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A fourth level of Frasnian carbonate mounds along the south side of the Dinant Synclinorium (Belgium)

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Abstract

An additional level of Frasnian mounds has been recognized in the La Boverie quarry at Rochefort and in four boreholes drilled in the Nord quarry at Frasnes, on the south side of the Dinant Synclinorium. It occurs between the Arche and Lion Members belonging respectively to the Moulin Liénaux and Grands Breux Formations, in the middle part of the stage. The new name of La Boverie Member is introduced at the top of the Moulin Liénaux Fm., for the deposits lying between the Arche and Bieumont Members; the latter is the basement of the Lion mound. The same succession has been observed in the sections of Moulin Bayot close to Vodelée, in the southeastern part of the Philippeville Anticlinorium. The La Boverie Member starts with rather deep bioclastic sediments, after the collapse of the carbonate factory at the top of the Arche mound. In the upper part of the lithostratigraphic unit, there is a thin buildup characterized by relatively shallow facies. The solitary rugose corals *Macgeea boveriensis* n. sp., *M. socialis* SOSHKINA, 1939 and *Sinodisphyllum posterum* (IVANIA, 1965) collected in the lower part of the La Boverie Member are described in detail whereas the revision of *S. kielcense* (ROZKOWSKA, 1979) occurring in the Bieumont Member is also provided.

Key words: Frasnian, Sedimentology, Stratigraphy, Rugose corals, Belgium.

Résumé

Un niveau supplémentaire de monticules frasniens a été reconnu dans la Carrière de la Boverie à Rochefort et dans quatre sondages forés dans la Carrière du Nord à Frasnes. Il se trouve entre les Membres de l'Arche et du Lion appartenant respectivement aux Formations du Moulin Liénaux et des Grands Breux, dans la partie moyenne de l'étage. Le nouveau nom du Membre de La Boverie est introduit au sommet de la Formation du Moulin Liénaux, pour les dépôts situés entre les Membres de l'Arche et de Bieumont; ce dernier est le soubassement du monticule du Lion. La même succession a été observée dans les coupes du Moulin Bayot près de Vodelée, dans la partie sud-est de l'Anticlinorium de Philippeville. Le Membre de La Boverie débute par des sédiments bioclastiques, plutôt profonds après l'effondrement de la production carbonatée au sommet du monticule de l'Arche. Dans la partie supérieure de l'unité lithostratigraphique, il y a une mince bioconstruction caractérisée par des faciès relativement peu profonds. Les Rugueux solitaires *Macgeea boveriensis* n. sp., *M. socialis* SOSHKINA, 1939 et *Sinodisphyllum posterum* (IVANIA, 1965) récoltés dans la partie inférieure du Membre de La Boverie sont décrits en détail tandis que la révision de *S. kielcense* (ROZKOWSKA, 1979) présent dans le Membre de Bieumont est également proposée.

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

Introduction and aim of the work

Since the classical studies of MAILLIEUX (1908 and 1913), three levels of carbonate mounds are known in the Frasnian of the southern border of the Dinant Synclinorium, from near Trélon towards the west to Marche-en-Famenne in the east. These are in ascending order the Arche, Lion and Petit-Mont Members (BOULVAIN *et al.*, 1999) belonging respectively to the Moulin Liénaux, Grands Breux and Neuville Formations (Fig. 1). The aim of the present work is to present evidences for the discovery of a fourth level of mounds occurring between the Arche and Lion Members.

The famous Arche and Lion buildups are located in the vicinity of Frasnes (Fig. 2). The Arche Member is exposed in the Arche quarry (LECOMPTE, 1954, CORNET, 1975 and BOULVAIN *et al.*, 2004) whereas the Lion Member is excavated in the Lion quarry (CORNET, 1975 and BOULVAIN *et al.*, 2004) and in the Nord quarry (LECOMPTE, 1954, BOULVAIN & COEN-AUBERT, 1998 and BOULVAIN *et al.*, 2004). Very recently, BOULVAIN *et al.* (2005) gave information about a set of outcrops situated some distance from Frasnes: the La Boverie quarry, close to Rochefort, partially investigated by LECOMPTE (1956) and CORNET (1975) and the Moulin Bayot sections, close to Vodelée, firstly described by DUMOULIN *et al.* (1998). At both locations, it was possible to study a series of buildups starting near the base of the Arche Member and ending within the Lion Member. At both locations also, an additional buildup was recognized between the Arche and Lion Members (BOULVAIN *et al.*, 2005).

The general presence of this additional buildup, though suspected along the south side of the Dinant Synclinorium, is now supported by its occurrence in four boreholes drilled in the Nord quarry at Frasnes. These boreholes

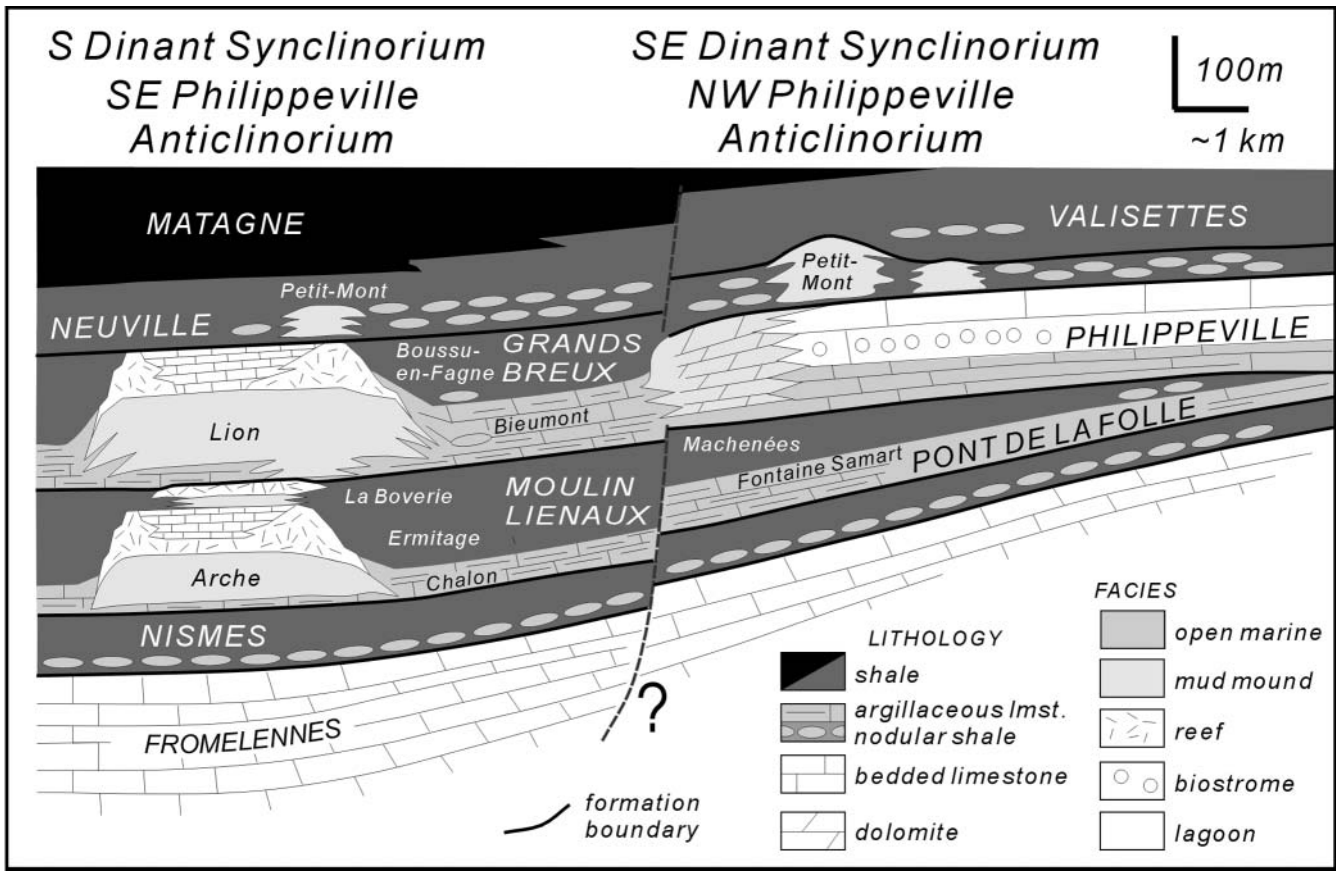

Fig. 1 — Schematic S-N cross-section and lithostratigraphic subdivisions of the Frasnian from the Dinant Synclinorium before Variscan tectonic structuration.

intersect from top to bottom the base of the Lion Member, its basement known as the Bieumont Member, the intermediate level and the uppermost part of the Arche Member. The name of La Boverie Member is introduced herein, as a subdivision of the Moulin Liénaux Fm., for the carbonate deposits lying between the Arche and Bieumont Member. Besides this stratigraphic interpretation, the sedimentology and the rugose corals of this new lithostratigraphic unit are investigated in detail.

Geographical and geological setting

The La Boverie quarry is located at the southeastern edge of the Dinant Synclinorium, 3 km north of Rochefort, on the Gerni plateau (IGN map 59/3, Lambert coordinates: x = 212.000 and y = 97.600). The series of buildups exposed in the quarry is nearly 220 m thick. The buildups extend at least 3.5 km laterally as outcrops of limestone related to them are found close to Humain, approximately 2 km east of the quarry. Eight sections were studied at La Boverie quarry (Fig. 3A) and one in Humain by BOULVAIN *et al.*, 2005.

The Moulin Bayot sections are situated in the southeastern part of the Philippeville Anticlinorium, 1 km west of Vodelée, close to the Hermeton valley (IGN map 58/2, Lambert coordinates: x = 175.000 and y = 95.700). The buildup unit extends laterally for approximately 3.5 km and is more than 150 m thick. Five sections were investigated on both sides of the river, by BOULVAIN *et al.*, 2005.

The Nord quarry is situated 500 m west of Frasnes, at the southern edge of the Dinant Synclinorium (IGN map 57/8, Lambert coordinates: x = 159.400 and y = 85.200). Boreholes were drilled in the floor of the quarry, north of its working face with a dip of 45° towards the south in order to intersect the north dipping beds of the mound (Fig. 3B).

Methods

Classical bed-by-bed description and sampling used in this work were supplemented by magnetic susceptibility analyses. These were carried out on each sample, using a Kappabridge KLY-3 device. The purpose of these analyses was to allow high precision lateral correlations, following the method adopted by CRICK *et al.* (1994).

Description of the sections

The complete sections of La Boverie quarry at Rochefort and Moulin Bayot at Vodelée have been described and

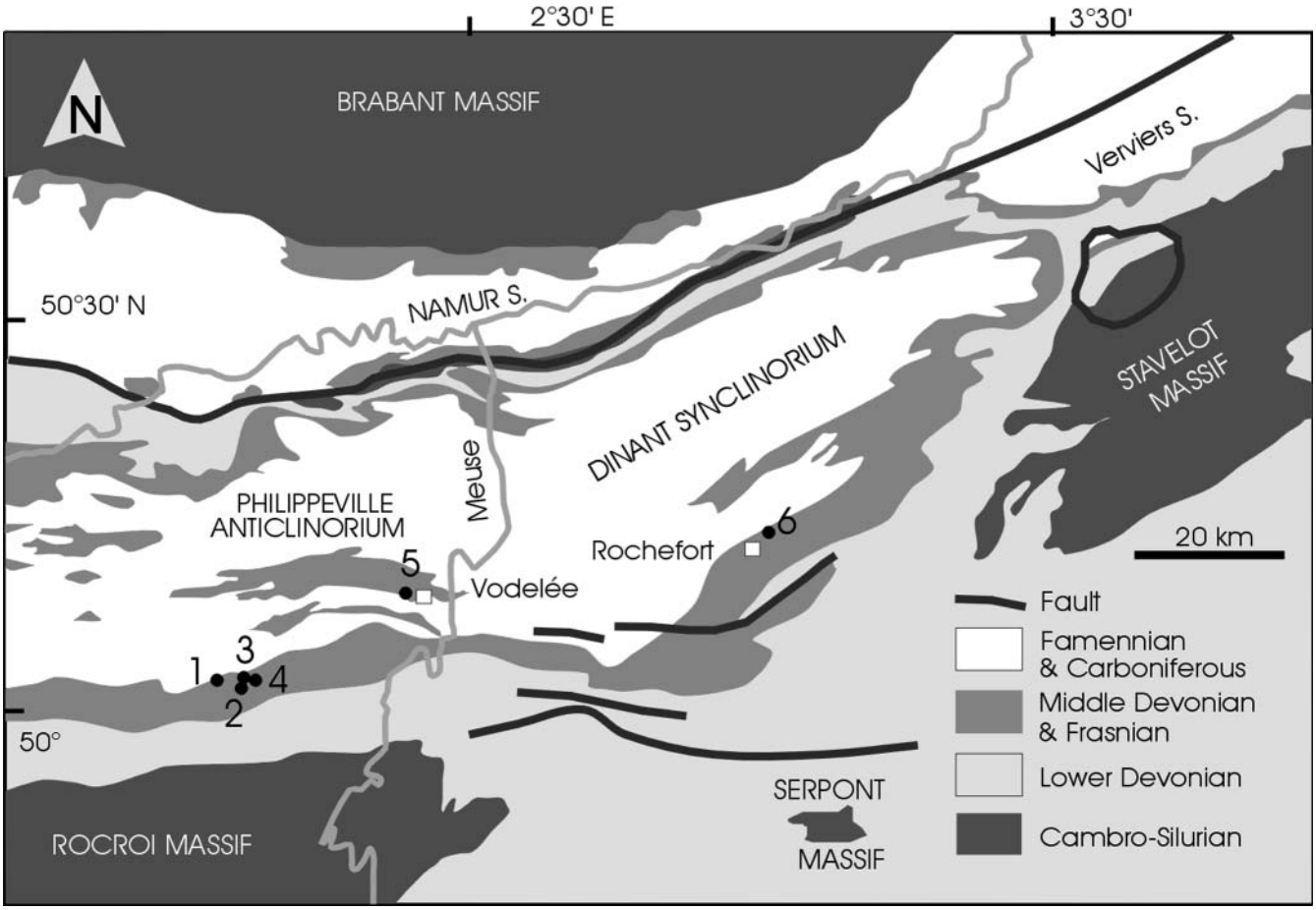

Fig. 2 — Schematic geological map of southern Belgium with location of the outcrops: 1 = Lompret quarry; 2 = Arche quarry (Frasnes); 3 = Nord quarry (Frasnes); 4 = Lion quarry (Frasnes); 5 = Moulin Bayot sections (Vodelée); 6 = La Boverie quarry (Rochefort).

located on a map by BOULVAIN *et al.* (2005). We give here a short description of the beds occurring between the Arche and Lion Members. The numbering of the sections is that from BOULVAIN *et al.* (2005).

LA BOVERIE QUARRY AT ROCHEFORT (Figs. 3A and 5)
In the western section B (corresponding to Rochefort MC-53), the base of the La Boverie Member is represented by nodular shales and argillaceous limestones overlying the Arche Member. These are microbioclastic packstones which contain brachiopods, crinoids, bryozoans, trilobites and fragments of corals and stromatoporoids.

The section F (corresponding to the west face of Rochefort MC-56) shows all the transitional beds of the La Boverie Member. The uppermost part of the Arche buildup is made up of peloidal and lithoclastic grainstones rich in dendroid stromatoporoids. It is capped, from 18 m to 21 m, by an argillaceous limestone, initially bioclastic with crinoids, peloids and brachiopods, then microbioclastic. From 21 to 29 m, there is a massive limestone. Its lower part consists of peloidal-lithoclastic grainstones with some reworked dendroid stromatoporoids; its upper part is composed of microbioclastic-peloidal packstones. From 29 m to 33 m occurs a microbioclastic argillaceous limestone followed from 33 m to 40 m, by grainstones rich in peloids and palaeosiphonocladales. From 40 m to 51 m, the colour of the sediment becomes lighter and grainstones to rudstones with peloids, dendroid stromatoporoids and corals are observed again, passing upwards into rudstones with stromatoporoids and rugose corals. This last unit represents typically the mound facies from the top of the La Boverie Member.

In section D (corresponding to the east face of Rochefort MC-56), the Arche Member (Fig. 4A) is overlain from 75.5 m to 82 m, by an argillaceous bioclastic limestone that includes fragments of corals, crinoids, brachiopods and fenestellids, sometimes with some trilobites. From 82 to 88 m, the facies remains rather similar with some grainstone beds and an increase upwards in peloids and palaeosiphonocladales. From 88 m to 103 m reappears the argillaceous bioclastic facies which locally is relatively rich in peloids. There is a sharp change at 103 m, with the appearance of the mound facies developed up to 113 m and composed of rudstones and grainstones containing stromatoporoids, encrusted rugose and tabulate corals, crinoids, peloids, lithoclasts and palaeosiphonocladales. The uppermost part of the La Boverie Member is a bioturbated fine-grained limestone, at the

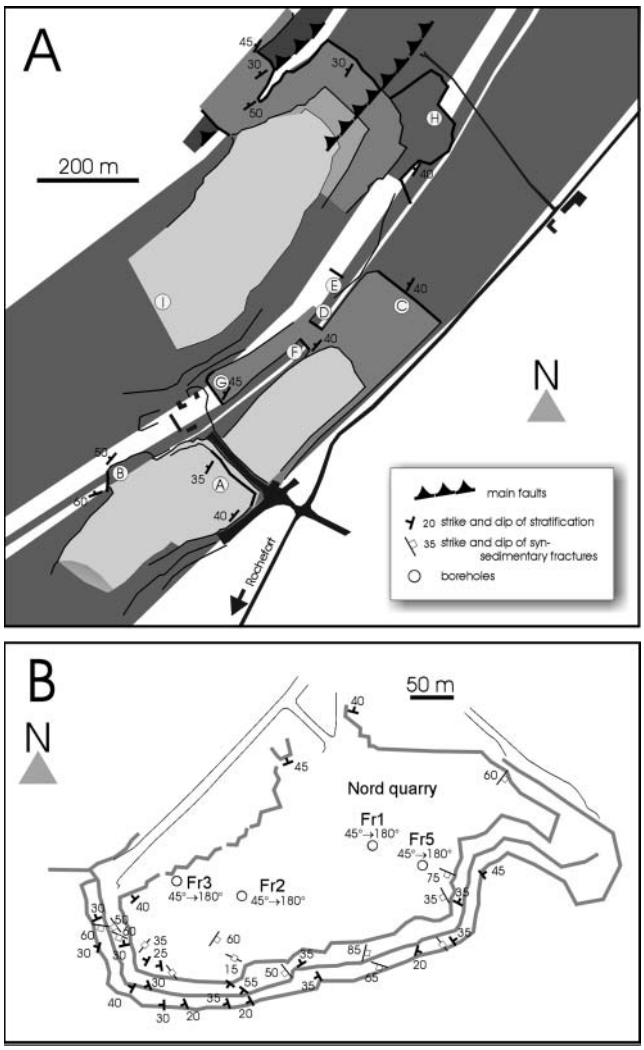

Fig. 3 — A. Location of sections B, D, E, F, G and H in the La Boverie quarry at Rochefort. B. Location of FR1-5 boreholes drilled in the Nord quarry at Frasnes; structural data are from BOULVAIN & COEN-AUBERT (1998).

top of which occurs a hardground with a ferruginous coating. In section E (continuation of Rochefort MC-56 to the east), the Bieumont Member, from 113 m to 130 m, consists of an argillaceous bioclastic limestone including fragments of corals, crinoids, stromatoporoids, brachiopods and fenestellids. This limestone appears to correspond to a succession of tempestites with one short biostromal interval indicated by laminar stromatoporoids.

In section G (corresponding to Rochefort MC-55), the Bieumont Member starts with some beds of argillaceous limestone and then consists of calcareous shales. These rocks are composed of argillaceous, often bioturbated bioclastic packstones with brachiopods, fenestellids, laminar stromatoporoids, crinoids and cricoconarids; further upwards, this unit becomes richer in branching tabulate corals and crinoids with common centimetric lenses of micrite within bioclastic packstones, probably announcing the starting of an indigenous carbonate production. The Lion mound starts sharply at 63 m with greenish-pinkish massive limestone that includes tabulate corals, crinoids, brachiopods and some fasciculate rugose corals or laminar stromatoporoids.

In the eastern and most complete section H (corresponding to Rochefort MC-52), a grey limestone bed marks the top of the Arche Member which is capped by 6 m of argillaceous limestones with lenses of bioclastic grainstone containing brachiopods, crinoids, fenestellids and peloids; these layers are tempestites. From 6 m to 16 m, a nodular shale grades upwards into an argillaceous well sorted bioclastic packstone, progressively enriched with peloids. The interval from 16 m to 26 m consists firstly of a grey bioclastic limestone and then of a light grey, locally laminated, indistinctly bedded limestone including peloids, lithoclasts, dendroid stromatoporoids, calcispheres, palaeosiphonocladales and crinoids. From 26 m to 31.5 m, there are rudstones with bulbous and dendroid stromatoporoids, lithoclasts, peloids and calcispheres, followed by floatstones with solitary and massive rugose corals, tabular stromatoporoids, crinoids, and bioclasts. This mound facies of the La Boverie Member passes upwards, from 31.5 m to 32 m, into a fenestral limestone with peloids, birds-eyes, calcispheres and palaeosiphonocladales. From 32 to 34 m, the Bieumont Member starts with a well sorted, darker bioclastic and argillaceous limestone including crinoids, tabular stromatoporoids and solitary rugose corals with some fenestellids. From 34 to 38 m, shales with bioclastic lenses are observed. Above this and up to 49.5 m, the nodular shale becomes gradually richer in laminar stromatoporoids, tabulate corals as well as in fasciculate and massive rugose corals; centimetric lenses of micrite are locally present. The first unit of the Lion mound is a light grey floatstone with stromatactis, branching tabulate corals, crinoids, brachiopods and stromatoporoids.

MOULIN BAYOT AT VODELEE

In the vicinity of Moulin Bayot, the mound of the La Boverie Member is represented by the upper part of section D. From 53 m to the end of the outcrop, there is a grey floatstone with corals, fenestrae, brachiopods, crinoids, bryozoans and peloids. The top of the section is characterized by bioclastic sediments rich in peloids overlying the bioconstructed facies. Close to 63 m, decimetric stromatactis are connected to neptunian dykes and filled with red microsparitic internal sediments.

The laterally time-equivalent section A exposes flank deposits. Above 5 m of shales, there are 3 m of black bioclastic limestones passing into 6 m of grey brown limestones. Further upwards, the section ends with a lighter-coloured and more massive limestone. The whole section is characterized by an alternation of bioclastic grainstones with peloids and lithoclasts, and argillaceous microbioclastic packstones with some peloids.

BOREHOLES IN THE NORD QUARRY AT FRASNES (Figs. 3B and 7)

In the FR3 borehole, the La Boverie Member is characterized, from 90 m to 79 m, by light grey massive lime-

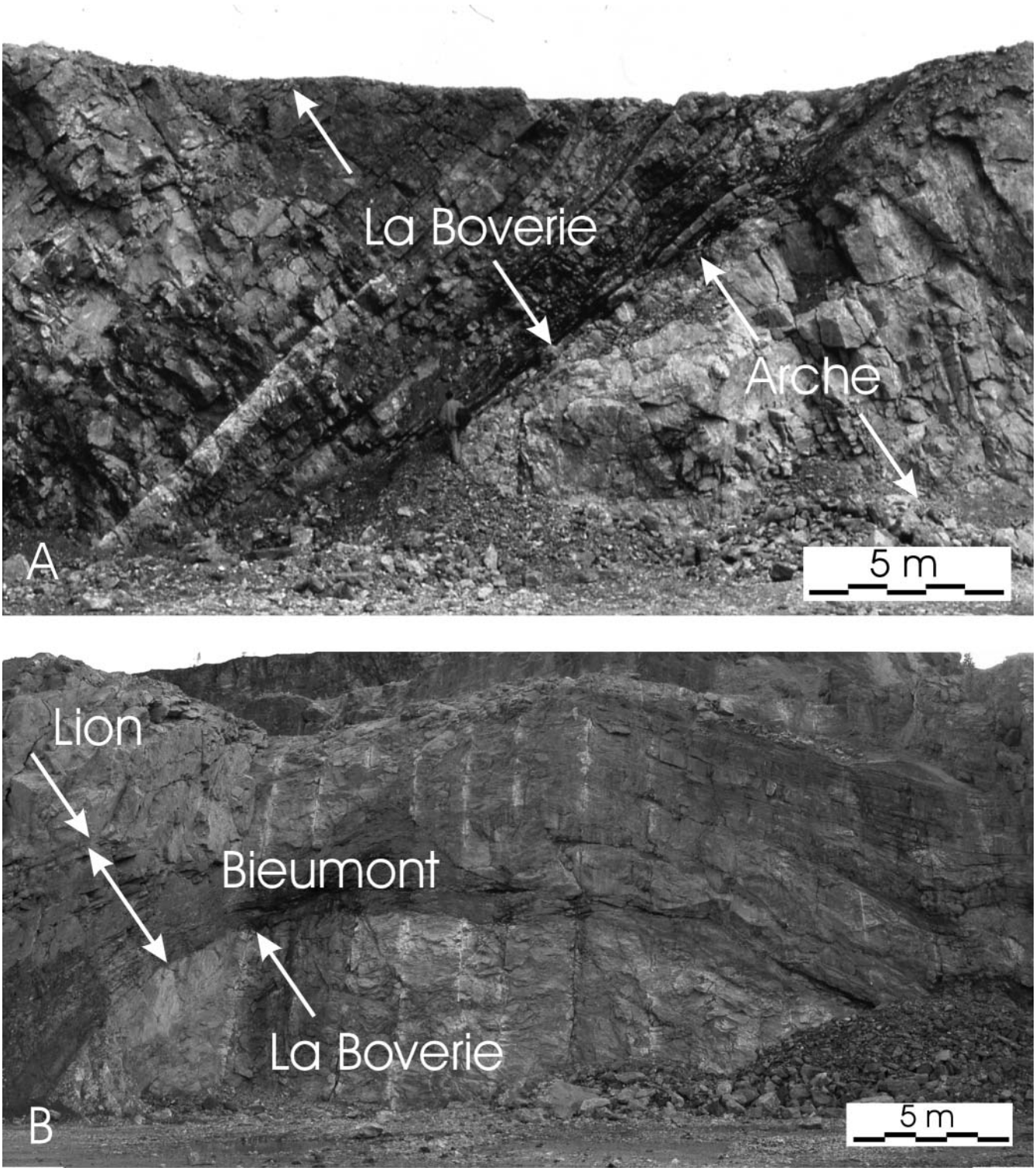

Fig. 4 — A. Photograph showing the transition between the upper part of the Arche Member (to the right) and the lower part of the La Boverie Member (argillaceous bioclastic facies) in section D of La Boverie quarry at Rochefort. B. Photograph showing the upper part of the La Boverie Member (massive reef facies), the Bieumont Member and the base of the Lion Member in the Nord quarry at Frasnes.

stones with some dendroid stromatoporoids and thrombolites; however, the limestone is slightly nodular and crinoidal in the bottom, with some corals at 88 m. Above this and up to 67 m, branching tabulate corals, laminar stromatoporoids and microbial mats dominate. At the top of the La Boverie Member, the limestone shows, between 67 m and 62 m, dm-sized stromatactis with some fasciculate rugose corals. From 62 m to 58 m, the Bieumont Member consists of dark shales with dm-sized bioclastic limestone lenses which are sometimes red at the top; massive rugose corals, branching tabulate corals and crinoids are locally scattered in these shales. The lower

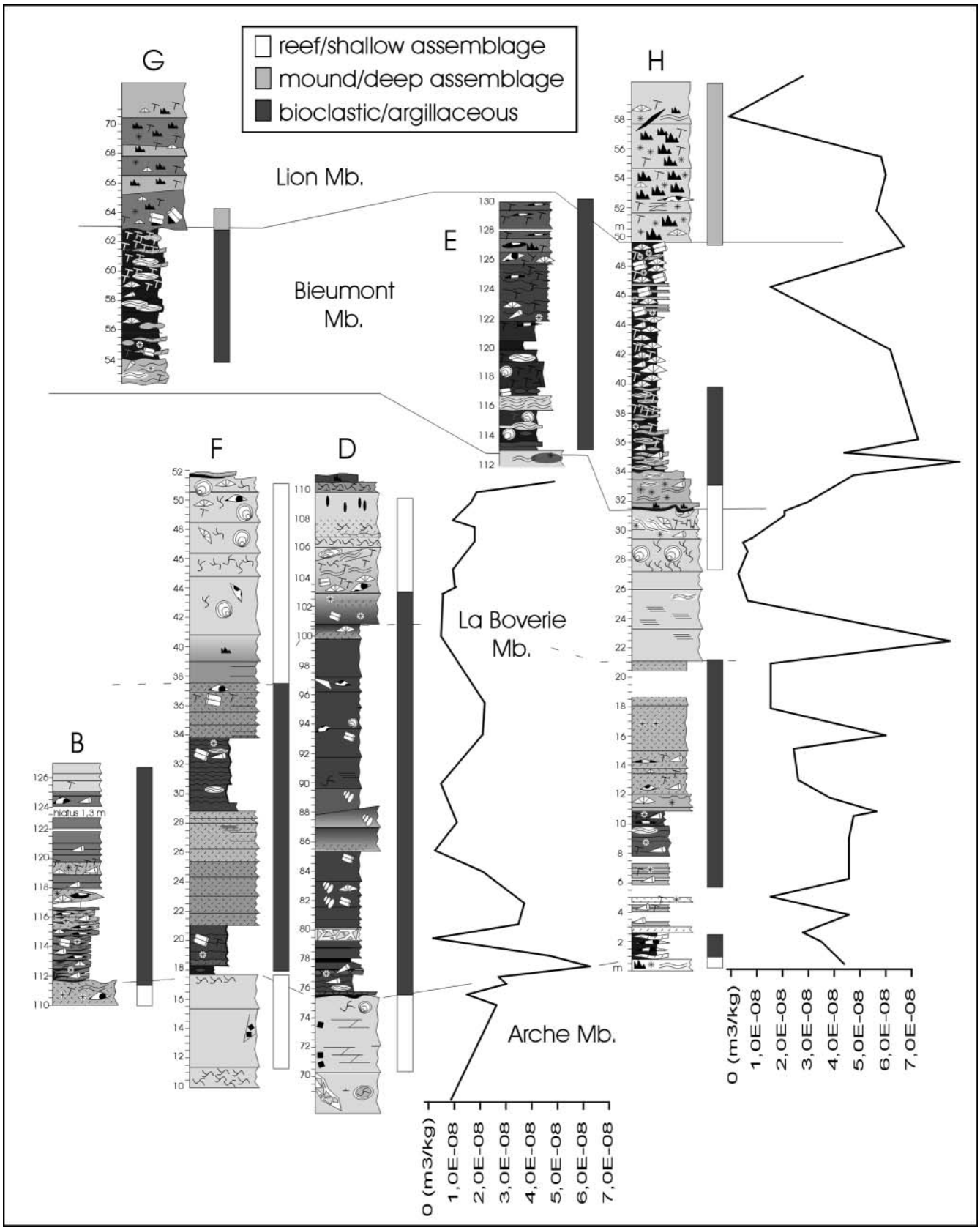

Fig. 5 — Lithologic logs of the La Boverie sections at Rochefort with facies interpretation and curves of magnetic susceptibility. (For explanation of conventional signs, see Fig. 6).

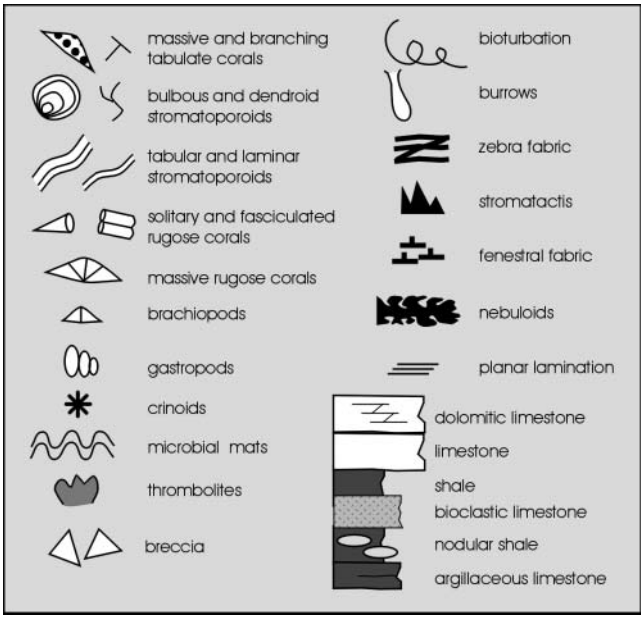

Fig. 6 — Explanation of conventional signs used in Figs. 5 and 7.

unit of the Lion mound (58 m - 49 m) is a red floatstone with stromatactis, massive and branching tabulate corals, crinoids and brachiopods. Further upwards, the limestone becomes grey.

The FR2 borehole intersects, up to 76.35 m, the upper part of the Arche Member which is characterized by a light grey limestone with dendroid and laminar stromatoporoids, microbial mats and branching tabulate corals. From 76.35 m to 75 m, the La Boverie Member starts sharply with dark shales containing bioclastic limestone lenses, crinoids and branching tabulate corals. Then, between 75 m to 72 m, dark grey limestones with fasciculate rugose corals, crinoids and branching tabulate corals are intercalated with layers of green shale. Above a 0.5 m dark shale level with branching tabulate corals and up to 61 m, the same dark grey limestone is observed, including massive and branching tabulate corals and crinoids. The next unit, from 61 m to 40 m, is characterized by dark grey limestones with dendroid and laminar stromatoporoids, microbial mats and crinoids; in the upper part of this unit, the colour changes to light grey, locally with reddish patches whereas stromatactis are observed close to the top of the La Boverie Member. The Bieumont Member consists, from 40 m to 32 m, of dark shales with crinoids, branching tabulate corals and local accumulations of massive rugose corals; between 32 m and 29 m, there are also laminar stromatoporoids in a more or less argillaceous limestone. From 29 m to 19 m, the lower part of the Lion Member is a grey limestone very rich in branching tabulate corals with subordinate laminar stromatoporoids.

In the bottom of the FR1 borehole, there are 2.6 m of red limestone containing branching and massive tabulate corals, laminar stromatoporoids and crinoids. These deposits are capped, between 87.7 m and 84 m, by grey argillaceous crinoidal limestones with some diverse tabulate corals; this facies recalls the base of the La Boverie Member. The next interval, from 84 m to 74 m, consists of dark grey limestones with stromatactis, laminar stromatoporoids and crinoids. From 74 m to 55 m, there are light grey limestones which include nebuloids, branching tabulate corals, microbial mats, dendroid and laminar stromatoporoids, stromatactis and some fasciculate or solitary rugose corals. A 1 cm thick bed of shale is covered up to 43 m, by dark grey or locally reddish limestones with dm-sized stromatactis, branching tabulate corals and crinoids. Between 43 m and 40.5 m, the Bieumont Member is represented by reddish to grey argillaceous limestones with branching tabulate corals, crinoids and massive rugose corals. It passes upwards into light grey massive limestones with massive and branching tabulate corals, belonging to the Lion Member.

The upper part of the Arche Member in the FR5 borehole is composed of a light grey limestone with microbial mats and dendroid or laminar stromatoporoids. This unit passes upwards (57 m - 45 m) into a red limestone that contains laminar stromatoporoids, branching or massive tabulate corals, stromatactis and some massive or solitary rugose corals. The next unit, from 45 m to 21 m, consists of a dark grey to light grey limestone with the same assemblage; microbial mats become more abundant upwards. At the base of the Bieumont Member, there is a 10 cm bed of dark shale which is succeeded by an argillaceous limestone with crinoids, massive rugose coral and branching tabulate corals. Dark shales include, from 20.5 m to 16 m, lenses of red limestone, lithoclasts, solitary and massive rugose corals, crinoids, brachiopods and branching tabulate corals. The Lion Member starts at 16 m with light grey limestones rich in branching tabulate corals, crinoids and laminar stromatoporoids, grading upwards into stromatactis-coral-crinoid floatstone. In this hole, there is no interruption of the mound sedimentation between the top of the Arche Member at 57 m and the base of the Bieumont Member at 21 m. Only the occurrence of red limestone from 57 m to 45 m seems to correspond to the deepening event that characterizes usually the base of the La Boverie Member.

Lithostratigraphic interpretation

In the La Boverie quarry at Rochefort, the argillaceous and bioclastic limestones capping the Arche Member were assigned to the Ermitage Member by BOULVAIN *et al*. (2005). These facies change rapidly upwards into a relatively thin buildup unit that was interpreted as the final development of the Arche Member. The more argillaceous deposits which follow, were ascribed to the Bieumont Member. The 70 m thick Lion Member overlies these argillaceous-bioclastic facies.

When considering the good lateral continuity of the intermediate buildup and its basement, now observed from Rochefort to Frasnes and Vodelée, it seems interesting to introduce a new name of member for the layers

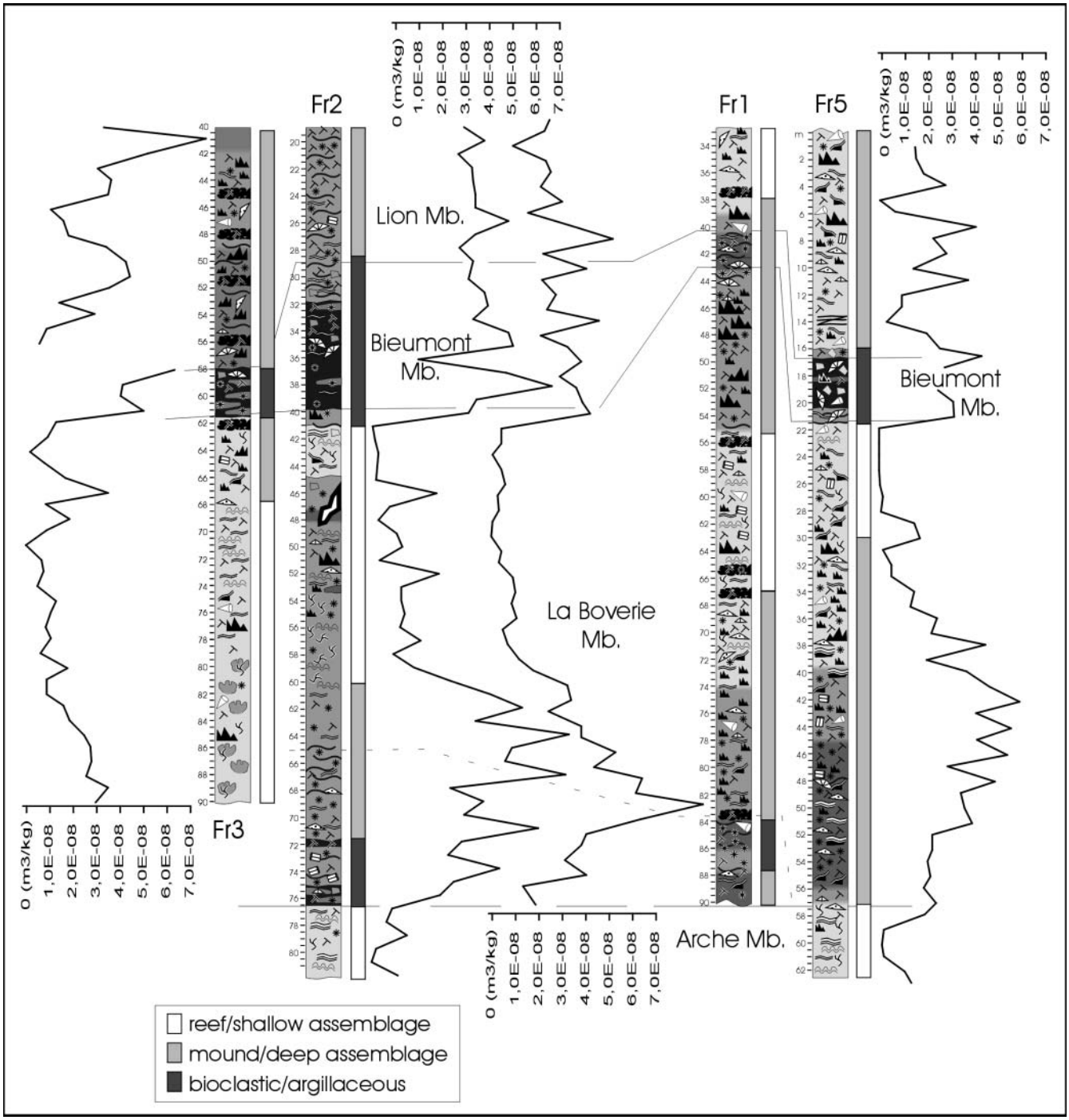

Fig. 7 — Lithologic logs of the boreholes drilled in the Nord quarry at Frasnes with facies interpretation and curves of magnetic susceptibility. (For explanation of conventional signs, see Fig. 6).

lying between the Arche and Bieumont Members. As these deposits are very well exposed in the La Boverie quarry, the name of La Boverie Member is proposed herein. This lithostratigraphic unit is the upper subdivision of the Moulin Liénaux Fm. in the reefal areas. In the vicinity of Rochefort, the La Boverie Member reaches a thickness of more than 30 m so that it can certainly be used from a mapping point of view. It was not recognized in the area of Frasnes by MARION & BARCHY (1999) because it was probably included in the upper part of the Arche Member. In the non reefal areas, which is the normal facies of the Frasnian along the south side of the Dinant Synclinorium, the carbonate sediments of the La Boverie Member pass laterally into fine shales forming the upper part of the Ermitage Member. This succession was described among others by COEN (1974 and 1977, unit b' and above) at Barvaux-sur-Ourthe and Han-sur-Lesse close to Rochefort.

In the La Boverie quarry at Rochefort, the La Boverie Member is clearly subdivided into a lower argillaceous part which is 22 m to 27.5 m thick and a mound unit which is restricted to its top with a thickness of 6 m to 11 m. In boreholes FR3, FR2 and FR1 drilled in the Nord quarry at Frasnes, argillaceous or nodular limestones are present at the base of the La Boverie Member, but the mound facies is more developed than at La Boverie quarry. In the borehole FR5, only red limestone occurs at the base of the new member. The Bieumont Member is highly coralliferous in the La Boverie and Nord quarries. But corals have been observed by BOULVAIN *et al.* (1999, p. 51), in the Bieumont Member of several localities from the south side of the Dinant Synclinorium such as Han-sur-Lesse, Focant and Barvaux-sur-Ourthe. As this lithostratigraphic unit is the basement of the Lion Member, the abundance of corals is certainly related to the development of large mounds in the La Boverie and Nord quarries.

Facies architecture and sedimentary dynamics

The first observation concerns the thickness of the La Boverie Member. It is rather steady, from about 34 m in the La Boverie quarry at Rochefort to 36 m or locally 45 m in the boreholes drilled in the Nord quarry at Frasnes. Lateral variations are rather related to facies than to thickness changes. Due to very precise lateral correlations based on curves of magnetic susceptibility, it is possible to reconstruct, time step by time step, the development of the intermediate buildup and its basement.

The top of the Arche Member (Fig. 8) consists everywhere of grey massive limestone with microbial mats and/or dendroid stromatoporoids. This shallow facies forms usually the upper part of the Arche and Lion Members (BOULVAIN *et al*., 2004 and 2005). Above this and with a sharp contact, there is a dark shale including bioclastic lenses or beds, except in the FR5 borehole at Frasnes and in section D of Moulin Bayot at Vodelée where there is a gradual transition upwards to a red limestone unit with stromatactis, corals and stromatoporoids. This implies the collapse of the Arche mound carbonate factory with the deposition of relatively deep argillaceous sediments. Very locally, carbonate production is maintained, but shows a severe facies retrogradation and the replacement of a microbial mat-dendroid stromatoporoid assemblage by a sponge-coral-crinoid assemblage often red coloured by iron bacteria (BOULVAIN *et al.*, 2001). Later, the carbonate accumulation increases and the shale is replaced upwards by argillaceous bioclastic limestones. Growing centres remain localized. This unit corresponds to the lower 15-20 m of the La Boverie Member. The next unit is laterally homogeneous. It consists of a massive, generally light grey limestone rich in dendroid or massive stromatoporoid, tabulate corals and microbial mats. This is a shallow facies close to that from the top of the Arche Member. This rapid

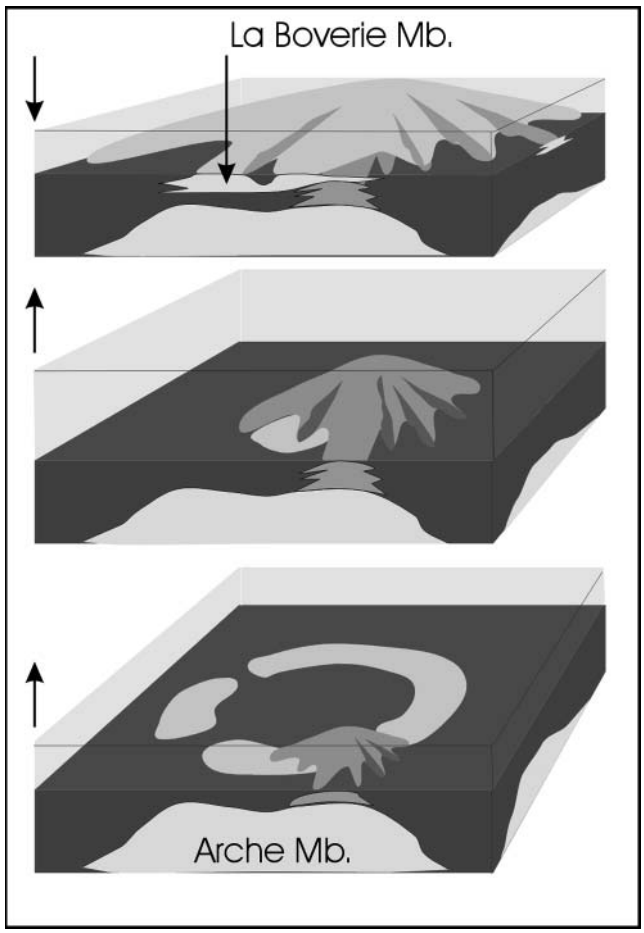

Fig. 8 — Model for the La Boverie Member development as a function of eustatic variations. Reef facies are in light grey, mound facies in medium grey and argillaceous bioclastic facies are in dark grey.

transition and the lateral progradation of a relatively shallow facies over deeper bioclastic sediments or mound facies are obvious in all sections. It suggests a sudden restart of the shallow-water carbonate factory, probably related to a sea-level fall. This second unit corresponds to the upper 10-20 m of the La Boverie Member. Hardgrounds are locally developed on the top of the buildups (section D at La Boverie).

The transition to the Bieumont and Lion Members resembles that between the Arche and La Boverie Members. It is mainly characterized by the collapse of the carbonate factory with widespread deposition of shales and bioclastic limestone lenses, except in some local areas such as the FR1 borehole at Frasnes where buildup development keeps on. These isolated ''survival'' mounds show again a return to the deeper sponge-coral-crinoid assemblage.

Stratigraphic distribution of the rugose corals

The rugose corals are very abundant in the La Boverie quarry. Large coralla of *Macgeea boveriensis* n. sp.,

M. socialis SOSHKINA, 1939 and *Sinodisphyllum posterum* (IVANIA, 1965) are observed at the base of the La Boverie Member. *Hexagonaria mirabilis* MOENKE, 1954 is already present 6 m above the top of the Arche Member, in section B. In the middle part of the La Boverie Member, there are several beds rich in fasciculate colonies of *Disphyllum* de FROMENTEL, 1861 and *Peneckiella* SOSHKINA, 1939. Accumulations of such thickets may constitute locally a coralliferous basement for the small mound which characterizes the top of La Boverie Member. In section D, *Hexagonaria mirabilis* occurs just below and at the base of this buildup. As mentioned by BOULVAIN *et al.* (2005), the highly diversified fauna of the Bieumont Member is represented by *H. mirabilis*, *S. balconi* COEN-AUBERT, 1980, *Peneckiella fascicularis* (SOSHKINA, 1939), *P. isylica* (BULVANKER, 1958), *Sinodisphyllum kielcense* (ROZKOWSKA, 1979), *Tabulophyllum conspectum* TSIEN, 1977, *T. sylvaticum* ROHART, 1988 and *Aristophyllum irenae* ROZKOWSKA, 1979 with some small specimens of *Macgeea socialis*. *Hexagonaria mirabilis* has also been collected in the lower part of the Lion Member and at the base of the argillaceous deposits of the Boussu-en-Fagne Member overlying this level of mounds.

In the Nord quarry at Frasnes, the La Boverie Member is rather poor in rugose corals which are mostly restricted to its lower part. One specimen of *Sinodisphyllum posterum* has been identified at 76.7 m, in borehole FR1. In borehole FR5, some colonies of *Hexagonaria mirabilis* and *Disphyllum* are present at the top of the red limestone occurring between 45 m and 57 m, above the grey limestone characteristic of the main part of the Arche Member. In borehole FR2, several levels with fasciculate colonies of *Disphyllum* have been observed close to the base of the La Boverie Member.

The thickness of the Bieumont Member is variable in the drill holes. This is also the case in the quarry itself where this lithostratigraphic unit has been completely excavated since the paper of BOULVAIN & COEN-AUBERT (1998). Moreover, its upper boundary is typically undulated with injections of black argillaceous limestones (Fig. 4B) so that these deposits have been confused with those of a neptunian sill by BOULVAIN & COEN-AUBERT (1998); at this time indeed, they were only cropping out locally at the base of the working face. In the Nord quarry, the rugose corals of the Bieumont Member are numerous, but exhibit a much lower diversity than at La Boverie quarry as they are only represented by *Hexagonaria mirabilis*, *Tabulophyllum sylvaticum* and *Aristophyllum irenae*.

Systematic Palaeontology

As the fauna of the La Boverie Member was unknown until now, the systematic description of the solitary rugose corals *Macgeea boveriensis*, *M. socialis* and *Sinodisphyllum posterum* is presented herein. In relation to the latter taxon, the revision of *S. kielcense* occurring in the Bieumont Member is also provided. The types of the new species and the figured specimens are stored in the collections of the Institut royal des Sciences naturelles de Belgique (IRScNB).

Family PHILLIPSASTREIDAE ROEMER, 1883
Genus *Macgeea* WEBSTER, 1889

= *Pterorrhiza* EHRENBERG, 1834
= *Pexiphyllum* WALTHER, 1929

Type species
By subsequent designation of FENTON & FENTON (1924, p. 54), *Pachyphyllum solitarium* HALL & WHITFIELD, 1873

DIAGNOSIS
Solitary rugose corals with a deep calice and the epitheca not quite extending to the rim of the calice so that the peripheral edges of the septa are exposed distally. Septa of two orders, non-carinate or sometimes faintly carinate, more or less long and dilated in the dissepimentarium, thin in the tabularium. Dissepimentarium with one outer row of flat dissepiments, a median pipe of horseshoe dissepiments and a few inner rows of small inclined dissepiments. Symmetrical fans of rhipidacanths centred over horseshoe dissepiments. Wide tabularium with incomplete or compound tabulae.

Macgeea boveriensis n. sp.
Plate 1, Figures 1-7, Plate 2, Figures 9, 10

v. 2005 — *Macgeea* sp. B – BOULVAIN *et al.*, p. 81, fig. 10.

Derivatio nominis
Latin adjective: *boveriensis, e* referring to La Boverie, type locality of the new species.

Holotype
IRScNB a12179 (=Pl. 1, Figs. 4, 5). Specimen Rochefort MC-52-C50 collected by COEN-AUBERT in 1995, 10 m above the base of the La Boverie Member of the Moulin Liénaux Fm..

Locus typicus
Northeast La Boverie excavation (Rochefort MC-52) corresponding to section H (Fig. 3A) and located 3 km to the north of Rochefort. Map sheet Rochefort 59/3, Lambert coordinates: x = 212.125 and y = 97.675, south side of the Dinant Synclinorium, Belgium.

Stratum typicum
Lower part of the La Boverie Member of the Moulin Liénaux Fm., middle part of the Frasnian.

Material and localities
Eighteen specimens with 32 thin sections. Personal sampling: Rochefort MC-52-B927, B930, B932, B936, B939, B944, B949, B950, B953, B959, C50, C52, C54, C319, C321, C322 and C323; Rochefort MC-56-C257.

DIAGNOSIS

A species of *Macgeea* with 68 to 78 septa at a diameter of 20 mm to 27 mm. Septa typically dilated in the wide dissepimentarium which includes several rows of inner dissepiments. Major septa leaving usually an open space in the centre of the tabularium.

DESCRIPTION

The material consists of ceratoid and sometimes conical or cylindrical coralla which are complete or fragmentary with frequent longitudinal ribs. Their height varies between 2 cm and 7 cm. In one specimen, prominent septal ridges are exposed above a low collar of epitheca at the margin of the calice. The outer wall is not very well preserved and is rarely encrusted by alveolitids.

The septa are normally non-carinate or bear locally a few spinose carinae. They are strongly dilated in the dissepimentarium where they are often characterized by a dark median line sometimes with small ramifications. The septa become usually thin beyond their entry into the tabularium and are rarely slender in the outer zone of flat dissepiments. In transverse section, the pipe of horseshoe dissepiments is occasionally coated with stereome, especially on its external side whereas the inner dissepiments are commonly apparent.

The major septa leave a more or less extensive open space in the centre of the tabularium, but in some specimens, they may also nearly reach the axis of the corallum. Their axial ends are sometimes forked, discontinuous, rhopaloid, curved, wavy, twisted or fusing to form pseudofossulae. The minor septa traverse the entire dissepimentarium or even enter into the tabularium where they may be contratingent. Occasionally, they are shorter or discontinuous at their inner ends.

The rather wide dissepimentarium consists of:
- one peripheral row of flat dissepiments, sometimes concave or intersecting laterally, which are not always preserved;
- one row of irregular horseshoe dissepiments with narrow symmetrical fans of rhipidacanths centred over them;
- 0 to 6 rows of inner inclined dissepiments more numerous in the upper part of the corallum.

In a few specimens, one or two rows of external inclined dissepiments occur intermittently between the flat and horseshoe dissepiments whose pipe is locally slightly thickened along its outer wall. A talon composed of globose dissepiments is present close to the base of several coralla. The tabulae are incomplete and intersecting laterally; their axial parts may be horizontal, concave or flat-topped.

There are 64 to 80 septa per corallum. The diameter of the corallum ranges from 16 mm to 32 mm. The width of the tabularium varies commonly between 13 mm and 18 mm and more generally between 10.5 and 21 mm.

DISCUSSION

Macgeea boveriensis is closely related to *M. proteus* SMITH, 1945 from the Mid Frasnian of the Northwest Territories in Canada which has been revised by MCLEAN (2005, p. 23). However, the latter species is separated from the former by the smaller size of the corallum characterized by more dilated septa in a rather narrow dissepimentarium with nevertheless several rows of inner dissepiments. In Belgium, *M. boveriensis* shows many affinities with the two younger subspecies *M. gallica gallica* LANG & SMITH, 1935 and *M. gallica gigantea* BRICE & ROHART, 1974 described by COEN-AUBERT (1982) and collected in the Boussu-en-Fagne Member of the Grands Breux Fm., on the south side of the Dinant Synclinorium. *M. gallica gallica* is distinguished from the new taxon by smaller coralla and tabularia and by major septa that are longer and less thick in the dissepimentarium. These last two features are also present in *M. gallica gigantea* which has additionally greater diameter and septal number as well as more series of inner dissepiments. In transverse section, *M. boveriensis* resembles the fragmentary holotype of *Debnikiella formosa* ROZKOWSKA, 1979 from the Frasnian of the Silesia-Cracow Upland in Poland, type species of *Debnikiella* ROZKOWSKA, 1979 and assigned to *Macgeea (Rozkowskaella)* WRZOLEK, 1987 by COEN-AUBERT & WRZOLEK, (1991, p. 12). But *M. (R.) formosa* differs from *M. boveriensis* by a wider dissepimentarium consisting of flat and external dissepiments, strongly arched dissepiments instead of horseshoe dissepiments and numerous rows of inner inclined dissepiments.

GEOGRAPHIC AND STRATIGRAPHIC OCCURRENCE

The species is only known in the middle part of the Frasnian of Belgium. The material sampled by the author comes from the lower part of the La Boverie Member of the Moulin Liénaux Fm. at Rochefort, on the south side of the Dinant Synclinorium.

Macgeea socialis SOSHKINA, 1939
Plate 2, Figures 1-8

* p. 1939 — *Macgeea socialis* sp. nov. – SOSHKINA, pp. 22, 50, pl. 2, figs. 13-16 (non pl. 2, figs. 17, 18).
1949 — *Macgeea (Macgeea) sozialis* Soshkina – VON SCHOUPPÉ, p. 174.
v 2005 — *Macgeea* sp. A – BOULVAIN *et al.*, p. 81, fig. 10.

Holotype

Pl. 2, figs. 15, 16 *in* SOSHKINA (1939). Specimen 519 and thin sections 355-356, 295 stored in the Palaeontological Institute, Russian Academy of Sciences in Moscow, Russia. Point 4582 along the Irgizla river, a tributary of the Belaya river, Southern Urals in Russia. Lower limestone beds overlying the Pashia ore-bearing series, lower part of the Frasnian.

Material and localities

Fifteen specimens with 22 thin sections. Personal sampling: Rochefort MC-52-B923, B929, B940, B942, B951 and B962; Rochefort MC-55-C153, C489 and C650; Rochefort MC-56-C252, C262, C298, C396, C407 and C410.

DIAGNOSIS

A species of *Macgeea* with 56 to 66 septa at a diameter of 13 to 20 mm. Septa typically dilated in the dissepimentarium which includes few rows of inner dissepiments. Major septa leaving an open space in the centre of the tabularium.

DESCRIPTION

The material consists of conical, trochoid or ceratoid coralla which are complete or fragmentary with frequent longitudinal ribs. Their height varies between 1.5 cm and 5.5 cm. One specimen is affected by rejuvenescence. The outer wall is not very well preserved and is rarely encrusted by auloporids or algae.

The septa are normally non-carinate or bear locally a few small carinae. They are dilated in the dissepimentarium where they may be characterized by a dark median line. The septa become thin or sometimes less thick beyond their entry into the tabularium. In some coralla, the septa are occasionally slender or discontinuous in the outer zone of flat dissepiments. In transverse section, the pipe of horseshoe dissepiments is often coated with stereome whereas there are rather few inner dissepiments apparent.

The major septa leave a more or less extensive open space in the centre of the tabularium; their axial ends are sometimes discontinuous, rhopaloid, curved or wavy. The minor septa traverse the entire dissepimentarium or even enter into the tabularium where they may be contratingent or divided into isolated fragments; they are occasionally shorter.

The dissepimentarium consists of:

– one peripheral row of flat dissepiments, sometimes concave or intersecting laterally, which are not frequently preserved;
– one row of irregular horseshoe dissepiments with narrow symmetrical fans centred over them; this pipe is coated with stereome on both sides, in several coralla;
– 0 to 4 or 5 rows of inner inclined dissepiments which are only locally present in many specimens.

The tabulae are incomplete and intersecting laterally; their axial parts are horizontal, concave, convex or flat-topped.

There are 50 to 72 septa per corallum. The diameter of the corallum ranges from 11 mm to 24 mm. The width of the tabularium varies commonly between 10 mm and 16.5 mm and more generally between 8.5 mm and 18 mm.

DISCUSSION

The Belgian material is similar to the holotype of *Macgeea socialis* figured by SOSHKINA (1939, pl. 2, figs. 15, 16). The paratype illustrated by this author (Pl. 2, figs. 17, 18) is very different as it is represented by a smaller corallum with fewer septa and only globose dissepiments. According to IVANOVSKI & SHURIGINA (1980, p. 22), *M. socialis* should be placed in synonymy with *M. berdensis* SOSHKINA, 1939 also from the Frasnian of the Urals in Russia. But this species is separated from *M. socialis* by septa strongly dilated in the dissepimentarium with some stereoplasmic thickenings and by several rows of inner dissepiments. There are some affinities between *M. socialis* and the paratype of *Debnikiella formosa* investigated by ROZKOWSKA (1979, pl. 3, fig. 12); this specimen is only known in transverse section and is also assigned to *Debnikiella* sp. by ROZKOWSKA (1979, p. 26).

In Belgium, *Macgeea socialis* is easily distinguished from *M. boveriensis* by fewer septa, a smaller size and a narrower dissepimentarium due to the weak development of the inner dissepiments. *M. socialis* is also related to *M. lacroixi* COEN-AUBERT, 1982 whose type series at Huy, on the south side of the Namur Synclinorium, comes from the lower part of the Lustin Fm. belonging to the middle part of the Frasnian. However, the latter taxon differs from the former by smaller septal number, diameters of the corallum and the tabularium and by much thicker septa in the dissepimentarium.

Finally, *M. socialis* resembles *M. symmetrica* SONG, 1974 and *M. bathycalyx yunnanensis* SONG, 1974 from the Upper Givetian of Western Yunnan in China, taxa that were reillustrated by SONG (1982, pl. 2, figs. 1, 3 and pl. 3, fig. 3). Both Chinese species and subspecies are characterized by smaller coralla with additionally slightly fewer septa in *M. symmetrica*. Moreover, the major septa may be longer in *M. bathycalyx yunnanensis* than in *M. socialis*. *M. bathycalyx yunnanensis* is considered as a synonym of *M. bathycalyx* (FRECH, 1886) by WANG (1994, p. 426) whereas it is regarded as a separate taxon by SCHRÖDER (1996, pp. 55 and 57) after his selection of a neotype for the German species collected in the Upper Eifelian of the Eifel Hills. This type specimen is separated from *M. socialis* by its smaller size and by rather thin septa at the periphery. The remainder of the material referred by SCHRÖDER (1996) to *M. bathycalyx* is heterogeneous with sometimes very dilated septa in the dissepimentarium.

GEOGRAPHIC AND STRATIGRAPHIC OCCURRENCE

The material sampled by the author at Rochefort, on the south side of the Dinant Synclinorium, comes from the lower part of the La Boverie Member of the Moulin Liénaux Fm. and from the Bieumont Member of the Grands Breux Fm.

Outside Belgium, *Macgeea socialis* is known only in the lower part of the Frasnian from the Southern Urals in Russia.

Family DISPHYLLIDAE HILL, 1939
Genus *Sinodisphyllum* SUN, 1958

= ?*Mansuyphyllum* FONTAINE, 1961

Type species

By original designation, *Disphyllum (Sinodisphyllum) variabile* SUN, 1958.

DIAGNOSIS
Solitary rugose corals. Septa of two orders, non-carinate to faintly carinate, more or less dilated in the dissepimentarium and thin in the tabularium. No stereoplasmic thickening against the wall or within the dissepimentarium. Major septa rather long. Minor septa traversing the entire dissepimentarium. Dissepimentarium composed of several rows of small inclined dissepiments which are more or less often arranged in horizontal layers at the periphery. Tabulae incomplete or compound.

DISCUSSION
The genus *Sinodisphyllum* SUN, 1958 has been used recently by different authors such as LIAO & BIRENHEIDE (1989), MCLEAN (1993), ROHART (1999 and 2002) and MA *et al.* (2002) though its type species, *S. variabile* SUN, 1958 from the Frasnian of the Hunan Province in China, is not well known. It is regarded by several of these authors as a possible senior synonym of *Mansuyphyllum* FONTAINE, 1961 and *Aristophyllum* BULVANKER, SPASSKY & KRAVTSOV, 1975 *in* BESPROZVANNYKH *et al.* (1975).

Sinodisphyllum is now preferred to *Mansuyphyllum* by BOULVAIN *et al.* (2005, p. 83) for the Frasnian material of Belgium referred to *S. kielcense* and assigned to the latter genus by BOULVAIN & COEN-AUBERT (1998). The type species of this taxon is *Cyathophyllum annamiticum* MANSUY, 1913 from the Middle Devonian of Vietnam and also needs revision. In any case, *Mansuyphyllum annamiticum* differs from *Sinodisphyllum* in having a rather narrow tabularium and numerous dissepiments which are typically arranged in horizontal layers at the periphery. The genus *Aristophyllum* has been used in Belgium, for the Frasnian species *A. irenae* ROZKOWSKA, 1979 by COEN-AUBERT (1994) and for the Lower Givetian species *A. luetti* COEN-AUBERT, 1997 by COEN-AUBERT (1997). Its type species, *A. terechovi* BULVANKER, SPASSKY & KRAVTSOV, 1975 *in* BESPROZVANNYKH *et al.* (1975) from the Frasnian of the Taymyr Kolyma Province in Russia, is mainly separated from *Sinodisphyllum* by a less developed dissepimentarium which is reduced to a few rows.

According to ZHEN & JELL (1996, p. 72), *Charactophyllum* SIMPSON, 1900 is another possible synonym of *Sinodisphyllum*. However, its type species, *Campophyllum nanum* HALL & WHITFIELD, 1873 from the Frasnian of Iowa in USA, which has been revised by SORAUF (1998, p. 54), is very particular due to the frequent dilation of the septa in the tabularium. This was also the conclusion of MCLEAN (1993, p. 110).

Sinodisphyllum posterum (IVANIA, 1965)
Plate 3, Figures 4-11

* 1965 — *Charactophyllum posterum* sp. nov.- IVANIA, p. 103, pl. 102, figs. 440-442.
v. 2005 — *Sinodisphyllum* sp.- BOULVAIN *et al.*, p.81, fig. 10.

Holotype
Pl. 102, figs. 440-442 *in* IVANIA (1965). Specimen 239/8 stored in the Palaeontological Museum of the State University of Tomsk, Russia. Right bank of the Bolshie Izyly river, 250 m higher than the railway bridge, near the Granit station of the West Siberian railway track, Kuznetsk Basin, Russia. Solomino Beds, top of the Frasnian.

Material and localities
Twelve specimens with 22 thin sections. Personal sampling: Rochefort MC-52-C51, C55 and C320; Rochefort MC-53-C110 and C113; Rochefort MC-56-C256, C258, C259, C260, C263 and C279; FR1 borehole in the North quarry of Frasnes at 76.7 m.

DIAGNOSIS
A species of *Sinodisphyllum* with 70 to 80 septa at a diameter of 19 mm to 27 mm. Septa slightly carinate. Major septa leaving a more or less extensive open space in the centre of the tabularium.

DESCRIPTION
The material consists of conical, ceratoid and cylindrical coralla which are complete or fragmentary. Their height varies between 4 cm and 8 cm. Several specimens show longitudinal ribs. The outer wall is not very well preserved and is rarely encrusted by thin laminar stromatoporoids or auloporids. In a juvenile section, it is partially thickened to form a narrow peripheral stereozone.

The septa are non-carinate or bear a few small spinose and knobbly carinae. They are dilated in the dissepimentarium and become generally thin in the tabularium or slightly beyond their entry into it. In very few coralla, a deposit of stereoplasma is occasionally present between the septa, near the outer wall or the septa are locally thinner at the periphery with a triangular thickening of their bases.

The major septa leave a more or less extensive open space in the centre of the tabularium; they rarely reach the axis of the corallum. In some specimens, their axial ends are forked, 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. Sometimes, they are more or less short or discontinuous especially at their inner ends.

The dissepimentarium consists of 5 to 12 or even 2 to 15 rows of small inclined dissepiments which are often arranged in horizontal layers at the periphery. Some spots of coarse and contiguous trabeculae occur locally in the dissepimentarium. The tabulae are incomplete and intersecting laterally. Their wide axial parts are frequently flat-topped and they are occasionally horizontal or concave.

There are 66 to 82 septa per corallum. The diameter of the corallum ranges from 15 mm to 34 mm. The width of the tabularium varies commonly between 10 mm and 15 mm and more generally between 8.3 mm and 18.5 mm.

DISCUSSION

According to IVANIA (1965), the holotype of *Sinodisphyllum posterum* has 74 to 90 septa; however, there are only 74 septa in the two transverse sections of this specimen illustrated by IVANIA (1965). *S. variabile*, type species of the genus, differs from *S. posterum* by septa less dilated in the dissepimentarium with rare carinae and by the local reduction of the minor septa in some paratypes.

There are several species closely related to *S. posterum*:

– *S. ruzhentsevi* (ULITINA, 2001) from the Frasnian of Mongolia characterized by a slightly greater diameter and ascribed to the genus *Temnophyllum* WALTHER, 1929 by ULITINA (2001, p. 21).
– *Sinodisphyllum chitralense* (REED, 1922) from the Frasnian of Chitral in Pakistan which differs by fewer septa and by narrower coralla and dissepimentaria; moreover, the dissepiments are arranged in horizontal layers at the periphery. This species has been referred to the genus *Campophyllum* MILNE-EDWARDS & HAIME, 1850 by REED (1922, P. 16).
– *Sinodisphyllum* sp. described by ROHART (1999, p. 58) from the Frasnian of Iran whose major septa reach more or less the centre of the tabularium.

The same feature is present in *S. multiseptatum* (SMITH, 1945) from the Frasnian of the Northwest Territories in Canada which has only been figured in transverse section by SMITH (1945, pl. 5, fig. 9); this taxon probably belongs to *Piceaphyllum* ROZKOWSKA, 1979 according to MCLEAN (1993, p. 117).

Neostringophyllum isetense SOSHKINA, 1951 from the Frasnian of the Urals in Russia is another species showing some affinities with *Sinodisphyllum posterum*. However, it is separated from the latter by smaller size and septal number and again by longer major septa. The holotype of *Neostringophyllum isetense* was illustrated as a representative of *N. pronini* SOSHKINA, 1951 by SOSHKINA *et al.* (1962, pl. 6, fig. 3) and the two species were placed in synonymy by IVANOVSKI & SHURIGINA (1980, p. 46). Moreover, *N. pronini* also from the Frasnian of the Urals was chosen by ROZKOWSKA (1979) as type species of *Piceaphyllum*. *P. pronini* is characterized by variable carination and dilation of the septa in the dissepimentarium and sometimes by shorter minor septa. Therefore, there is some confusion about the definition of the genus *Piceaphyllum* as already discussed by COEN-AUBERT (2005, p. 72).

GEOGRAPHIC AND STRATIGRAPHIC OCCURRENCE

The material sampled by the author at Rochefort and Frasnes, on the south side of the Dinant Synclinorium, comes from the lower part of the La Boverie Member of the Moulin Liénaux Fm.

Outside Belgium, *Sinodisphyllum posterum* is known only at the top of the Frasnian from the Kuznetsk Basin in Russia.

Sinodisphyllum kielcense (ROZKOWSKA, 1979)
Plate 1, Figure 8, Plate 2, Figures 11-13,
Plate 3, Figures 1-3

* 1979 — *Ceratophyllum kielcense* sp. n. – ROZKOWSKA, p. 22, pl. 3, figs. 7-10.
1979 — *Temnophyllum elongatum* sp. n. – ROZKOWSKA, p. 31, pl. 4, fig. 6.
v 1998 — *Mansuyphyllum elongatum* (Rozkowska, 1979) – BOULVAIN & COEN-AUBERT, p. 33, pl. 3, figs. F-K.
2002 — *Sinodisphyllum kielcense* (Rozkowska, 1980) – ROHART, p. 115, pl. 6, fig. 3, pl. 7, figs. 1, 2.
2003 — *Ceratophyllum kielcense* Rozkowska, 1979 – FEDOROWSKI, p. 93, pl. 40, figs. 3, 4.
2003 — *Temnophyllum elongatum* Rozkowska, 1979 – FEDOROWSKI, p. 96, pl. 41, fig. 7.
v 2005 — *Sinodisphyllum kielcense* (Rozkowska, 1979) – BOULVAIN *et al.*, pp. 81, 83 and fig. 10.

Holotype

Pl. 3, fig. 10 *in* ROZKOWSKA (1979). Specimen TcI/9 stored in the Department of Geology from the University of Poznan, Poland. Lower or middle part of the Frasnian in the Wietrznia quarry at Kielce, Holy Cross Mountains, Poland.

Material and localities

Thirteen specimens with 19 thin sections. Personal sampling: Rochefort MC-52-B967 and C17; Rochefort MC-55-C138, C140, C141, C143, C144, C145, C147, C148, C154 and C647; Rochefort MC-56-C303.

DIAGNOSIS

A species of *Sinodisphyllum* with 48 to 60 septa at a diameter of 10 mm to 17 mm. Septa slightly carinate. Major septa leaving an open space in the centre of the tabularium or reaching the axis of the corallum. Rather few rows of dissepiments arranged in horizontal layers at the periphery

DESCRIPTION

The material consists of small, complete or fragmentary coralla which are often cylindrical, but may also be conical, trochoid or ceratoid. Their height varies between 1.5 cm and 4 cm. Several specimens show longitudinal ribs and growth lines. A few lateral offsets have been observed. The outer wall is not very well preserved.

The septa are non-carinate or bear some small knobbly carinae. They are more or less dilated in the dissepimentarium and become thin in the tabularium or slightly beyond their entry into it. In several coralla, an inner layer of dissepiments is partly thickened with stereoplasma whereas the septa are locally contiguous at the periphery, in rare specimens.

The major septa leave a small open space in the centre of the tabularium which is occasionally more important; in a few coralla, their inner ends are forked, curved or fusing to form pseudofossulae. The minor septa traverse the entire dissepimentarium or even enter in the tabular-

ium where they may be contratingent. Sometimes, they are more or less short or discontinuous at their axial ends.

The dissepimentarium consists of 4 to 6 rows of small dissepiments which are in horizontal layers at the periphery and inclined in its inner part. At the tip of one corallum, there are only 1 or 2 rows of dissepiments which are locally peneckielloid near the outer wall. The inner border of the dissepimentarium is occasionally obscured by a deposit of stereoplasma. The tabulae are incomplete and intersecting laterally; sometimes, their axial parts are more or less flat-topped.

There are 48 to 56 septa and rarely 64 septa per corallum. The diameter of the corallum ranges from 9 mm to 22 mm. The width of the tabularium varies commonly between 6.8 mm and 9.8 mm, but may reach 12 mm.

Discussion

The specific name *Sinodisphyllum kielcense* was already used by Boulvain *et al.* (2005) for the Belgian material assigned to *Mansuyphyllum elongatum* (Rozkowska, 1979) by Boulvain & Coen-Aubert (1998) who compared also these two taxa. Meanwhile, the precise dimensions of the holotype of *Sinodisphyllum kielcense* from the Frasnian of the Holy Cross Mountains in Poland have been given by Rohart (2002) whereas the same specimen has been figured at a correct magnification by Fedorowski (2003). So the variability of *S. kielcense* is now well understood. On the contrary, the description of *Temnophyllum elongatum* made by Rozkowska (1979) is only based on its rather fragmentary holotype associated with *Sinodisphyllum kielcense* at its type locality of Sobiekurow, also in the Holy Cross Mountains.

The material of *S. kielcense* from La Boverie quarry at Rochefort investigated herein differs from that of Boulvain & Coen-Aubert (1998) by slightly fewer septa and narrower coralla, by the systematic occurrence of an open space in the centre of the tabularium and by a local inner stereozone somewhat more frequent. From a quantitative point of view, it is more closely related than previously to the sampling of Rozkowska (1979) and Rohart (2002). As for the rest, *S. kielcense* is easily distinguished from *S. posterum* by smaller size and septal number and by fewer dissepiments which are typically arranged in horizontal layers at the periphery.

Geographic and stratigraphic occurrence

The material described in this paper comes from the lower part of the Bieumont Member of the Grands Breux Fm. at Rochefort, on the south side of the Dinant Synclinorium. According to Boulvain & Coen-Aubert (1998), the species is also present:

- at the base of the overlying Lion and Boussu-en-Fagne Members from Frasnes, in the same structural unit;
- at the top of the Pont de La Folle Fm. and at the base of the Neuville Fm. from Neuville, in the Philippeville Massif.

Outside Belgium, *Sinodisphyllum kielcense* occurs in the upper part of the Pâtures Member of the Frasnian Beaulieu Fm. in the Boulonnais, France and in the Frasnian of the Holy Cross Mountains and the Silesia-Cracow Upland, in Poland.

Conclusion

A fourth level of Frasnian mounds has been observed at Frasnes and Rochefort on the south side of the Dinant Synclinorium as well as at Vodelée in the southeastern part of the Philippeville Anticlinorium. It lies between the Arche and Lion Members and is assigned to the new La Boverie Member which occurs at the top of the Moulin Liénaux Fm., in the reefal areas. Though partly investigated, the rugose coral fauna of the La Boverie Member seems to be particular with one new taxon: *Macgeea boveriensis* and two other species: *M. socialis* and *Sinodisphyllum posterum* showing affinities with the Frasnian of the Urals and the Kuznetsk Basin in Russia.

From a sedimentological point of view, the rather thin La Boverie Member presents the same succession of facies induced by the sea-level variations as the much thicker Arche and Lion mounds. In fact, there is a regression at the top of the Arche Member followed by a transgression in the lower part of the La Boverie Member and again a shallowing event at the top of this lithostratigraphic unit. These short, but nevertheless severe fluctuations have also been mentioned by Gouwy & Bultynck (2000, p. 37 and fig. 16), on the basis of the changes in the conodont biofacies. According to these authors, they occur at the top of their second major T-R cycle for the Ardennes, meaning above the Arche Member, in the upper part of the Ermitage Member and close to the boundary between the *Palmatolepis punctata* and *P. hassi* conodont Zones. So these sea-level variations can be recognized at the scale of the sedimentation basin and are probably of eustatic origin.

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Explanation of Plates

All specimens are figured at magnification x 3.

PLATE 1

Macgeea boveriensis n. sp.
Fig. 1 — Paratype. IRScNB a12180. Rochefort MC-52-C319. Transverse section.
Figs. 2, 3 — Paratype. IRScNB a12181. Rochefort MC-52-C52. Transverse and longitudinal sections.
Figs. 4, 5 — Holotype. IRScNB a12179. Rochefort MC-52-C50. Transverse and longitudinal sections.
Figs. 6, 7 — Paratype. IRScNB a12182. Rochefort MC-52-B959. Transverse and longitudinal sections.

Sinodisphyllum kielcense (ROZKOWSKA, 1979)
Fig. 8 — IRScNB a12193. Rochefort MC-55-C144. Transverse section.

PLATE 2

Macgeea socialis SOSHKINA, 1939
Figs. 1, 2 — IRScNB a12184. Rochefort MC-52-B951. Transverse and longitudinal sections.
Figs. 3, 4 — IRScNB a12185. Rochefort MC-56-C262. Transverse and longitudinal sections.
Fig. 5 — IRScNB a12186. Rochefort MC-52-B962. Transverse section.
Fig. 6 — IRScNB a12187. Rochefort MC-52-B940. Transverse section.
Figs. 7, 8 — IRScNB a12188. Rochefort MC-52-B923. Transverse and longitudinal sections.

Macgeea boveriensis n. sp.
Figs. 9, 10 — Paratype. IRScNB a12183. Rochefort MC-52-B950. Transverse and longitudinal sections.

Sinodisphyllum kielcense (ROZKOWSKA, 1979)
Fig. 11 — IRScNB a12194. Rochefort MC-55-C147. Transverse section.
Figs. 12, 13 — IRScNB a12195. Rochefort MC-56-C303. Transverse and longitudinal sections.

PLATE 3

Sinodisphyllum kielcense (ROZKOWSKA, 1979)
Fig. 1 — IRScNB a12196. Rochefort MC-55-C154. Transverse section.
Figs. 2, 3 — IRScNB a12197. Rochefort MC-52-B967. Transverse and longitudinal sections.

Sinodisphyllum posterum (IVANIA, 1965)
Figs. 4, 5 — IRScNB a12189. Rochefort MC-56-C258. Transverse and longitudinal sections.
Figs. 6, 7 — IRScNB a12190. Rochefort MC-56-C259. Transverse and longitudinal sections.
Figs. 8, 9 — IRScNB a12191. Rochefort MC-53-C113. Transverse and longitudinal sections.
Figs. 10, 11 — IRScNB a12192. Rochefort MC-56-C279. Transverse and longitudinal sections.

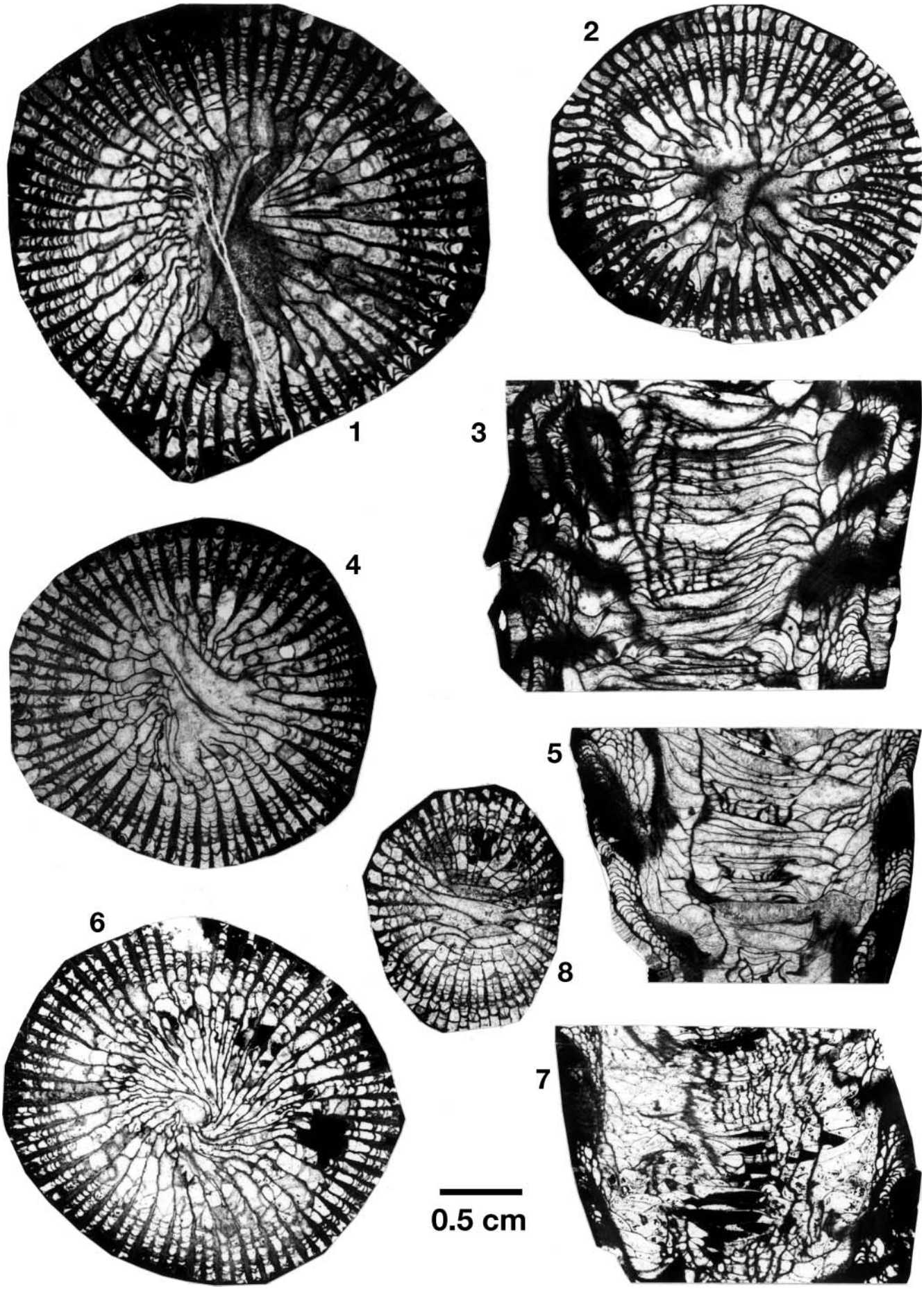

PLATE 1

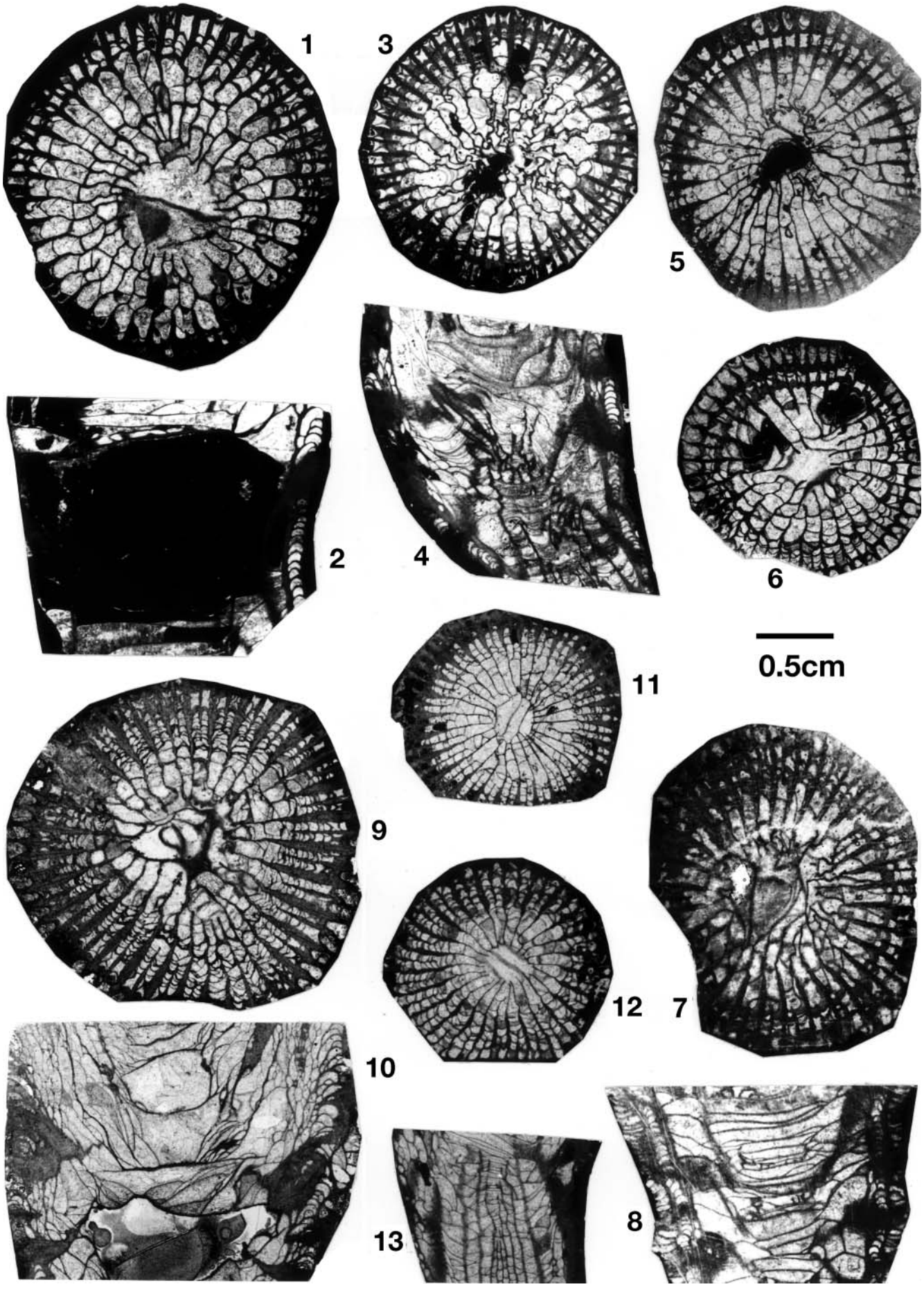

PLATE 2

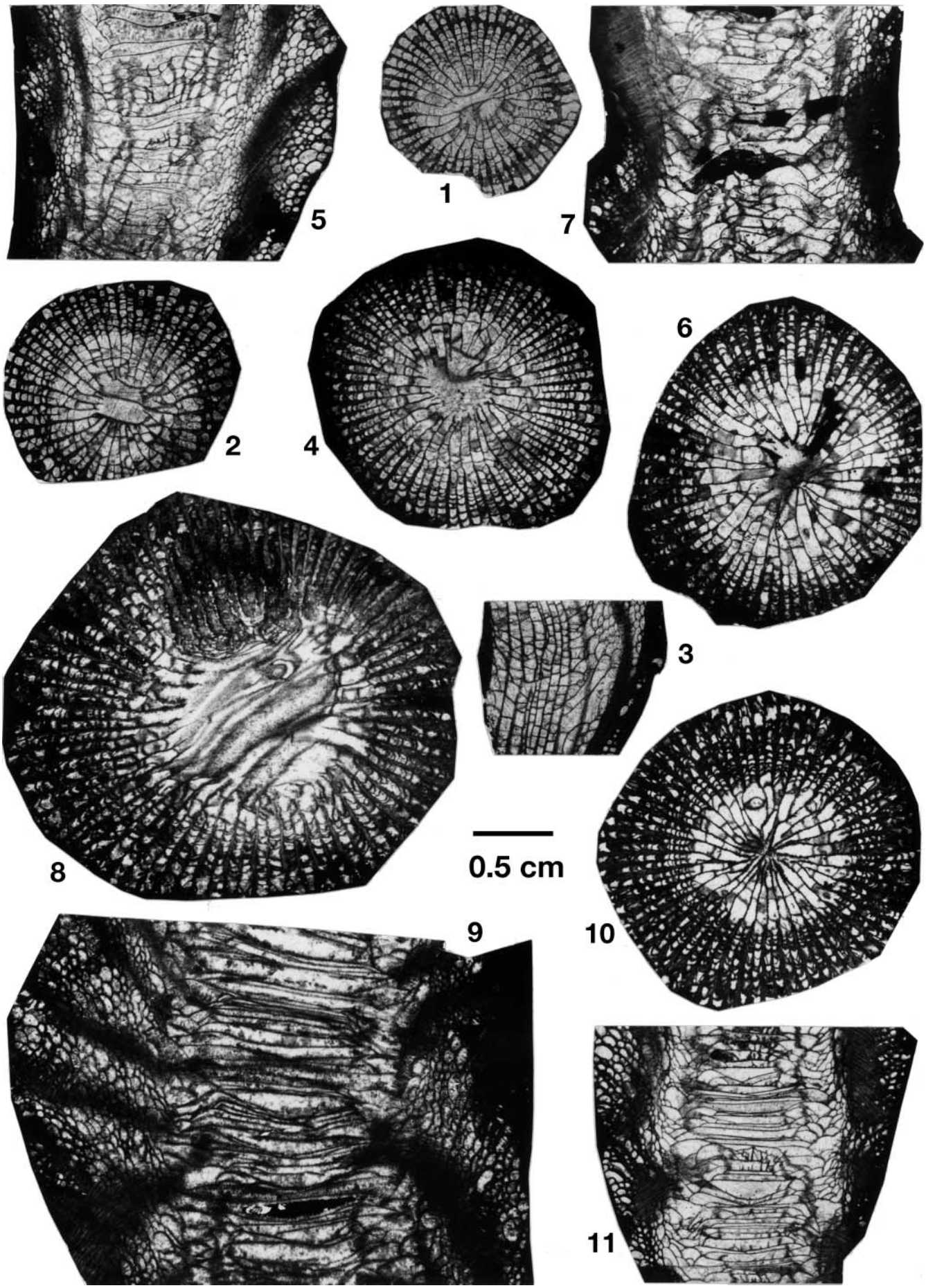

PLATE 3