the border of the tabularium; locally also, the septa are contiguous in the dissepimentarium or a deposit of stereoplasma occurs between them.

The major septa reach the axis of the corallites or leave a small space in the centre of the tabularium which may be more important; their axial ends are sometimes twisted, wavy, curved, divided into isolated fragments or fusing to form pseudofossulae. The minor septa often traverse the entire dissepimentarium or even enter into the tabularium where they are occasionally contratingent. Sometimes, the minor septa traverse nearly all the dissepimentarium or they are restricted to its outer part; in rare cases, they are shorter, reduced to spines or discontinuous especially at their inner ends.

The dissepimentarium consists of 2 to 5 or even 1 to 8 rows of globose dissepiments, which are in horizontal layers in its outer part and inclined in its inner part. In several colonies, the peripheral dissepiments may be more or less peneckielloid; there are also a few more bulbous dissepiments close to the shape of horseshoes. In some specimens also, partial fans of rhipidacanthine trabeculae are observed mostly in the inner part of the dissepimentarium. The tabulae are incomplete and intersecting laterally; their axial parts are rather frequently flat-topped, occasionally concave and rarely horizontal or convex. Some concave tabulae are also present.

There are 38 to 60 septa per corallite. The diameter of the corallites ranges from 5.5 mm to 16 mm. The width of the tabularium varies commonly between 4 mm and 8.5 mm and more generally between 3.3 mm and 10 mm.

Discussion

Peneckiella discreta is typically a transitional species between the genera *Peneckiella* and *Disphyllum*. Indeed, peneckielloid dissepiments are not present in every colony whereas normal globose dissepiments may be well developed. However, the new taxon is preferably assigned to *Peneckiella* rather than to *Disphyllum* due to the association of peneckielloid dissepiments with partial fans of rhipidacanthine trabeculae. At the Belgian scale, *Peneckiella discreta* resembles *P. fascicularis* described by COEN-AUBERT (1995, p. 40) in the Philippeville and Grand Breux Formations respectively from the Philippeville Massif and the south side of the Dinant Synclinorium. Nevertheless, the latter species is distinguished from the former by smaller septal number, diameters of the corallites and tabularia and by septa more dilated in the dissepimentarium without forming an inner wall.

Among the Belgian sampling also, there are some affinities between the new species and the specimens of *Disphyllum preslense* characterized by septa rather thick in the dissepimentarium. However, these colonies differ from *Peneckiella discreta* by the lack of peneckielloid dissepiments and inner wall. Such an inner wall occurs in the samples coming from the Pâtures Member of the Beaulieu Formation in the Boulonnais, France and ascribed by ROHART (2002, p. 113) to *Disphyllum gradatum*; but it is not observed in the small corallites of the original material figured by TSIEN (1970, fig. 21).

Peneckiella pachyfusiseptata (LAKHOV, 1981) from the Frasnian of Novaya Zemlya in Russia is very close to *P. discreta*. However, its holotype and only colony illustrated by LAKHOV (1981, pl. 1, fig. 1) shows septa more strongly dilated in the dissepimentarium and rare peneckielloid dissepiments though sigmoidal and horseshoe dissepiments are mentioned in the description. This taxon was referred by LAKHOV (1981) to the genus *Zelolasma* PEDDER, 1964 which is mainly separated from *Peneckiella* by major and minor septa subequal and confined to the dissepimentarium. *Disphyllum depressum* (HINDE, 1890) from the Frasnian of Western Australia is also similar to *Peneckiella discreta*; moreover, its holotype figured by HILL (1936, pl. 1, figs. 6-7) and HILL & JELL (1970, pl. 8, fig. 7) exhibits some horseshoe dissepiments. Unfortunately, the variability of this taxon with larger corallites and a few more septa is not well known.

Other species of *Disphyllum* which may have an inner wall, but without peneckielloid or horseshoe dissepiments, are related to *Peneckiella discreta*. This is the case for:

- *Disphyllum annulatum* KONG, 1978 from the Givetian of the Guizhou Province in China described by KONG & HUANG (1978, p. 75) and different in having septa thinner or less thick in the dissepimentarium and no carinae;
- *D. major* JIA, 1977 from the Devonian of the South Central regions in China which is considered as a subspecies of *D. longiseptatum* by JIA *et al.* (1977, p. 139) and which is distinguished from *Peneckiella discreta* by fewer carinae and a narrower dissepimentarium;
- *Disphyllum virgatum* collected by COEN-AUBERT (1989 and 2004) at the top of the Upper Givetian Fromelennes Formation from the south side of the Dinant Synclinorium, which lacks carinae and is once more characterized by a narrow dissepimentarium.

Geographic and stratigraphic occurrence

The species is only known in the Middle Frasnian from different areas of Belgium. The material sampled by the author and J.M. Graulich comes from:

- the middle part of the Bovesse Formation at Huccorgne, on the north side of the Namur Synclinorium;
- the upper part of the Su Wary Formation intersected in the bottom of the Wépion borehole located in the Namur Synclinorium;
- the middle part of the reefal limestones characteristic of the lower part of the Lustin Formation at Annevoie-Rouillon, on the north side of the Dinant Synclinorium;
- the top of the Machenées Member from the Pont de la Folle Formation at Somzée, on the north side of the Dinant Synclinorium and the Fontaine Samart Member of the same lithostratigraphic unit in the area of Barbençon;
- the La Boverie Member of the Moulin Liénaux Formation at Frasnes and Rochefort, on the south side of the Dinant Synclinorium.

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References

BIRENHEIDE, R., 1990. Untersuchungen an rugosen Korallen aus dem Bereich der Mittel-Devon/Ober-Devon-Grenze des Rheinischen Schiefergebirges. *Senckenbergiana lethaea*, **70**: 259-295.

BOULVAIN, F., BULTYNCK, P., COEN, M., COEN-AUBERT, M., LACROIX, D., LALOUX, M., CASIER, J.G., DEJONGHE, L., DUMOULIN, V., GHYSEL, P., GODEFROID, J., HELSEN, S., MOURAVIEFF, N.A., SARTENAER, P., TOURNEUR, F. & VANGUESTAINE, M., 1999. Les formations du Frasnien de la Belgique. *Memoirs of the Geological Survey of Belgium*, **44**: 1-125.

BOULVAIN, F. & COEN-AUBERT, M., 2006. A fourth level of Frasnian carbonate mounds along the south side of the Dinant Synclinorium (Belgium). *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre*, **76**: 31-51.

BOULVAIN, F., CORNET, P., DA SILVA, A-C., DELAITE, G., DEMANY, B., HUMBLET, M., RENARD, M. & COEN-AUBERT, M., 2004. Reconstructing atoll-like mounds from the Frasnian of Belgium. *Facies*, **50**: 313 - 326.

BOULVAIN, F., DEMANY, B. & COEN-AUBERT, M., 2005. Frasnian carbonate buildups of Southern Belgium: the Arche and Lion Members interpreted as atolls. *Geologica Belgica*, **8**: 69-89.

BULTYNCK, P. & DEJONGHE, L., 2002. Devonian lithostratigraphic units (Belgium). *Geologica Belgica*, **4**: 39-69.

BULVANKER, E.Z., 1941. Rugosa Glavnogo devonskogo polya. *In*: Fauna Glavnogo devonskogo polya, tom 1. Paleontologicheskiy Institut, Akademiya Nauk SSSR, Izdatelstvo Nauka, Moskva, pp. 133-137 (in Russian).

BULVANKER, E.Z., 1958. Devonskie chetyrekhluchevye korally okrain Kuznetskogo basseyna. Vsesoyuznyi nauchno-issledovatelskiy Geologicheskiy Institut (VSEGEI), Leningrad, 212 pp (in Russian).

CASIER, J.G., & OLEMPSKA, E., 2008. Early Frasnian ostracods from the Arche quarry (Dinant Synclinorium, Belgium) and the *Palmatolepis punctata* Isotopic Event. *Acta Palaeontologica Polonica*, **53**: 635-646.

CHEN, M.S., 1959. Nekotorye siluriykie i devonskie stromatoporoidei i korally iz rayona Lushanya vostochnoy chasti provintsii Guychzhnou. Acta Palaeontologica Sinica, **7**: 285-318 (in Russian).

COEN, M., 1976. Le Frasnien du lambeau de poussée hercynien de la Tombe (Ardenne belge). *Annales de la Société Géologique du Nord*, **96**: 69-71.

COEN, M., 1977. La klippe du Bois Niau. *Bulletin de la Société belge de Géologie*, **86**: 41-44.

COEN-AUBERT, M., 1973. Le Givetien et le Frasnien de la vallée du Hoyoux. *Service Géologique de Belgique, Professional Paper*, **1973/6**: 1-12.

COEN-AUBERT, M., 1974. Le Givetien et le Frasnien du Massif de la Vesdre. Stratigraphie et paléogéographie. *Mémoires in quarto de la Classe des Sciences de l'Académie Royale de Belgique*, 2e série, **18** (2): 1-146.

COEN-AUBERT, M., 1980. Rugueux massifs cérioïdes du Givetien et du Frasnien de la Belgique. *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre*, **51** (14): 1-53.

COEN-AUBERT, M., 1982. Rugueux solitaires du Frasnien de la Belgique. *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre*, **54** (6): 1-65.

COEN-AUBERT, M., 1987. Description de deux espèces de *Wapitiphyllum* MCLEAN, R.A. et PEDDER, A.E.H., 1984 récoltées dans le Frasnien de Huccorgne, au bord nord du Bassin de Namur. *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre*, **56**: 57-65.

COEN-AUBERT, M., 1988. Les unités lithostratigraphiques du Dévonien moyen et du Frasnien dans le sondage de Wépion. *Service Géologique de Belgique, Professional Paper*, 1988/1 (**231**): 1-26.

COEN-AUBERT, M., 1989. Les Rugueux dévoniens du sondage de Nieuwkerke (extrémité occidentale du Synclinorium de Namur, Belgique). *Annales de la Société Géologique du Nord*, **108**: 100-102.

COEN-AUBERT, M., 1994. Stratigraphie et systématique des Rugueux de la partie moyenne du Frasnien de Frasnes-lez-Couvin (Belgique). *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre*, **64**: 21-56.

COEN-AUBERT, M., 1995. Espèces du genre *Peneckiella* Soshkina, 1939 dans le Frasnien de la Belgique. *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre*, **65**: 35-49.

COEN-AUBERT, M., 1996. Rugueux frasniens du sondage de Focant. *Annales de la Société Géologique de Belgique*, **117**: 57-67.

COEN-AUBERT, M., 2000. Stratigraphy and additional rugose corals from the Givetian Mont d'Haurs Formation in the Ardennes. *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre*, **70**: 5-23.

COEN-AUBERT, M., 2004. Two new species of Temnophyllids (Rugosa) from the Upper Givetian of Belgium. *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre*, **74**: 19-34.

COEN-AUBERT, 2008. Fasciculate Disphyllids (Rugosa) from the Early Givetian Trois-Fontaines Formation in Belgium. *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre*, **78**: 31-50.

COEN-AUBERT, M. & COEN, M., 1975. Le Givetien et le Frasnien dans la vallée de la Meuse de Tailfer à Yvoir (bord

nord du Bassin de Dinant). *Annales de la Société Géologique de Belgique*, **97**: 499-524.

COEN-AUBERT, M., DEJONGHE, L., CNUDDE, C. & TOURNEUR, F., 1986. Etude stratigraphique, sédimentologique et géochimique de trois sondages effectués à Membach (Massif de la Vesdre). *Service Géologique de Belgique, Professional Paper*, 1985/10 (**223**): 1-57.

COEN-AUBERT, M. & LACROIX, D., 1985. Le Frasnien dans la partie orientale du bord nord du Synclinorium de Namur. *Bulletin de la Société belge de Géologie*, **94**: 117-128.

DE FROMENTEL, E., 1861. Introduction à l'étude des polypiers fossiles. Savy, Paris, 357 pp.

DELCAMBRE, B. & PINGOT, J.L., 2000. Gozée-Nalinnes 52/3-4. Carte géologique de Wallonie, échelle: 1/25.000.

DELCAMBRE, B. & PINGOT, J.L., 2004. Biesme-Mettet 53/1-2. Carte géologique de Wallonie, échelle: 1/25.000.

DUMOULIN, V., 2001. Gandrieu-Beaumont 52/5-6. Carte géologique de Wallonie, échelle: 1/25.000.

DUMOULIN, V. & MARION, J.M., 1997. Silenrieux-Walcourt 52/7-8. Carte géologique de Wallonie, échelle: 1/25.000.

DUMOULIN, V., MARION, J.M., BOULVAIN, F., COEN-AUBERT, M. & COEN, M., 1998. Nouvelles données lithostratigraphiques sur le Frasnien de l'Anticlinorium de Philippeville. *Annales de la Société Géologique du Nord*, (2), **6**: 79-85.

ERRERA, M., MAMET, B. & SARTENAER, P., 1972. Le calcaire de Givet et le Givetien à Givet. *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre*, **48** (1): 1-59.

GEINITZ, H.B., 1846. Grundriss der Versteinerungskunde. Arnoldische Buchhandlung, Dresden und Leipzig, 813 pp.

GOLDFUSS, A., 1826. Petrefacta Germaniae 1: 1-76. Arnz & Comp., Düsseldorf.

GOUWY, S. & BULTYNCK, P., 2000. Graphic correlation of Frasnian sections (Upper Devonian) in the Ardennes, Belgium. *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre*, **70**: 25-52.

GRAULICH, J.M., 1961. Le sondage de Wépion. *Mémoires pour servir à l'explcation des Cartes géologiques et minières de Belgique*, **2**: 1-86.

GÜRICH, G., 1896. Das Palaeozoicum im Polnischen Mittelgebirge. *Verhandlungen der Russisch-kaiserlichen Mineralogischen Gesellschaft zu St. Petersburg*, (2), **32**: 1-539.

HILL, D., 1936. Upper Devonian Corals from Western Australia. *Journal of the Royal Society of Western Australia*, **22**: 25-39.

HILL, D., 1939. The Devonian rugose corals of Lilydale and Loyola, Victoria. *Proceedings of the Royal Society of Victoria*, new series, **51**: 219-256.

HILL, D., 1954. Coral faunas from the Silurian of New South Wales and the Devonian of Western Australia. *Bulletin, Bureau of Mineral Ressources, Geology and Geophysics*, **23**: 1-51.

HILL, D., 1981. Part F, Coelenterata, Supplement 1, Rugosa and Tabulata, 2 vols. *In*: TEICHERT, C. (Editor), Treatise on Invertebrate Paleontology. The Geological Society of America, Inc. and The University of Kansas, Boulder, Colorado and Lawrence, Kansas, 762 pp.

HILL, D. & JELL, J.S., 1970. Devonian corals from the Canning Basin Western Australia. *Geological Survey of Western Australia, Bulletin*, **121**: 1-158.

HINDE, G.J., 1890. Notes on the palaeontology of Western Australia. 2. Corals and Polyzoa. *The Geological Magazine*, new series, (3), **7**: 194-204.

IVANIA, V.A., 1965. Devonskie korally Sayano-Altayskoy gornoy oblasti. Izd. Tomskogo Universiteta, Tomsk, 398 pp. (in Russian).

IVANOVSKI, A.B., 1984. Istoriya izucheniya paleozoyskikh korallov i stromatoporoidey. Rugozy (1975-1983). *Trudy Paleontologicheskogo Instituta*, **207**: 1-88 (in Russian).

IVANOVSKI, A.B. & SHURIGINA, M.V., 1980. Reviziya devonskikh rugoz Urala. *Trudy Paleontologicheskogo Instituta Akademiya Nauk SSSR*, **186**: 1-64 (in Russian).

JIA, H.Z., XU, S.Y., KUANG, G.D., ZHANG, B.F., ZHUO, Z.B. & WU, J.S., 1977. Anthozoa. *In*: Hubei Provincial Geological Science Research Institute (Editor), Atlas of the paleontology of the South Central Regions, part 2, Late Paleozoic. Geological Publishing House, Beijing, pp. 109-270.

KONG, L. & HUANG, Y.M., 1978. Tetracoralla. *In*: Guizhou Stratigraphy and Palaeontology Work Team (Editor), Palaeontological Atlas of Southwest China. Guizhou Volume. Part I, Cambrian-Devonian. Geological Publishing House, Beijing, pp. 35-161.

LAKHOV, G.V., 1981. Novye vidy kolonialnykh devonskikh rugoz Novoy Zemli. *Zapiski Leningradskogo Gornogo Instituta*, **85**: 65-74 (in Russian).

LANG, W. D. & SMITH, S., 1934. Ludwig's "Corallen aus Paläolitischen Formationen" and the genotype of *Disphyllum* de Fromentel. *The Annals and Magazine of Natural History*, (10), **13**: 78-81.

LANG, W.D. & SMITH, S., 1935. *Cyathophyllum caespitosum* GOLDFUSS and other Devonian corals considered in a revision of that species. *The Quarterly Journal of the Geological Society of London*, **91**: 538-589.

LECOMPTE, M., 1960. Compte-rendu de la session extraordinaire de la Société Géologique de Belgique et de la Société belge de Géologie, de Paléontologie et d'Hydrologie du 25 au 28 septembre 1959. *Annales de la Société Géologique de Belgique*, **83**: 1-134.

McLEAN, R.A., 2007. Kyphophyllid rugose corals from the

Frasnian (Upper Devonian) of Canada and their biostratigraphic significance. *Palaeontographica Canadiana*, **26**: 1-109.

MOENKE, M., 1954. Rodzaj *Hexagonaria* w dewonie Gor Swietokrzyskich. *Acta Geologica Polonica*, **4**: 445-483.

PEDDER, A.E.H., 1964. Two new genera of Devonian tetracorals from Australia. *Proceedings of the Linnean Society of New South Wales*, **88**: 364-367.

REED, F.R.C., 1922. Devonian fossils from Chitral and the Pamirs. *Memoirs of the Geological Survey of India, Palaeontologia Indica*, new series, **6** (2): 1-134.

ROEMER, C.F., 1883. Lethaea geognostica. I. Theil, Lethaea palaeozoica. Zweite Lieferung. Stuttgart, pp. 324-543 und Atlas.

ROEMER, F.A., 1855. Beiträge zur geologischen Kenntniss des nordwestlichen Harzgebirges. Dritte Abtheilung. *Palaeontographica*, **5**: 1-44.

ROHART, J.C., 1988. Rugueux givetiens et frasniens de Ferques (Boulonnais-France). *In*: BRICE, D. (Editeur), Le Dévonien de Ferques. Bas-Boulonnais (N. France). *Biostratigraphie du Paléozoïque*, **7**: 231-297.

ROHART, J.C., 2002. Coraux rugueux du Membre des Pâtures, Formation de Beaulieu (Frasnien de Ferques, Boulonnais). *Annales de la Société Géologique du Nord*, (2), **9**: 111-128.

ROZKOWSKA, M., 1960. Blastogeny and individual variations in tetracoral colonies from the Devonian of Poland. *Acta Palaeontologica Polonica*, **5**: 3-64.

ROZKOWSKA, M., 1979. Contribution to the Frasnian Tetracorals from Poland. *Palaeontologia Polonica*, **40**: 3-56.

SCHRÖDER, S., 2005. Stratigraphie und Systematik rugoser Korallen aus dem Givetium und Unter-Frasnium des Rheinischen Schiefergebirges (Sauerland/Bergisches Land). *Zitteliana*, **B25**: 39-116.

SEMENOFF-TIAN-CHANSKY, P., 1961. Madréporaires paléozoïques. *In*: SEMENOFF-TIAN-CHANSKY, P., LAFUSTE, J. & DURAND DELGA, M., Madréporaires du Dévonien de Chénoua (Algérie). *Bulletin de la Société Géologique de France*, (7), **3**: 290-319.

SOSHKINA, E.D., 1939. Verkhnedevonskie korally Rugosa Urala. *Trudy Paleontologicheskogo Instituta*, **9**: 1-88 (in Russian).

SOSHKINA, E.D., 1949. Devonskie korally Rugosa Urala. *Trudy Paleontologicheskogo Instituta*, **15** (4): 1-160 (in Russian).

TSIEN, H.H., 1970. Espèces du genre *Disphyllum* (Rugosa) dans le Dévonien moyen et le Frasnien de la Belgique. *Annales de la Société Géologique de Belgique*, **93**: 159-182.

TSIEN, H.H., 1971. The Middle and Upper Devonian reef-complexes of Belgium. *Petroleum Geology of Taiwan*, **8**: 119-173.

TSIEN, H.H., 1975. Introduction to the Devonian Reef development in Belgium. Livret-Guide, Excursion C (Nord de la France et de la Belgique), 2e Symposium International sur les Coraux et Récifs coralliens fossiles, Paris 1975. Bruxelles, pp. 3-43.

TSIEN, H.H., 1977a. Espèces du genre *Tabulophyllum* (Rugosa) dans le Dévonien moyen et le Frasnien de la Belgique. *Annales de la Société Géologique de Belgique*, **99**: 263-282.

TSIEN, H.H., 1977b. The sequence and distribution of Frasnian rugose corals fauna in Belgium. *Mémoires du B.R.G.M.*, **89**: 203-220.

TSIEN, H.H., 1977c. L'activité récifale au cours du Dévonien moyen et du Frasnien en Europe occidentale et ses particularités en Belgique. *Annales de la Société Géologique du Nord*, **97**: 57-66.

TSIEN, H.H., 1980. Les régimes récifaux dévoniens en Ardenne. *Bulletin de la Société belge de Géologie*, **89**: 71-102.

WEBSTER, C.L., 1889. Description of a new genus of corals from the Devonian rocks of Iowa. *The American Naturalist*, **23** (272): 710-712.

WEDEKIND, R., 1922. Zur Kenntnis der Stringophyllen des oberen Mitteldevon. *Sitzungsberichte der Gesellschaft zur Beförderung der gesamten Naturwissenschaften zu Marburg*, **1921** (1): 1-16.

WHITEAVES, J.F., 1898. Revision of the nomenclature of some of the species described or enumerated in previous parts of this volume, and additional notes on others, necessitated by the progress of palaeontological research. *Contributions to Canadian Palaeontology*, **1**: 419-427.

YOH, S.S., 1937. Die Korallenfauna des Mitteldevons aus der Provinz Kwangsi, Südchina. *Palaeontographica*, A, **87**: 45-76.

YOH, S.S., 1957. On the discovery of the Early Upper Devonian fauna in East Kueichow and its stratigraphical significance. *Acta Scientiarium Naturalium Universitatis Pekinensis*, **3**: 487-502.

ZHEN, Y.Y., 1995. Late Emsian rugose corals of the Mount Podge area, Burdekin Basin, north Queensland. *Alcheringa*, **19**: 193-224.

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Explanation of Plates

All the specimens are figured at magnification x 3.

PLATE 1

Disphyllum hilli TSIEN, 1970

Fig. 1 – IRScNB a12623. Chênée MC-1974-85-553B. Transverse section.
Figs 2-3 – IRScNB a12624. Rochefort MC-53-C205. Transverse and longitudinal sections.
Figs 4-5 – IRScNB a12625. Rochefort MC-53-C105I. Transverse and longitudinal sections.
Fig. 6 – IRScNB a12626. Nalinnes MC-1975-2-43. Transverse section.
Figs 7-10 – IRScNB a12627. Rochefort MC-53-C104A. Transverse and longitudinal sections.

Peneckiella discreta n. sp.

Fig. 11 – Paratype. IRScNB a12649. Rochefort MC-55-C493. Transverse and longitudinal sections.
Fig. 12 – Paratype. IRScNB a12650. Rochefort MC-55-C671. Transverse and longitudinal sections.

PLATE 2

Disphyllum grabaui TSIEN, 1970

Figs 1-2 – IRScNB a12630. Rochefort MC-53-C206. Transverse and longitudinal sections.
Figs 3-5 – IRScNB a12631. Rochefort MC-53-C101. Transverse and longitudinal sections.
Figs 6-7 – IRScNB a12632. Couvin MC-1974-97-C576. Transverse and longitudinal sections.
Figs 8-9 – IRScNB a12633. Rochefort MC-53-C105E. Transverse and longitudinal sections.
Fig. 10 – IRScNB a12634. Chênée MC-1974-85-553H. Transverse section.

Disphyllum preslense n. sp.

Figs 11-12 – Holotype. IRScNB a12641. Tamines MC-1975-1-26. Transverse and longitudinal sections.

PLATE 3

Disphyllum preslense n. sp.

Figs 1-2 – Paratype. IRScNB a12642. Nalinnes MC-57-C446. Transverse and longitudinal sections.

Disphyllum rugosum (WEDEKIND, 1922)

Fig. 3 – IRScNB a12635. Couvin FR2 borehole in the Nord quarry of Frasnes at 70.8 m. Transverse section.
Fig. 4 – IRScNB a12636. Nalinnes MC-1975-2-63D. Transverse section.
Figs 5-6 – IRScNB a12637. Nalinnes MC-1975-2-63F. Transverse and longitudinal sections.
Figs 7-8 – IRScNB a12638. Gandrieu Reugnies R1 borehole in France at 76 m. Transverse and longitudinal sections.
Figs 9-10 – IRScNB a12639. Nalinnes MC-1975-2-63E. Transverse and longitudinal sections.
Fig. 11 – IRScNB a12640. Braives MC-1979-1-W793. Transverse section.

PLATE 4

Disphyllum preslense n. sp.

Fig. 1 – Paratype. IRScNB a12643. Nalinnes MC-1975-2-63I. Transverse section.
Figs 2-4 – Paratype. IRScNB a12644. Tamines MC-1975-1-24. Transverse and longitudinal sections.
Figs 5-6 – Paratype. IRScNB a12645. Nalinnes MC-58-C333. Transverse and longitudinal sections.
Figs 7-8 – Paratype. IRScNB a12646. Nalinnes MC-58-C336. Transverse and longitudinal sections.
Figs 9-10 – Paratype. IRScNB a12647. Naninne MC-1974-115-C703H. Transverse and longitudinal sections.

Peneckiella discreta n. sp.

Figs 11-13 – Holotype. IRScNB a12648. Rochefort MC-55-C644. Transverse and longitudinal sections.

PLATE 5

Peneckiella discreta n. sp.

Figs 1-3 – Paratype. IRScNB a12651. Rochefort MC-55-C659. Transverse and longitudinal sections.
Figs 4-5 – Paratype. IRScNB a12652. Rochefort MC-55-C669. Transverse and longitudinal sections.
Figs 6-7 – Paratype. IRScNB a12653. Rochefort MC-55-C666. Transverse and longitudinal sections.
Fig. 8 – Paratype. IRScNB a12654. Rochefort MC-55-C670. Transverse section.

Disphyllum hilli TSIEN, 1970

Fig. 9 – IRScNB a12628. Couvin MC-1974-97-C585. Transverse section.
Fig. 10 – IRScNB a12629. Nalinnes MC-1975-2-28. Transverse section.

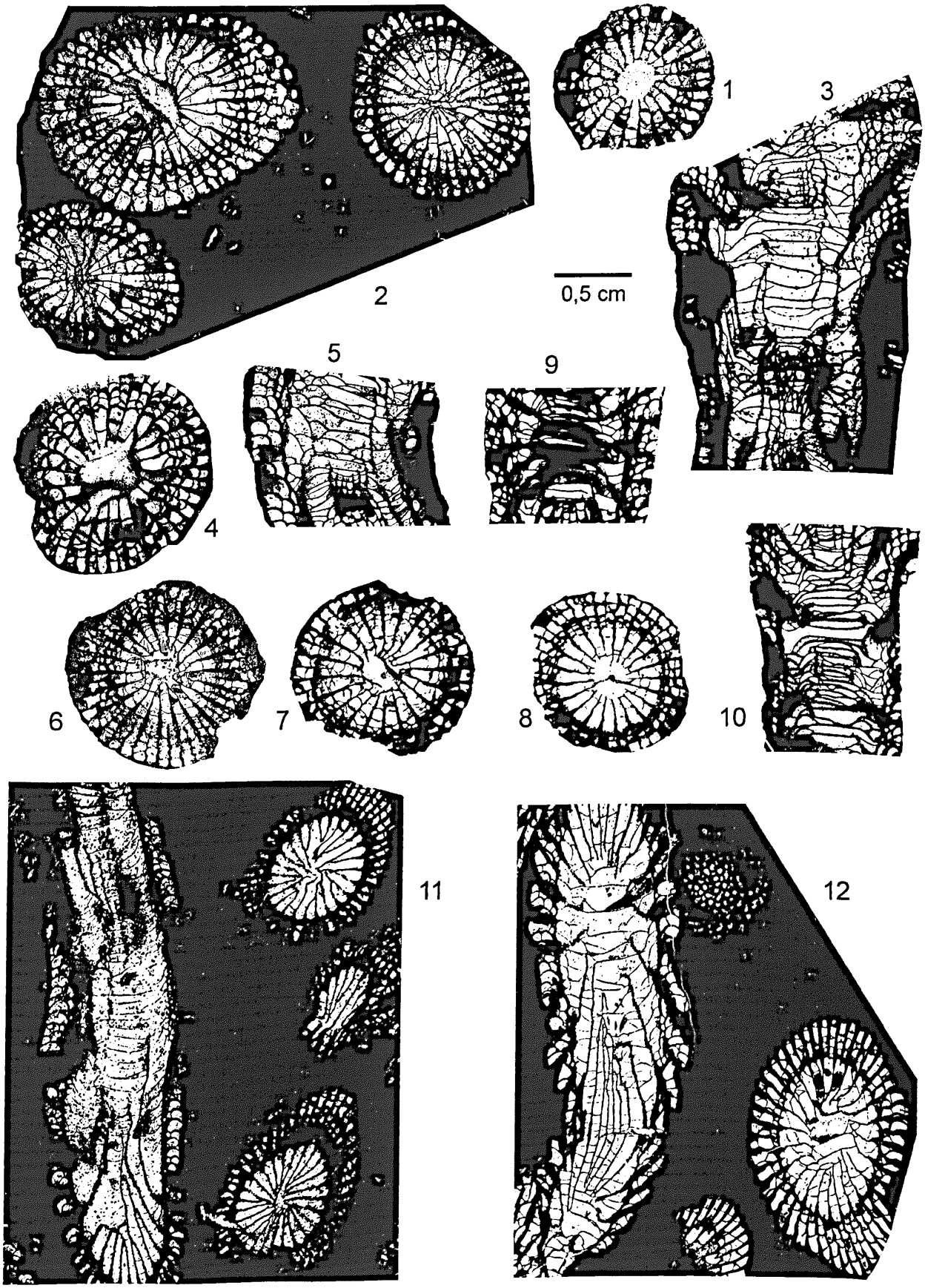

PLATE I

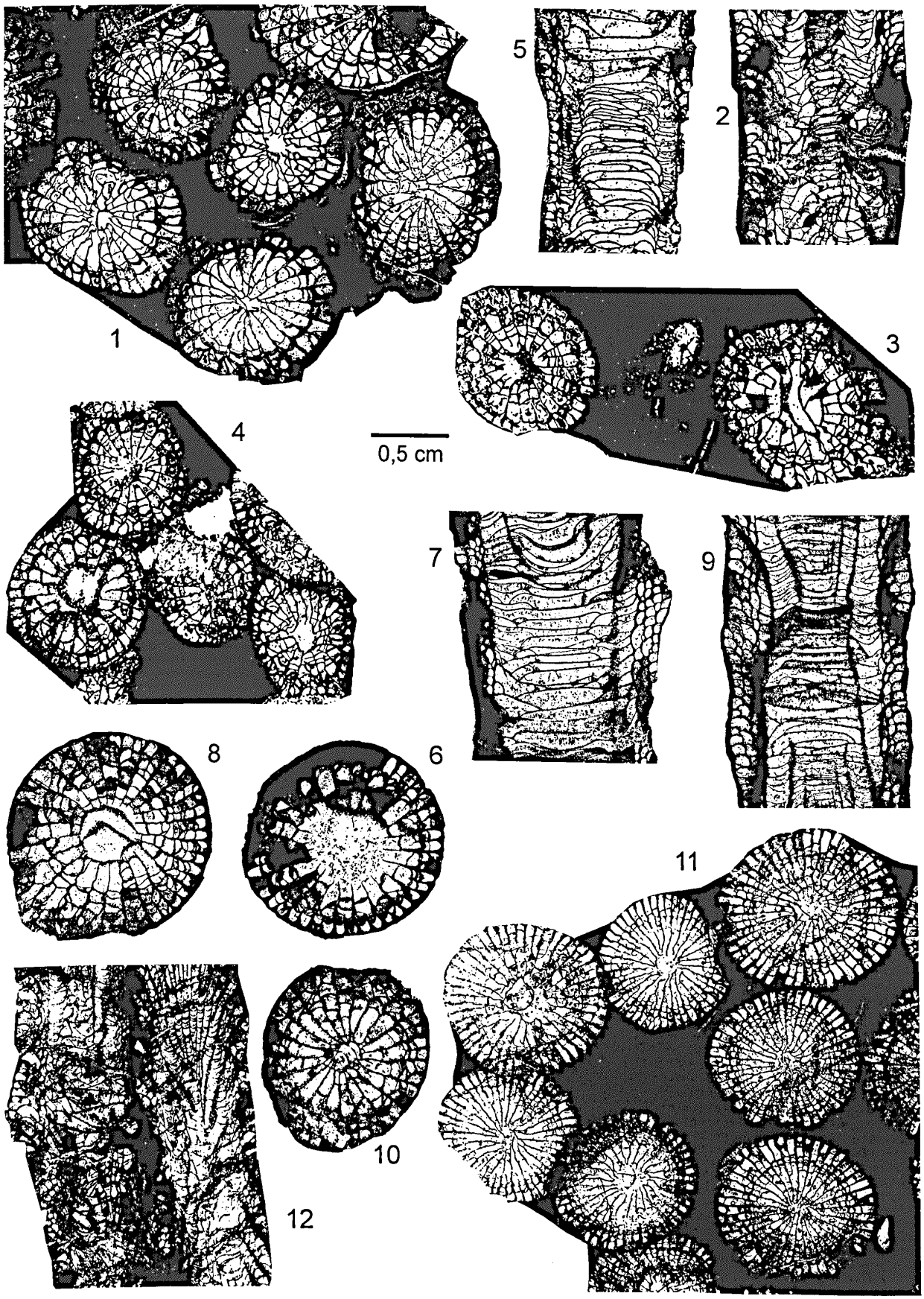

PLATE 2

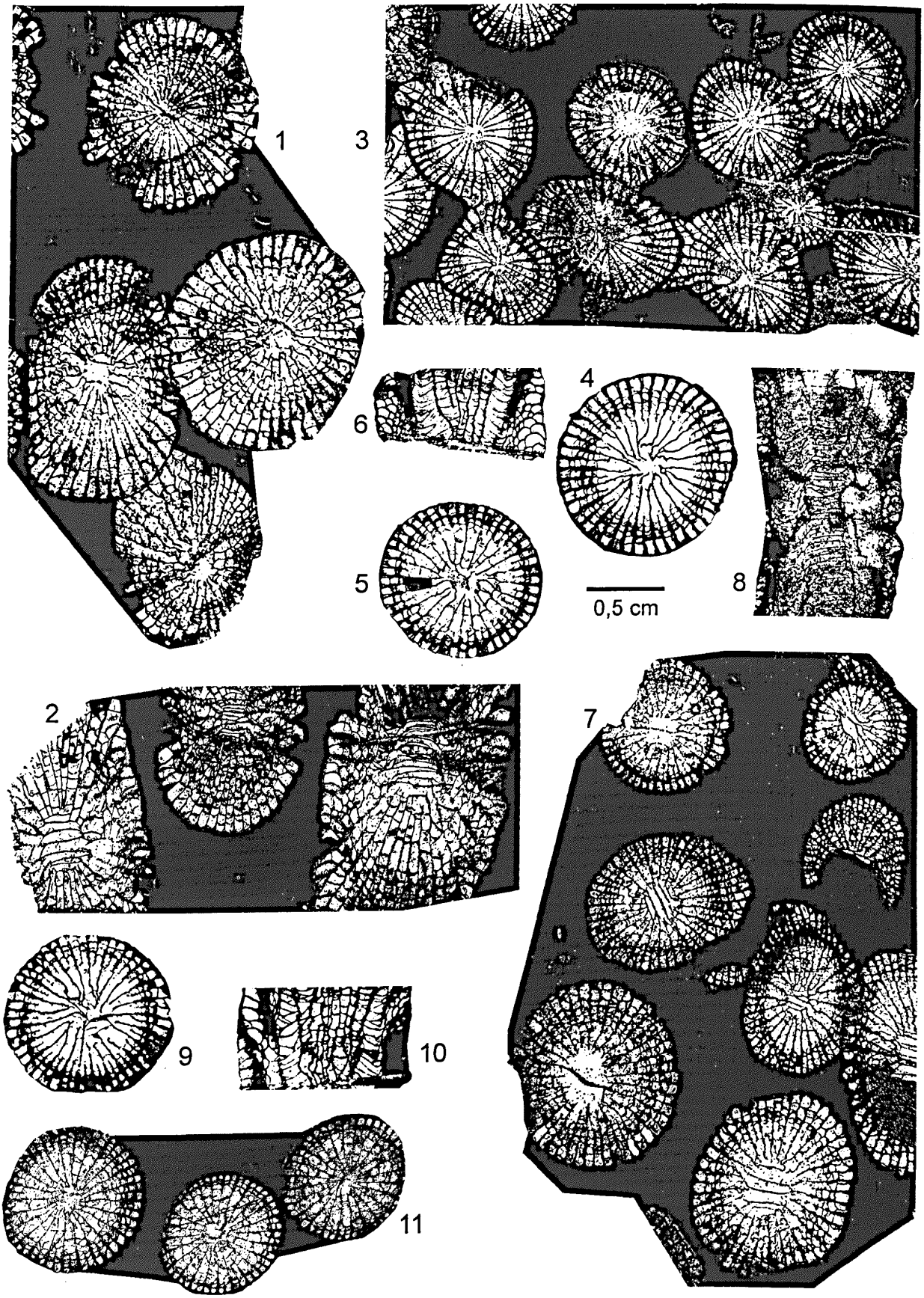

PLATE 3

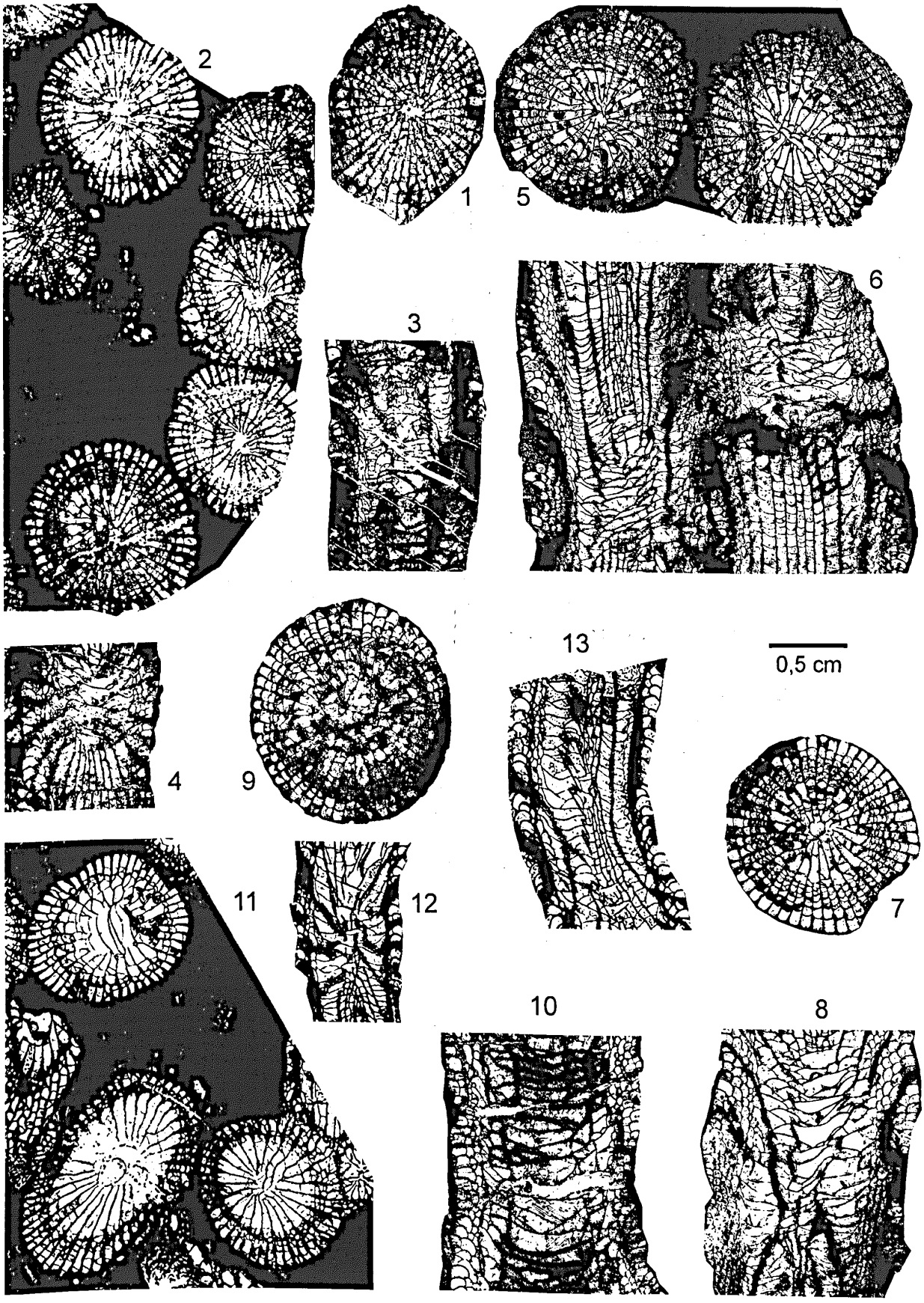

PLATE 4

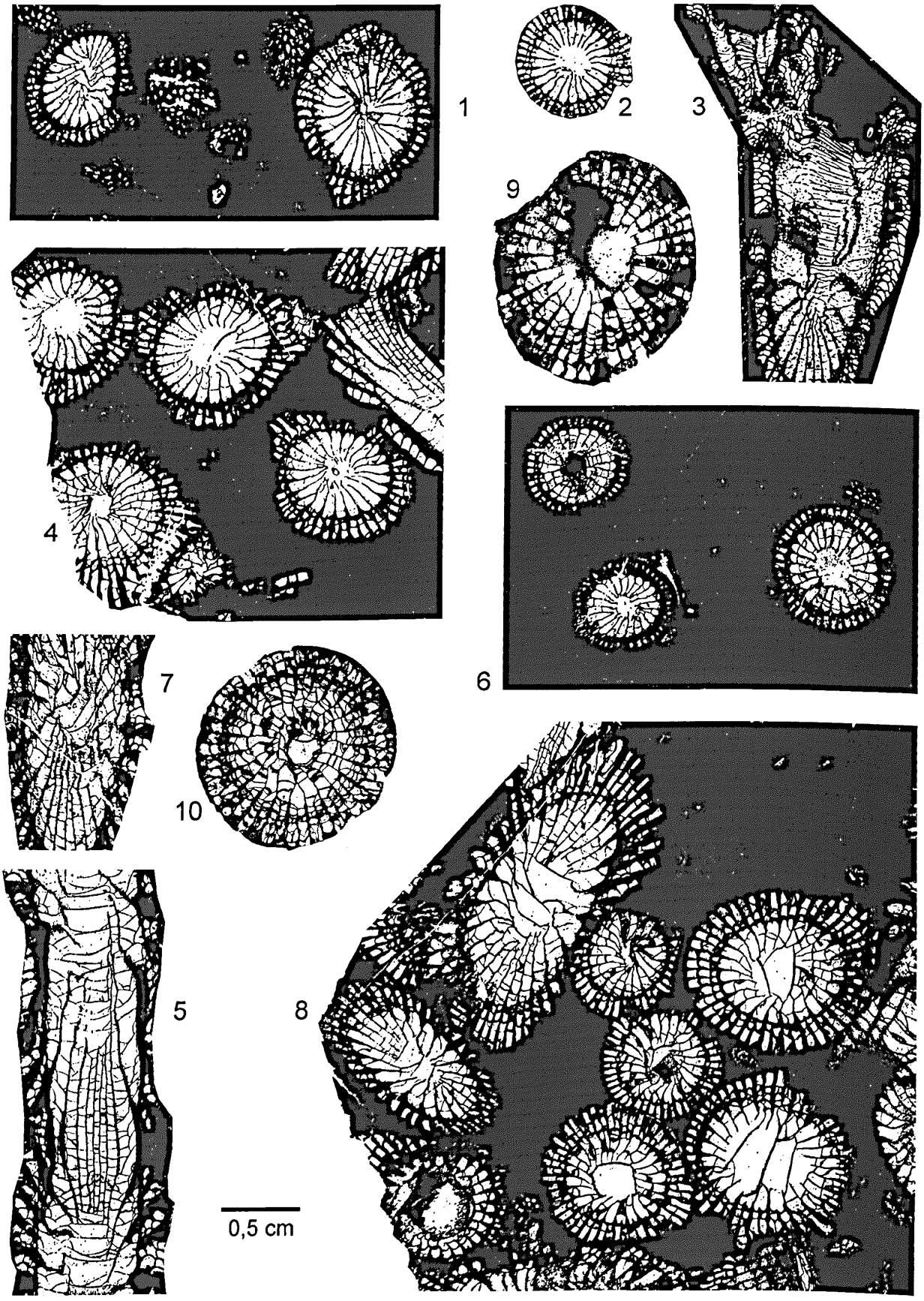

PLATE 5