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Temnophyllids and Spinophyllids (Rugosa) from the Givetian Mont d'Haurs Formation in Belgium

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Abstract

Temnophyllum majus WALTHER, 1929, *T. imperfectum* n. sp., *Spinophyllum spongiosum* (SCHLÜTER, 1889) and *S. blacourti* (ROHART, 1988) are described in detail and come mainly from the lower part of the Givetian Mont d'Haurs Formation, on the south side of the Dinant Synclinorium. The type specimens of *S. spongiosum*, *Temnophyllum majus*, *T. latum* WALTHER, 1929 and *T. clavatum* WALTHER, 1929 as well as the holotype of *Spinophyllum altevogti* (OLIVER & SORAUF, 1988) are refigured herein. As a whole, the fauna from the Mont d'Haurs Formation, which belongs to the Lower *Polygnathus varcus* Zone, is widely distributed in various areas of Europe and Asia and shows strong affinities with the Givetian rugose corals of Germany and the Boulonnais in France.

Key-words: Rugose corals, Givetian, Taxonomy, Stratigraphy, Belgium.

Résumé

Temnophyllum majus WALTHER, 1929, *T. imperfectum* n. sp., *Spinophyllum spongiosum* (SCHLÜTER, 1889) et *S. blacourti* (ROHART, 1988) sont décrits en détail et proviennent principalement de la partie inférieure de la Formation givetienne du Mont d'Haurs, au bord sud du Synclinorium de Dinant. Les spécimens types de *S. spongiosum*, *Temnophyllum majus*, *T. latum* WALTHER, 1929 et *T. clavatum* WALTHER, 1929 de même que l'holotype de *Spinophyllum altevogti* (OLIVER & SORAUF, 1988) sont refigurés dans ce travail. L'ensemble de la faune de la Formation du Mont d'Haurs, qui appartient à la Zone à *Polygnathus varcus* inférieure, est largement répandue dans diverses régions d'Europe et d'Asie et montre de nettes affinités avec les Rugueux givetiens d'Allemagne et du Boulonnais en France.

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

Introduction

After the papers of COEN-AUBERT (1999 and 2000) mainly devoted to colonial rugose corals, it is interesting to investigate the rich fauna of solitary rugose corals occurring in the Mont d'Haurs Formation from the south side of the Dinant Synclinorium. The following taxa are described herein: *Temnophyllum majus* WALTHER, 1929, *T. imperfectum* n. sp., *Spinophyllum spongiosum* (SCHLÜTER, 1889) and *S. blacourti* (ROHART, 1988). *S. spongiosum* is the type species of *Spinophyllum* WEDEKIND, 1922 whereas *Temnophyllum majus* is compared to the other species of *Temnophyllum* WALTHER, 1929 introduced by WALTHER (1929).

From a stratigraphical point of view, the Mont d'Haurs Formation belongs to the Lower *Polygnathus varcus* conodont Zone and lies in the upper part of the Givetian between the Terres d'Haurs and Fromelennes Formations (Fig. 6). From a geographical point of view and as it was the case before, most specimens come from the area between Beauraing and Han-sur-Lesse located to the east of Givet (Fig. 1). However, some coralla have been collected in three poorly known outcrops of Nismes situated 5 km to the northeast of Couvin. Moreover, the north side of the Dinant Synclinorium and the Namur Synclinorium characterized by different facies have also provided a few samples.

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

Description of the outcrops

NORTHERN LES LIMITES QUARRY AT AVE-ET-AUFFE (Wellin MC-1988-6; Fig. 2)

This active quarry is the most complete section investigated in the Mont d'Haurs Formation. It has been located on a map and described previously by COEN-AUBERT (1999, p. 27, figs. 2, 3 and 2000, p. 5, fig. 2).

At the top of the Terres d'Haurs Formation, which consists of coarsely crinoidal limestone, there are already some rugose corals represented by *Sociophyllum wedekindi* COEN-AUBERT, 1999, *Acanthophyllum simplex*

(WALTHER, 1929) and *Spinophyllum spongiosum*. Then, the Mont d'Haurs Formation reaches a thickness of about 180 m and is subdivided into two parts.

The limestone is rather argillaceous and often very rich in corals and stromatoporoids in the lower part of the lithostratigraphic unit which is 91 m thick. At the top of these 91 m, there is a double level of thin-bedded limestone which has a thickness of 10 m and which is a key bed in the area between Beauraing and Han-sur-Lesse. The rugose coral fauna from the lower part of the Mont d'Haurs Formation exhibits a great diversity and shows some vertical distribution. *S. spongiosum* is restricted to the first 37 m of the lithostratigraphic unit whereas *Disphyllum semenoffi* COEN-AUBERT, 2000 has only been found between 16 m and 28 m above its base. Other species such as *S. blacourti*, *Acanthophyllum simplex* and *Sociophyllum wedekindi* occur throughout the lower part of the Mont d'Haurs Formation. *S. isactis* (FRECH, 1886), *Temnophyllum majus* and *T. imperfectum* have also been observed up to the second level of thin-bedded limestone, but appear respectively 17 m, 22 m and 35 m above the top of the Terres d'Haurs Formation. *Argutastrea tenuiseptata* COEN-AUBERT & LÜTTE, 1990 is very common in the upper 45 m from the lower part of the Mont d'Haurs Formation where it is locally accompanied by *A. wangi* (TSIEN, 1978). *Grypophyllum denckmanni* WEDEKIND, 1922 is rather rare in the northern Les Limites quarry.

In the upper part of the Mont d'Haurs Formation which is 89.5 m thick, the rugose corals are less abundant and are represented by *Argutastrea wangi*, *Wapitiphyllum laxum* (GÜRICH, 1896) and *Sunophyllum beichuanense* HE, 1978.

WELLIN QUARRY (Wellin MC-1986-4; Fig 2)

The disused quarry of Wellin has been located on a map by COEN-AUBERT (1999, fig. 2) and described in detail by COEN-AUBERT (2000, p. 6, fig. 2). Below the first level of thin-bedded limestone from the Mont d'Haurs Formation are exposed 40 m of argillaceous and rather pure limestone which contain a highly diversified fauna of corals and stromatoporoids. *Disphyllum semenoffi* is restricted to the base of this sequence. *Acanthophyllum simplex*, *Grypophyllum denckmanni* and *Sociophyllum wedekindi* are observed throughout these 40 m. *S. isactis*, *Temnophyllum majus*, *T. imperfectum* and *Spinophyllum blacourti* are very abundant in the middle part of these reefal limestones whereas *Argutastrea tenuiseptata* is only present in their upper 11 m.

Above the first level of thin-bedded limestone, there is a lack of outcrop which is 28.5 m thick. In its middle however, one can see 0.85 m of argillaceous or dolomitic limestone which contains massive stromatoporoids, a few corallites of *Sociophyllum isactis* and *S. wedekindi* and numerous coralla of *Temnophyllum majus*. This bed belongs already to the upper part of the Mont d'Haurs Formation. At the end of the section, there are about 10 m of biostromal limestone with intercalations of fine limestone, where a few specimens of *T. majus* and *Grypophyllum denckmanni* still occur.

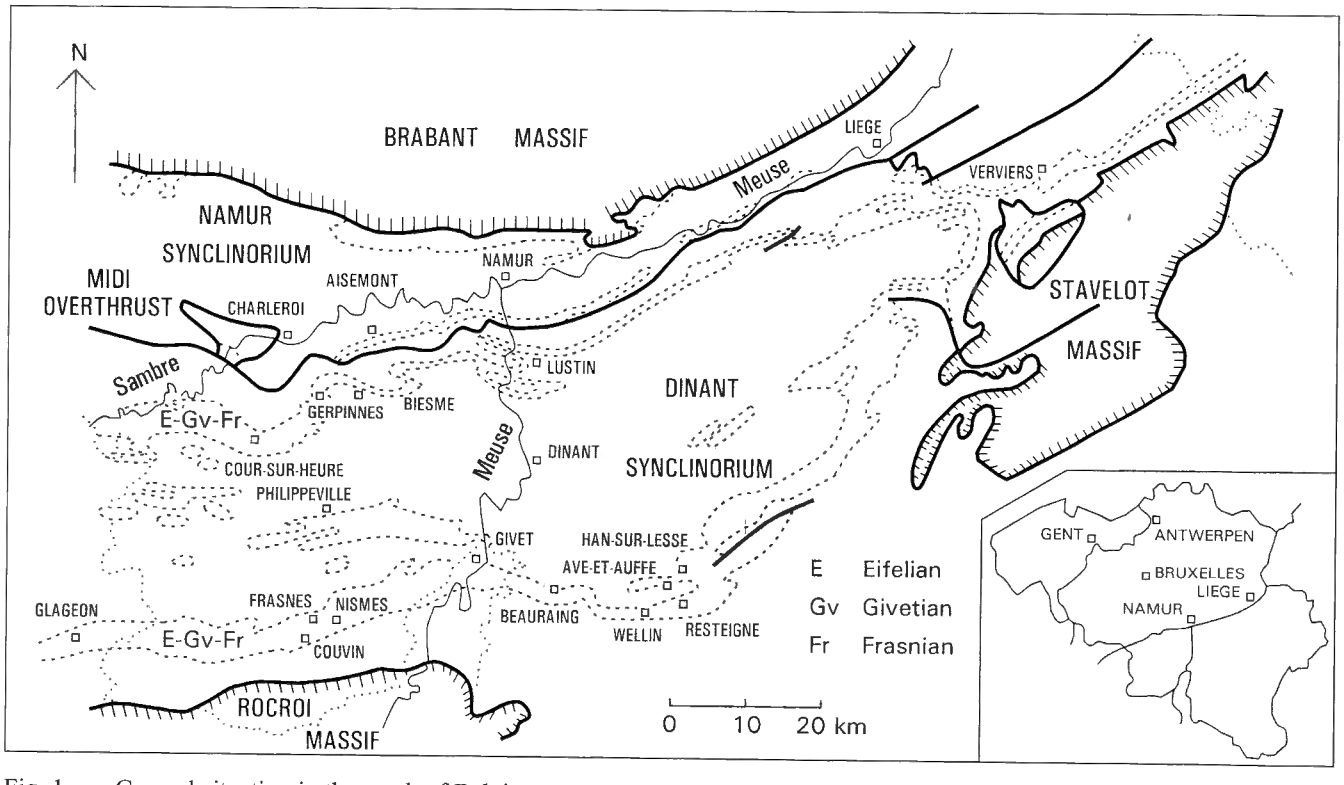

Fig. 1 — General situation in the south of Belgium.

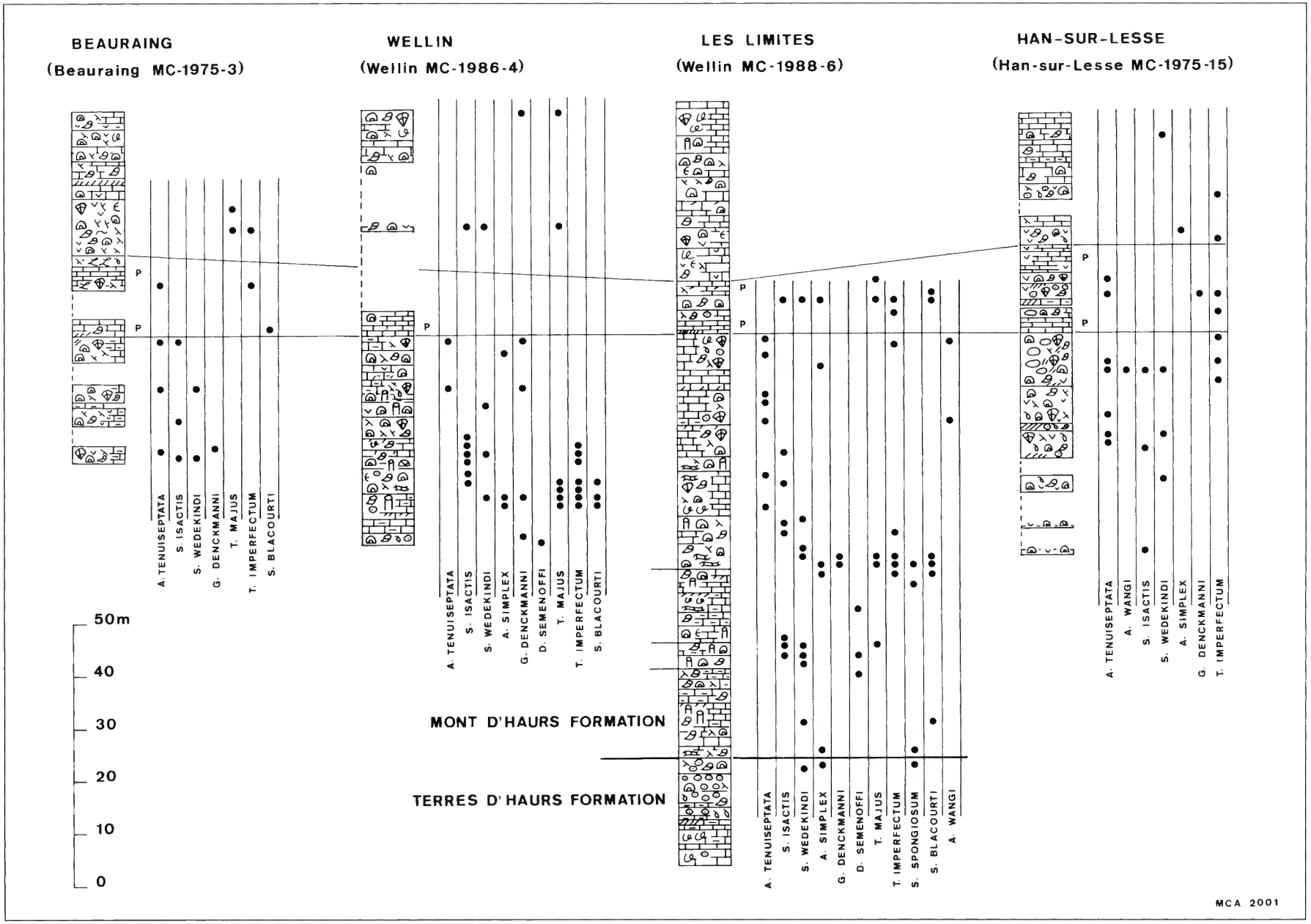

Fig. 2 — Comparative logs of the Beauraing quarry, the Wellin quarry, the northern Les Limites quarry at Ave-et-Auffe and the Han-sur-Lesse section with the distribution of rugose corals. (For explanation of conventional signs, see Fig. 3).

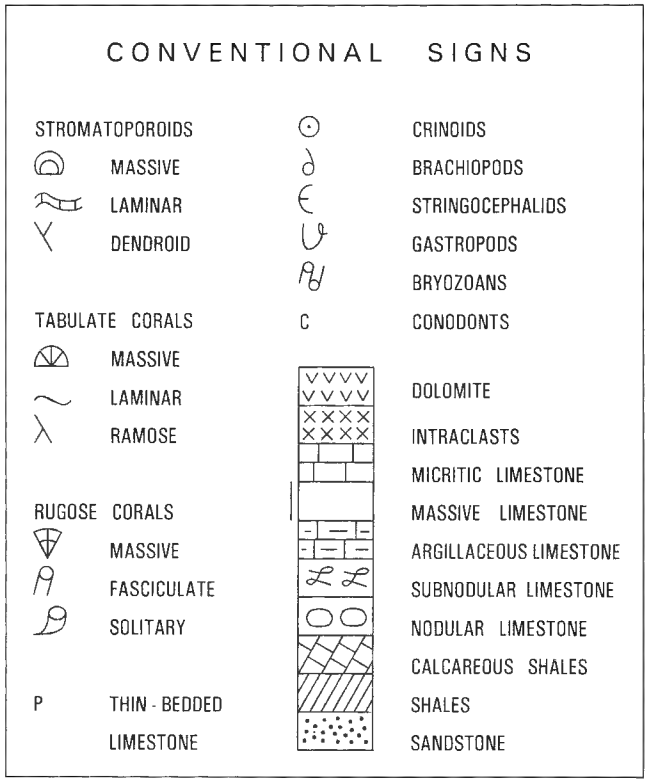

Fig. 3 — Explanation of conventional signs used in Figs. 2 and 5.

BEAURAING QUARRY (Beauraing MC-1975-3; Fig. 2)

The Mont d'Haurs Formation is exposed in the second quarry excavated to the south of Beauraing, along the road to Winenne. The outcrop has been located on a map and described by COEN-AUBERT (1999, p. 29, figs. 3 and 5).

Below the first level of thin-bedded limestone, there is a discontinuous section showing 24 m of rather argillaceous limestone, very rich in corals and stromatoporoids. *Argutastrea tenuiseptata*, *Sociophyllum isactis*, *S. wedekindi* and rare *Grypophyllum denckmanni* occur in this part of the sequence. One corallum of *Spinophyllum blacourti* has been collected at the base of the thin-bedded limestones whereas *Argutastrea tenuiseptata* and *Temnophyllum imperfectum* are present between these two levels. Then, the upper part of the Mont d'Haurs Formation starts with about 10 m of dolomitic limestone which contains numerous massive and dendroid stromatoporoids, alveolitids, thamnoporids and solitary rugose corals including *T. imperfectum* and *T. majus*.

HAN-SUR-LESSE SECTION
(Han-sur-Lesse MC-1975-15; Fig. 2)

The Han-sur-Lesse section in the Mont d'Haurs Formation is situated along the road to Rochefort and has also been located on a map and described by COEN-AUBERT (1999, p. 29, figs. 3 and 6). *Sociophyllum isactis* has been observed at the base of the outcrop which is very discontinuous. In the 30 m of reefal and often argillaceous limestones, which lie below the key layers of thin-bedded limestones, occur *S. isactis*, *S. wedekindi*, *Temnophyllum imperfectum* and *Argutastrea tenuiseptata* accompanied locally by *A. wangi*. *A. tenuiseptata* and *Temnophyllum imperfectum* are present with rare *Grypophyllum denckmanni* in the coralliferous beds between the two levels of thin-bedded limestones. A few specimens of *Temnophyllum imperfectum*, *Acanthophyllum simplex* and *Sociophyllum wedekindi* have been collected up to 20 m above the base from the upper part of the Mont d'Haurs Formation.

RESTEIGNE QUARRY (Wellin MC-1974-95)

In the disused quarry of Resteigne, the base of the Mont d'Haurs Formation is exposed in continuity with the Terres d'Haurs Formation. This transition has been described and figured by COEN-AUBERT (1999, p. 29 and 2000, fig. 2). As it is the case in the northern Les Limites quarry, *Spinophyllum spongiosum* and *Acanthophyllum simplex* are present at the top of the Terres d'Haurs Formation which is also characterized by coarsely crinoidal limestone. COEN-AUBERT (2000) has mentioned at the base of the Mont d'Haurs Formation the occurrence of *A. simplex*, *Grypophyllum denckmanni* and *Sociophyllum wedekindi*.

AREA OF NISMES (Figs. 4 and 5)

The three outcrops investigated in the Mont d'Haurs Formation at Nismes have been shown to the author by Coen and Dumoulin who are revising the geological map of Olloy-sur-Viroin - Treignes.

Along the west and east sides of the big excavation called Matricolo (outcrop Olloy-sur-Viroin MC-65) and lying in the Bois Mousti, to the southwest of Nismes, there are two good sections in the upper 42 m from the lower part of the Mont d'Haurs Formation. At the top of this sequence, some thin-bedded limestones occur, but this level is not so remarkably developed as in the area between Beauraing and Han-sur-Lesse. Below this key level, the

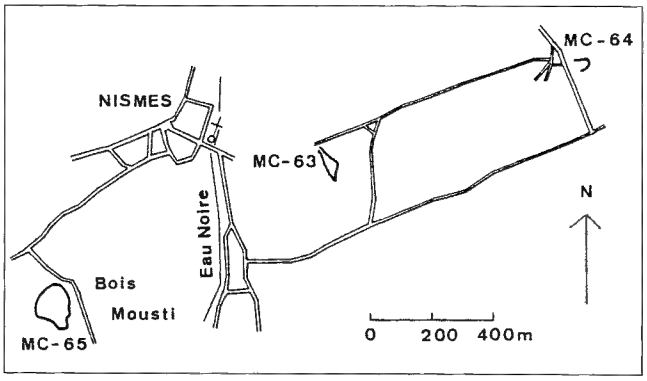

Fig. 4 — Location of the three outcrops investigated at Nismes.

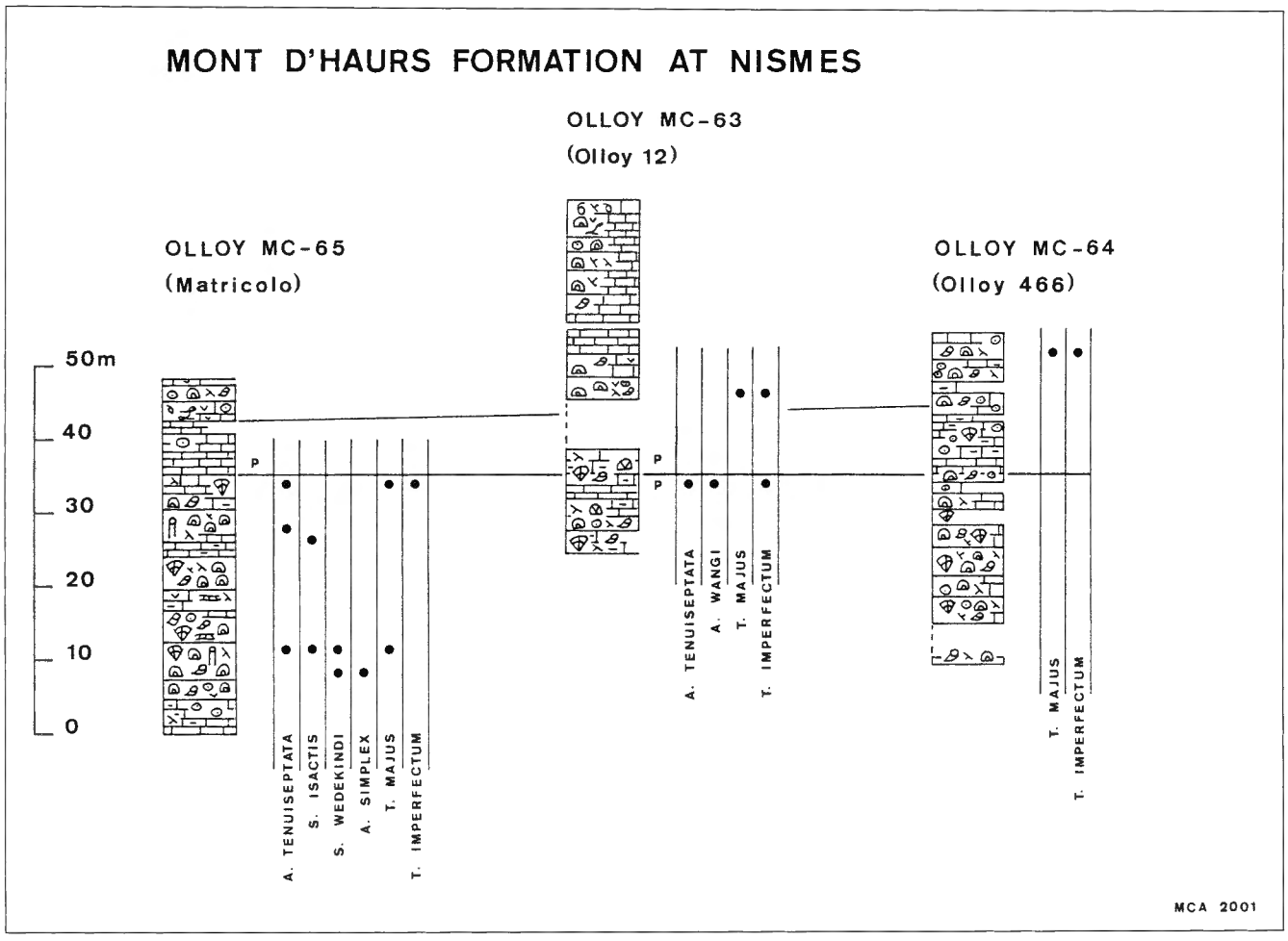

Fig. 5 — Comparative logs of the three outcrops investigated at Nismes with the distribution of rugose corals. (For explanation of conventional signs, see Fig. 3).

more or less argillaceous limestones are rich in corals and stromatoporoids and contain *Argutastrea tenuiseptata*, *Sociophyllum isactis*, *S. wedekindi*, *Acanthophyllum simplex*, *Temnophyllum majus* and *T. imperfectum*.

A similar succession is exposed in the small hole (outcrop Olloy-sur-Viroin MC-64 and point Olloy 466 of Coen and Dumoulin) located 1250 m to the northeast of Nismes. Just above the equivalent of the thin-bedded limestones appear crinoidal limestones with reef building organisms in some layers and two bedding planes full of solitary rugose corals including *T. imperfectum* and *T. majus*.

In another excavation (outcrop Olloy-sur-Viroin MC-63 and point Olloy 12 from the old collection of the IRScNB) lying 400 m to the east of Nismes, one can see the top of the reefal and argillaceous limestones from the lower part of the Mont d'Haurs Formation overlain by 3.5 m of more or less thin-bedded limestones. After a lack of outcrop which is about 7 m thick, the upper part of the Mont d'Haurs Formation is exposed with a thickness of 66 m and is characterized by an alternation of fine or bioclastic limestones and biostromes with massive stromatoporoids accompanied by dendroid stromatoporoids, thamnoporids, scolioporids and solitary rugose corals. These coralla are not very well preserved in this outcrop whereas colonies of *Argutastrea tenuiseptata* and *A. wangi* are present near the top of the lower part from the Mont d'Haurs Formation.

North side of the Dinant synclinorium and Namur synclinorium

Several specimens have also been collected at the localities of Cour-sur-Heure, Gerpinnes and Aisemont investigated by Coen-Aubert (2000, pp. 8-11, figs. 4-6). Though Cour-sur-Heure belongs to the northern part of the Dinant Synclinorium, its Givetian facies are similar to those from the south side of the same synclinorium. In the southern quarry of Cour-sur-Heure (outcrop Gozée MC-47), *Spinophyllum blacourti* is present in the Terres d'Haurs Formation, 13 m below its top whereas *Temnophyllum imperfectum* has been found close to the top from the lower part of the Mont d'Haurs Formation, in the vicinity of the conodont sample mentioned by Coen-Aubert (2000, p. 9).

Gerpinnes is situated 11 km to the northeast of Cour-sur-Heure, also on the north side of the Dinant Synclinorium.

However, the Givetian deposits are very different here as the Mont d'Haurs Formation passes laterally into the Névremont Formation. At the base of the disused railway section from Gerpinnes (outcrop Nalinnes MC-1975-2), *T. imperfectum* and *Spinophyllum blacourti* occur together with *Acanthophyllum simplex* and *Argutastrea tenuiseptata*, in 16 m of argillaceous and more or less reefal limestones by which the outcrop starts in the Névremont Formation.

Along the railway section at Aisemont (outcrop Tamines MC-1983-2), on the south side of the Namur Synclinorium, there are, close to the base of the Névremont Formation, 12 m of argillaceous limestones and shales which contain brachiopods, crinoids and several beds rich in rugose corals represented by *A. tenuiseptata*, *Acanthophyllum simplex*, *Grypophyllum denckmanni*, *Spinophyllum spongiosum*, *S. blacourti* and *Temnophyllum imperfectum*.

Finally, one corallum of *T. imperfectum* has been sampled at the depth of 1242 m, in the borehole of Leuze (125E/298) described by COEN-AUBERT *et al.* (1981). The city of Leuze lies in the Tertiary from the western part of Belgium, 16 km to the east of Tournai; its palaeozoic basement belongs to the north side of the Namur Synclinorium. In fact, *T. imperfectum* has been observed in the Alvaux Formation which is the lateral equivalent of the Névremont Formation in this area. In the Leuze borehole, the Alvaux Formation has been intersected between 1157 m and 1373 m and is 216 m thick. It is characterized by an alternation of argillaceous limestones and shales with a few beds of anhydrite. Besides *T. imperfectum*, *Argutastrea tenuiseptata* has been recognized at 1363 m, near the base of the lithostratigraphic unit.

Stratigraphic distribution of the rugose corals

On the south side of the Dinant Synclinorium, the lower part of the Mont d'Haurs Formation is characterized by a highly diversified fauna of rugose corals (Fig. 6). Some species such as *Sociophyllum wedekindi*, *Acanthophyllum*

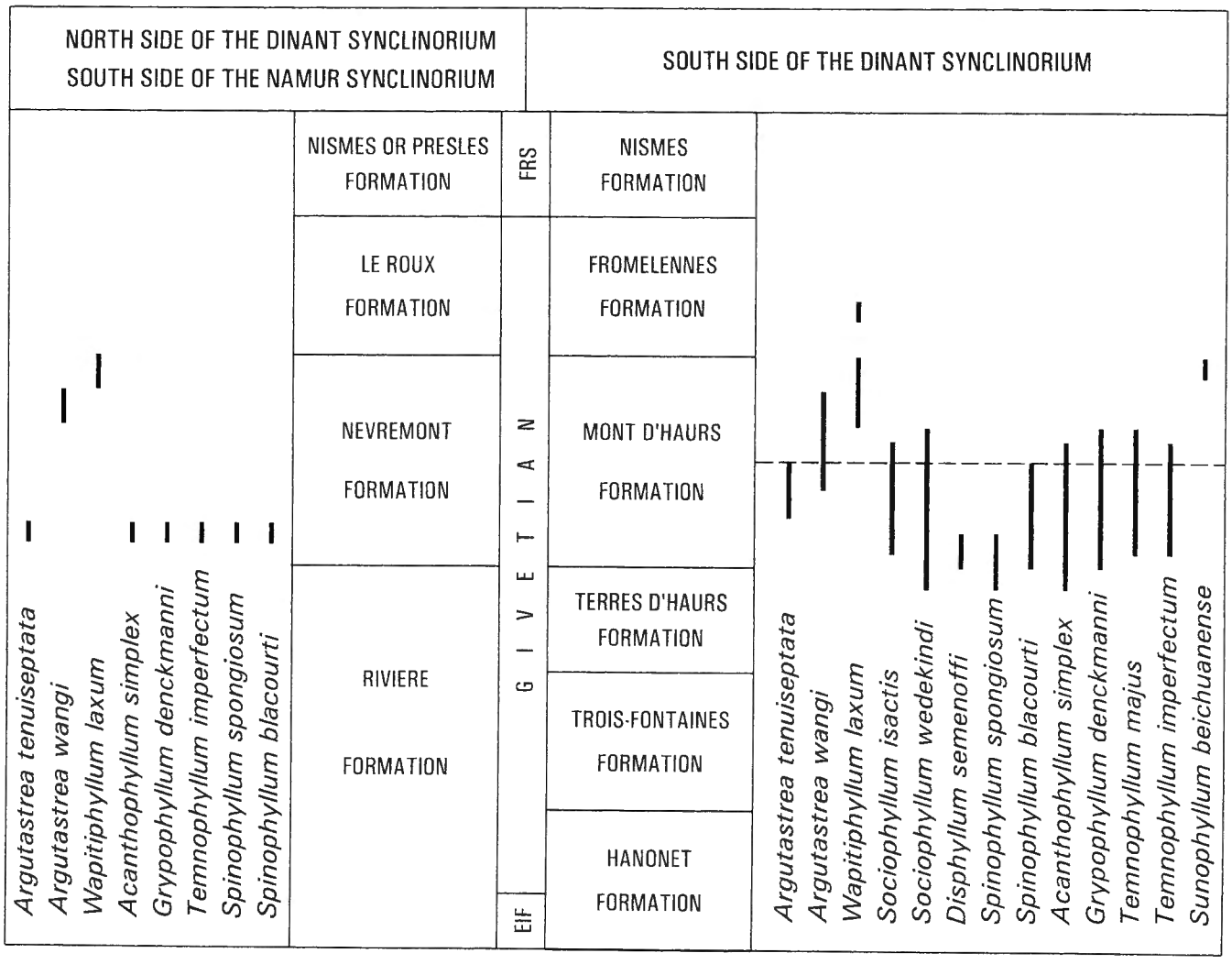

Fig. 6 — Stratigraphic distribution of the rugose corals investigated in the Mont d'Haurs Formation on the south side of the Dinant Synclinorium and in the Névremont Formation on the north side of the Dinant Synclinorium and the south side of the Namur Synclinorium.

simplex and *Spinophyllum spongiosum* are already present at the top of the underlying Terres d'Haurs Formation. Then, *S. spongiosum* and *Disphyllum semenoffi* are restricted to the base of the Mont d'Haurs Formation whereas *Sociophyllum wedekindi*, *Acanthophyllum simplex*, *Grypophyllum denckmanni* and *Spinophyllum blacourti* are observed throughout the lower part of the lithostratigraphic unit. Other taxa such as *Sociophyllum isactis*, *Temnophyllum majus* and *T. imperfectum* are also very common in the lower part of the Mont d'Haurs Formation, but do not occur at its base. *Argutastrea tenuiseptata* appears rather high in the sequence and is locally accompanied by *A. wangi* which is more frequent in the upper part of the Mont d'Haurs Formation. At the base of these deposits, the fasciculate and solitary rugose corals remain rather abundant and are still represented by several species from the lower part of the lithostratigraphic unit. Higher in the Mont d'Haurs Formation, the fauna of the biostromes intercalated with back reef facies is dominated by massive stromatoporoids. However, at the top of the lithostratigraphic unit, the rugose and tabulate corals become again numerous with the occurrence of *Wapitiphyllum laxum* and *Sunophyllum beichuanense*.

On the north side of the Dinant Synclinorium and on the south side of the Namur Synclinorium, the Mont d'Haurs Formation passes laterally into the Névremont Formation. *Acanthophyllum simplex*, *Grypophyllum denckmanni*, *Temnophyllum imperfectum*, *Spinophyllum spongiosum*, *S. blacourti* and *Argutastrea tenuiseptata* are reported close to its base whereas *A. wangi* and *Wapitiphyllum laxum* characterize its upper part.

Biogeographic implications

The rugose corals investigated in the Mont d'Haurs Formation by COEN-AUBERT (1999 and 2000) and herein show strong affinities with the Givetian faunas from the Boulonnais in France and from the Eifel Hills, the Bergisches Land and the Sauerland in Germany. Firstly, it is to be mentioned that five species have been introduced in Germany, namely *Sociophyllum isactis*, *Temnophyllum majus*, *Spinophyllum spongiosum*, *Acanthophyllum simplex* and *Grypophyllum denckmanni*. In the Eifel Hills, the three latter taxa and *Argutastrea tenuiseptata*, whose stratigraphic distribution has been discussed by COEN-AUBERT & LÜTTE (1990, p. 23), are known in the Rodert and Kerpen Formations or at least in one of them. In the Bergisch Gladbach-Paffrath syncline from the Bergisches Land, *A. tenuiseptata* is recorded in the Torringen Formation whereas *Grypophyllum denckmanni*, *Spinophyllum spongiosum* and *Sociophyllum isactis* have been collected in the Büchel Formation. About *S. isactis*, it must be noted that its lectotype figured by WEDEKIND (1925, pl. 4, fig 12) has been found again by BIRENHEIDE (1998, p. 179). Unfortunately, this information remained unknown to COEN-AUBERT (1999, p. 34) before the publication of her paper though the material of the Ardennes was compared with that of WEDEKIND (1925). In the North Bergisches Land, *Acanthophyllum simplex* is reported in the Schwelm Formation and at the top of the Givetian by BIRENHEIDE (1990). Also in the Schwelm Formation, but in the North Sauerland occur *A. simplex*, *Grypophyllum denckmanni*, *Temnophyllum majus* and *Spinophyllum spongiosum*. On the other hand and in the same area, the colony referred to *Argutastrea tenuiseptata* by MAY (1993, p. 28) and sampled near the Eifelian-Givetian boundary differs from the Belgian specimens by rather thick septa. Finally, it is well known that the Rodert and Torringen Formations are roughly time-equivalent to the Terres d'Haurs Formation whereas the Kerpen, Büchel and Schwelm Formations are more or less of the same age as the Mont d'Haurs Formation. These data are confirmed by the recent Devonian Correlation Table published by WEDDIGE (1996: R160dm96, 1998: R002dm97 and R012dm97 and 2000: R410dm00).

Besides *Spinophyllum blacourti* defined in this area, *Acanthophyllum simplex*, *Wapitiphyllum laxum*, *Argutastrea wangi* and *A. tenuiseptata* are present in the Blacourt Formation from the Boulonnais. According to COEN-AUBERT & LÜTTE (1990, p. 22), the latter taxon was described as *Disphyllia periclada* (KRÄMER, 1982) by ROHART (1988). Moreover, the stratigraphic distribution of these rugose corals, as stated by ROHART (1988, tab 2) in the Griset Member of the Blacourt Formation, is rather similar to that observed in the Mont d'Haurs Formation from Belgium.

In the Givetian of Great Britain, *Acanthophyllum simplex* is reported in West Somerset whereas *Temnophyllum majus* and *Grypophyllum denckmanni* have been recognized in South Devon. The latter taxon is also mentioned by JOSEPH & TSIEN (1975, p. 190) in the Givetian of the Pyrenees in France. To the south of Europe, *Acanthophyllum simplex* has been collected by COEN-AUBERT (2002, p. 34) in the Upper Givetian of the Tafilalt and the Ma'der in Morocco.

In Poland, *Wapitiphyllum laxum* has been introduced in the Upper Givetian of Dziewki from Silesia. According to WRZOLEK (1993, p. 232), it is associated with *Temnophyllum majus* identified by the author as *T. latum* WALTHER, 1929. Both species were also sampled by WRZOLEK (1993) in the Upper Givetian of the Holy Cross Mountains. Furthermore, *Wapitiphyllum laxum* is highly characteristic of the Upper Givetian from Moravia in the Czech Republic, as mentioned by GALLE (1985, p. 55). *Sociophyllum isactis* was observed by KETTNEROVA (1932, p. 47) in the Givetian of the same area whereas *Grypophyllum denckmanni* has been found by GALLE (1994, p. 45) in the Acanthopyge limestone of Bohemia, also in the Czech Republic. This lithostratigraphic unit is traditionally assigned to the Eifelian, but it is possible that it belongs to the Givetian after the last data of conodonts given by GALLE (1994, p. 42).

Farther to the east, *Sunophyllum beichuanense* has been defined in the Givetian of the Sichuan Province in China whereas *Sociophyllum isactis* and *Grypophyllum denckmanni* have a wide geographic range according to

COEN-AUBERT (1999, p. 33 and 2000, p. 14). Indeed, one or both of these species occur:
- in the Givetian of the Russian Platform and the Urals in Russia;
- in the Givetian of the Tien Shan, Guizhou and Yunnan in China as well as in the Middle Devonian of Northeast China and the Gansu Province.

Moreover, *Sociophyllum isactis* has been reported in the Givetian of New South Wales and North Queensland in Australia. So it appears that many taxa identified in the Mont d'Haurs Formation from Belgium are present in various areas from the Old World Realm and occasionally in Australia whereas none of them is recorded in the Middle Devonian of North America.

Systematic Palaeontology

Family DISPHYLLIDAE HILL, 1939
Genus *Temnophyllum* WALTHER, 1929

Type species
By subsequent designation of LANG *et al.* (1940, p. 132), *Temnophyllum latum* WALTHER, 1929.

DIAGNOSIS
Solitary rugose corals. Septa of two orders, non-carinate or sometimes faintly carinate. Both orders of septa frequently in lateral contact in the outer part of the dissepimentarium so as to form a wide peripheral stereozone which is complete or partial. Septa more or less dilated in the inner part of the dissepimentarium and thin in the tabularium. Major septa reaching the axis of the corallum 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 corallum in its inner part. Tabulae usually incomplete.

Temnophyllum majus WALTHER, 1929
Plate 1, Figures 3-13, Plate 2, Figures 13, 14

v *	1929	*Temnophyllum major*- WALTHER, p. 127.
v	1929	*Temnophyllum clavatum*- WALTHER, p. 128, fig. 18.
v	1929	*Temnophyllum nodosum*- WALTHER, p. 125, figs. 15, 16.
v non	1929	*Temnophyllum latum*- WALTHER, p. 123, fig. 14.
v	1975	*Temnophyllum latum*- TSIEN, fig. 16a.
v p.	1977	*Temnophyllum latum*- TSIEN, figs. 4o, p (non fig. 4n = *Temnophyllum imperfectum* n. sp. herein).
v	1978	*Temnophyllum majus* Walther 1928- BIRENHEIDE, p. 86, pl. 12, fig. 2.
p.	1985	*Temnophyllum majus* Walther 1928- BIRENHEIDE & LIAO, p. 242 (non pl. 3, fig. 13).

Lectotype
Pl. 12, figs. 2b, c *in* BIRENHEIDE (1978) and pl. 1, figs. 3, 4 figured herein, chosen by BIRENHEIDE & LIAO (1985, p. 242). Specimen and thin sections SMF WDKD 6995-6997 stored in the Forschungsinstitut Senckenberg at Frankfurt am Main, Germany. Upper Givetian Schwelm Formation at Sundwig near Iserlohn in North Sauerland, Germany.

Material and localities
Eighty specimens with 124 thin sections. Personal sampling: Wellin MC-1988-6-A719, A721, A723, A725, B4, B87 and B114; Wellin MC-1986-4-A508B, A508C, A508L, A510D, A510E, A510F, A526H, A532D, A532J, A532P, A532Q, A532T, A532U, A532V, A535D, A544A, A544B, A544C, A546, A5841, A5842, A5843, A5846, A58410, A58411, A58412, A58416, A58417 and A58423; Beauraing MC-1975-3-Z703, Z706 and Z707; Han-sur-Lesse MC-1975-15-Z943; Olloy-sur-Viroin MC-64-C839; Olloy-sur-Viroin MC-65-C867 and C896. Old collection from the Institut royal des Sciences naturelles de Belgique: Agimont (Mont d'Haurs at Givet)-Gi-28566, 28580, 28584, 28589, 28591, 28601, 28603, 28606, 28609, 28668, 28694, 28959, 28963, 28966, 28967, 28969, 28970, 28974, 28978, 28981, 28982, 28985, 28993, 28995 and 29004; Olloy-sur-Viroin 12-Gid-11894, 11896, 11915, 11917, 11923, 11929, 11935, 11953, 11959, 12012, 12163 and 12368.

DIAGNOSIS
A species of *Temnophyllum* with 56 to 66 septa at a diameter of 11 mm to 20 mm. Wide and continuous stereozone at the periphery forming a ring against the wall and obscuring the outer part of the dissepimentarium.

DESCRIPTION
The material consists of complete or fragmentary coralla which are often cylindrical and sometimes conical, tochoid or ceratoid. Their height varies between 1.5 cm and 4.5 cm, but may reach 7 cm. Longitudinal ribs have been observed in a few specimens and one of them shows constrictions due to rejuvenescence. The outer wall is not always well preserved, but is frequently encrusted by thin laminar stromatoporoids or rarely by alveolitids.

A wide and continuous stereozone, where the septa are contiguous laterally, occurs systematically in the outer part of the dissepimentarium though some voids appear locally at the periphery of several coralla. Beyond the stereozone, the septa are non-carinate and dilated in the dissepimentarium and become thinner in the tabularium. Occasionally, they are dilated throughout their length, less thick in the tabularium or again dilated at their axial ends. The major septa reach the axis of the corallum or leave a more or less extensive open space in the centre of the tabularium. In very few specimens, one can observe a weak whorl, pseudofossulae, a plane of bilateral symmetry, trabeculae or isolated fragments of septa. The minor septa traverse the entire dissepimentarium or even enter into the tabularium where they may be contratingent; they are rarely shorter.

The dissepimentarium consists of 4 to 14 rows of small globose dissepiments which are in horizontal layers at the periphery and inclined in its inner part. Its outer part is

normally obscured by contiguous coarse trabeculae which are subhorizontal or slightly inclined towards the outer wall. The tabulae are incomplete and intersecting laterally; sometimes their general pattern is concave or convex.

There are 52 to 70 septa per corallum. The diameter of the corallum ranges from 8 mm to 26 mm. The width of the tabularium varies commonly between 5.5 mm and 10 mm and more generally between 4.5 mm and 11.5 mm.

DISCUSSION

Up to now, *Temnophyllum majus* was only known by two specimens from the type locality of Sundwig in the Sauerland, Germany (Pl. 1, figs. 3-6). According to BIRENHEIDE (1978, p. 86), it differs only by larger coralla from *T. latum* of the Givetian Oberhonsel or Schwelm Formation from the same area and type species of *Temnophyllum*. But the holotype of *T. latum* (Pl. 1, figs. 1, 2) figured among others by BIRENHEIDE & LIAO (1985, pl. 7, fig. 38) shows clearly that the peripheral stereozone is not continuous in transverse section as in *T. majus*. This particularity has been described in detail by PICKETT (1967, p. 67) and has been observed by the writer. However, several identifications of *T. latum* in the literature seem to concern coralla of *T. majus*. This is for instance the case for the material of MIDDLETON (1959, p. 154) which comes from the Givetian of South Devon in Great Britain and for the material of WRZOLEK (1993, p. 232) which comes from the Givetian of Silesia and the Holy Cross Mountains in Poland and maybe from the Upper Frasnian of the latter area. This is also the case for the two transverse sections of *T. latum* illustrated by TSIEN (1975 and 1977) and collected in the Mont d'Haurs Formation at Givet in France.

The diameters of the Belgian specimens referred to *T. majus* are often not so large as those of the lectotype and paralectotype. They are more similar to those of the coralla of *T. clavatum* WALTHER, 1929 (Pl. 1, fig. 7) and *T. nodosum* WALTHER, 1929 figured by WALTHER (1929) and also recorded in the Givetian of the Sauerland. In these two taxa, the wide peripheral stereozone is complete as in *T. majus*. On the other hand, this stereozone is poorly developed in the sample assigned to the latter species by BIRENHEIDE & LIAO (1985) and found in the Givetian of the Guizhou Province in China.

T. altum (WALTHER, 1929) from the Lower Frasnian of North Sauerland, that has been revised by BIRENHEIDE & LIAO (1985, p. 240), is closely related to *T. majus*. However, its outer stereozone invests nearly the entire dissepimentarium so that the minor septa project only locally beyond it. Moreover, it is characterized by slightly smaller size and septal number and by axial tabellae systematically convex.

A more or less complete stereozone is developed in the outer part of the dissepimentarium of several other taxa. In *Entelophyllum alpinum* VON SCHOUPPÉ (1951) from the Givetian of the Carnic Alps in Austria, that probably belongs to the genus *Temnophyllum* and that was described by VON SCHOUPPÉ (1954, p. 403), the septa are not typically contiguous in the wide stereozone. Additionally, they are less numerous in this species which is only represented by its not well preserved holotype. In the two specimens of *Temnophyllum etheridgei* ZHEN & JELL, 1996 from the Givetian of North Queensland in Australia illustrated by ZHEN & JELL (1996, pl. 12, figs. 7 and 8), the peripheral stereozone is partially destroyed by weathering; these two coralla are also rather small with slightly fewer septa. In *Tortophyllum zhongguoense* JIA, 1977 from the Devonian of the Hunan Province in China investigated by JIA *et al.* (1977, p. 146), the outer stereozone is completely abraded in longitudinal section so that the structure of the dissepimentarium cannot be observed. In *Temnophyllum mosaicusum* KONG, 1978 from the Givetian of the Guizhou Province described by KONG & HUANG (1978, p. 96), the major septa are strongly fusiform. There are also some affinities between *T. majus* and *T. waltheri* YOH, 1937 from the Givetian of the Guangxi Province in China, especially with one of the paratypes figured by YOH (1937, pl. 7, fig. 3). However in the holotype from YOH (1937, pl. 7, fig. 1), the peripheral stereozone is not perfectly continuous in transverse section and does not appear in longitudinal section. Moreover, the other paratype illustrated by YOH (1937, pl. 7, fig. 2) probably belongs to the genus *Spinophyllum* as it was already suggested by BIRENHEIDE & LIAO (1985, p. 243).

GEOGRAPHIC AND STRATIGRAPHIC OCCURRENCE

The material sampled by the author comes mainly from the lower part of the Mont d'Haurs Formation at Nismes, Beauraing, Wellin, Ave-et-Auffe and Han-sur-Lesse, on the south side of the Dinant Synclinorium. However, some specimens have been collected somewhat higher in several of these localities.

Outside Belgium and Givet in France, *Temnophyllum majus* occurs only in the Givetian Schwelm Formation from the Sauerland in Germany.

Temnophyllum imperfectum n. sp.

Plate 2, Figures 1-10

v p. 1977 *Temnophyllum latum*- TSIEN, fig. 4n (non figs. 4o, p = *Temnophyllum majus* WALTHER, 1929).

(v non 1929 *Temnophyllum latum*- WALTHER, p. 123, fig. 14).

Derivatio nominis

From *imperfectus* (latin) = incomplete, referring to the incomplete stereozone of the species.

Holotype

IRScNB a11727 (= Pl. 2, Figs. 1, 2). Specimen Olloy-sur-Viroin MC-64-C824 collected by COEN-AUBERT in 1999, 6 m above the lower part of the Mont d'Haurs Formation.

Locus typicus

Small excavation (Olloy-sur-Viroin MC-64; Fig. 4) located in the Bois des Abannets, 1250 m to the northeast of

Nismes. Map sheet Olloy-sur-Viroin IGNB 58/5, Lambert coordinates: x= 164.125 and y= 85.125, south side of the Dinant Synclinorium, Belgium.

Stratum typicum
Base of the upper part of the Mont d'Haurs Formation, middle part of the Givetian.

Material and localities
Seventy-two specimens with 111 thin sections. Personal sampling: Wellin MC-1988-6-A705, A799, B111G, B111I, B111L, B118, B120, B176 and B243; Wellin MC-1986-4-A510C, A510G, A511, A526C, A531E, A535N, A544D, A548 and A567; Beauraing MC-1975-3-Z685, Z686 and Z704; Han-sur-Lesse MC-1975-15-23, 83, 91, 94, 105, 108, 109, 110, 119 and 121; Olloy-sur-Viroin MC-64-C823, C824, C825, C829, C830, C831, C832, C833 and C835; Olloy-sur-Viroin MC-65-C897 and C898; Gozée MC-47-C517 and C518; Nalinnes MC-1975-2-X38; Tamines MC-1983-2-Z5526, Z55213, Z55224, Z55227 and Z55229; Leuze-borehole 125E/298 at 1242 m. Old collection from the Institut royal des Sciences naturelles de Belgique: Agimont (Mont d'Haurs at Givet)-Gi-28386, 28432, 28437, 28468, 28470, 28493, 28496, 28520, 28526, 28528, 28570, 28596, 28610, 28615, 28631, 28643, 29021, 29044 and 29072; Olloy-sur-Viroin 12-Gid-11985 and 12404.

DIAGNOSIS
A species of *Temnophyllum* with 56 to 68 septa at a diameter of 12 mm to 20 mm. Incomplete and variable stereozone developed in the outer part of the dissepimentarium. Possible occurrence of a few carinae.

DESCRIPTION
The material consists of conical, cylindrical and sometimes ceratoid coralla which are frequently fragmentary; their height varies between 1.5 cm and 5 cm. Growth lines and longitudinal ribs have been observed in a few specimens; the calice is deep rather rarely. A corallum shows lateral offsets whereas another one is affected by rejuvenescence. The outer wall is not often well preserved. Some coralla are encrusted by thin laminar stromatoporoids or even by auloporids, alveolitids, thamnoporids and fistuliporids.

The septa are non-carinate and typically dilated in the dissepimentarium. However, a few spinose or knobbly carinae occur occasionally; they are locally stronger in rare specimens. The septa are thinner, attenuated or rather thick in the tabularium. Sometimes, they are characterized by a dark median line in the dissepimentarium. A peripheral stereozone, which is never continuous, is more or less developed against the wall and between the septa in the outer part of the dissepimentarium. Occasionally also, a stereoplasmic thickening affects a layer of dissepiments.

The major septa reach the axis of the corallum or leave a small open space in the centre of the tabularium which is more extensive in a few specimens. The inner ends of the major septa may be rhopaloid, curved, forked or fused axially to form a pseudofossula. The minor septa traverse the entire dissepimentarium or even enter into the tabularium where they are sometimes contratingent. They are rarely shorter or discontinuous at their axial ends.

The dissepimentarium consists of 7 to 14 or even of 5 to 17 rows of small globose dissepiments which are in horizontal layers at the periphery and inclined in its inner part. Some spots of coarse trabeculae occur in the dissepimentarium whereas an outer stereozone is only present in a few specimens. The tabulae are incomplete and intersecting laterally; their axial parts are rarely convex or flat-topped.

There are 50 to 72 septa per corallum. The diameter of the corallum ranges from 10 mm to 25 mm. The width of the tabularium varies commonly between 6 mm and 10 mm and more generally between 4.5 mm and 13 mm.

DISCUSSION
Temnophyllum imperfectum is very close to *T. majus*, especially by its quantitative data, that is to say by nearly similar number of septa, diameter of the corallum and of the tabularium. In fact, the former species differs mainly from the latter in having an incomplete stereozone that does not invest all the outer part of the dissepimentarium. That is why one of the coralla figured by TSIEN (1977) as *T. latum* is referred herein to *T. imperfectum*. For the same reason, it is also possible that the sample from the Lower Givetian of the Eifel Hills figured by SCHRÖDER & SALERNO (2001, pl. 2, fig. 19) as *T.* sp. cf. *latum* belongs to the new species; but, it is partially abraded in transverse section and its diameter is rather small.

Some carinae are present in a few specimens of *T. imperfectum*. These specimens look more or less like the Givetian material from the lower part of the Blacourt Formation in the Boulonnais, France, that was assigned to *T. longiseptatum* (LÜTTE, 1984) by ROHART (1988, p. 275). However, the latter species was described in the genus *Charactophyllum* SIMPSON, 1900 by LÜTTE (1984, p. 184) and transferred to the genus *Spinophyllum* by LÜTTE & OEKENTORP (1988, p. 34), BIRENHEIDE & LÜTTE (1990, p. 6) and WRZOLEK & WACH (1994, p. 53). Indeed, the German sampling of *S. longiseptatum* which comes from the Givetian Kerpen Formation of the Eifel Hills, is characterized by more numerous and stronger carinae than *Temnophyllum imperfectum*.

T. neospongiosum (IVANIA, 1957) from the Givetian of the Kuznetsk Basin in Russia is also a species that was ascribed to the genus *Charactophyllum* by IVANIA (1957, p. 63 and 1965, p. 101). Though it has several features in common with *Temnophyllum imperfectum*, it is once more distinguished from the new taxon by its better developed carination. As for *T. breviseptatum* FAN, 1988 *in* HE & FAN (1988, p. 183) from the Devonian of the Sichuan Province in China, it resembles *T. imperfectum* by its incomplete and variable stereozone, but is separated from it by rather small coralla.

GEOGRAPHIC AND STRATIGRAPHIC OCCURRENCE
The species is only known in the middle part of the Givetian from Belgium and Givet in France. The material sampled by the author comes mainly from the south side

of the Dinant Synclinorium where it has been found in the lower part of the Mont d'Haurs Formation at Ave-et-Auffe, Wellin, Beauraing, Han-sur-Lesse and Nismes and also somewhat higher in the three latter localities. Some specimens have been collected:

- in the lower part of the Mont d'Haurs Formation at Cour-sur-Heure, on the north side of the Dinant Synclinorium;
- in the lower part of the Névremont Formation at Gerpinnes, on the north side of the Dinant Synclinorium and at Aisemont, on the south side of the Namur Synclinorium;
- in the middle part of the Alvaux Formation at Leuze, on the north side of the Namur Synclinorium.

The corallum figured by TSIEN (1977) comes from the Mont d'Haurs Formation at Givet.

Genus *Spinophyllum* WEDEKIND, 1922

= *Truncicarinulum* YU & KUANG, 1982
= *Charisphyllum* OLIVER & SORAUF, 1988
= *Spongielasma* CAO, 1983 *in* CAO *et al.* (1983)

Type species
By monotypy, *Campophyllum spongiosum* SCHLÜTER, 1889.

DIAGNOSIS
Solitary rugose corals. Septa of two orders, highly and irregularly carinate in the dissepimentarium with yardarm and zigzag carinae. Septa more or les dilated in the dissepimentarium and thin in the tabularium. Major septa reaching the axis of the corallum 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 arranged in horizontal layers in its outer part and inclined towards the axis of the corallum in its inner part. Tabulae incomplete or compound.

Spinophyllum spongiosum (SCHLÜTER, 1889)
Plate 2, Figures 11, 12, Plate 3, Figures 3-7

v * 1889 *Campophyllum spongiosum* Schlüt.- SCHLÜTER, p. 46.
1922 *Spinophyllum spongiosum* Schlüter- WEDEKIND, fig. 2.
non 1951 *Charactophyllum spongiosum* (Schlüter)- SOSHKINA, p. 71, pl. 12.
non 1952 *Charactophyllum spongiosum* (Schlüter)- SOSHKINA, p. 91, pl. 28.
non 1960 *Charactophyllum spongiosum* (Schlüter, 1889)- ZHELTONOGOVA & IVANIA, p. 402, pl. D-53, fig. 4, pl. D-54, fig. 1.
non 1963 *Charactophyllum spongiosum* (Schlüter)- SMELOVSKAYA, p. 205, pl. 42, fig. 5, pl. 43, figs. 5-7.
non 1965 *Charactophyllum spongiosum* (Schlüter)- IVANIA, p. 102, pl. 54, figs. 245, 246, pl. 55, figs. 249, 250.
v 1967 *Cylindrophyllum (Cylindrophyllum) spongiosum* (Schlüter 1889)- PICKETT, p. 55.
1978 *Charactophyllum spongiosum* (Schlüter 1889)- BIRENHEIDE, p. 85, pl. 12 fig. 1.
1981 *Spinophyllum spongiosum* (Schlüter)- HILL, fig. 172, 3.
non 1987 *Spinophyllum spongiosum* (Schlüter)- CAO & OUYANG, p. 172, pl. 30, fig. 4.
v p. 1990 *Spinophyllum spongiosum* (Schlüter 1889)- BIRENHEIDE & LÜTTE, p. 4, pl. 1, figs. 4, 6-8, pl. 2, figs. 10-14, pl. 3, 15-20 (non pl. 1, figs. 1-3, 5, 9).
v 1994 *Spinophyllum spongiosum* (Schlüter)- WRZOLEK & WACH, pl. 2, fig. 11.

Lectotype
Pl. 3, fig 15 *in* BIRENHEIDE & LÜTTE (1990), pl. 2, fig. 11 *in* WRZOLEK & WACH (1994) and pl. 2, figs. 11, 12 figured herein, chosen by BIRENHEIDE & LÜTTE (1990, p. 4). Specimen Nr 174a of the SCHLÜTER collection stored in the Paläontologisches Institut from the University of Bonn in Germany. Givetian Büchel Formation of the disused Büchel quarry near Herrenstrunden and Bergisch Gladbach in the Bergisches Land, Germany.

Material and localities
Ten specimens with 15 thin sections. Personal sampling: Wellin MC-1988-6-A704, B150 and B241; Wellin MC-1974-95-Z841, Z847 and Z850; Tamines MC-1983-2-Z55212. Old collection from the Institut royal des Sciences naturelles de Belgique: Agimont (Mont d'Haurs at Givet)-Gi-28309, 28310 and 28841.

DIAGNOSIS
A species of *Spinophyllum* with 60 to 70 septa at a diameter 13 mm to 21 mm. Yardarm and zigzag carinae rather strong and numerous. No stereoplasmic thickening between the septa in the adult stage.

DESCRIPTION
The material consists of fragments of conical, ceratoid and cylindrical coralla whose height varies between 0.8 cm and 5.5 cm. Longitudinal ribs are occasionally present. The outer wall is not well preserved though it may be rather thick. It is locally encrusted by thin laminar stromatoporoids or auloporids in a few specimens.

The septa bear yardarm, zigzag, spinose and knobbly carinae which are more or less numerous and strong. They are dilated in the dissepimentarium and become thinner or sometimes less thick in the tabularium. In some specimens, the septa are locally slender or discontinuous at the periphery. A rare deposit of stereoplasma is present within the dissepimentarium of a few coralla.

The major septa reach the axis of the corallum or leave an open space in the centre of the tabularium. Occasionally, their inner ends are discontinuous, fusing axially or forming pseudofossulae; small spinose carinae occur in the tabularium of one sample. The minor septa traverse the entire dissepimentarium or enter the tabularium where they may be contratingent; they are rarely discontinuous at their axial ends.

The dissepimentarium consists of 8 to 14 rows of small dissepiments which are in horizontal layers at the periph-

ery and inclined in its inner part. Coarse trabeculae, which are frequently isolated and only locally contiguous, extend across the entire dissepimentarium. The tabulae are incomplete and intersecting laterally; their axial parts are sometimes horizontal or flat-topped.

There are 62 to 76 septa per corallum. The diameter of the corallum ranges from 11.5 mm to 25 mm whereas the width of the tabularium varies between 5 mm and 10.5 mm.

DISCUSSION

As *Spinophyllum spongiosum* is the type species of *Spinophyllum*, it is a pity that BIRENHEIDE & LÜTTE (1990) chose as lectotype a specimen whose transverse section belongs to a juvenile stage (Pl. 2, fig. 11). In this transverse section, one can see more or less strong zigzag carinae, but also stereoplasmic thickenings in some parts of the dissepimentarium. However, these stereoplasmic thickenings do not occur in the German adult coralla of *S. spongiosum* figured by WEDEKIND (1922), BIRENHEIDE (1978) and HILL (1981). Among the abundant material illustrated by BIRENHEIDE & LÜTTE (1990), some stereoplasmic thickenings are present, but I agree with WRZOLEK & WACH (1994, p. 53) that such specimens must be assigned to *S. longiseptatum*.

Differences in the carination mainly justify the exclusion of the Russian and Chinese references from the synonymy of *S. spongiosum*. These carinae are poorly developed in the Givetian sample from the Qinling Mountains investigated by CAO & OUYANG (1987) as well as in part of the Givetian material from the Urals figured by SOSHKINA (1951, pl. 12, fig. 1 and 1952). The other corallum illustrated in thin sections by SOSHKINA (1951, pl. 12, fig. 3 and 1952) is much larger than *S. spongiosum* and shows typically dilated septa with numerous yardarm carinae. Some strong carinae occur only at the periphery of the specimens collected by SMELOVSKAYA (1963) in the Givetian from the Tarbagatai ridge. Finally, weak carinae are confined to the external part of rather thick septa in the sampling of ZHELTONOGOVA & IVANIA (1960) and IVANIA (1965) coming from the Givetian of the Kuznetsk Basin.

S. spongiosum has several features in common with the three paratypes of *S. altevogti* (OLIVER & SORAUF, 1988) from the Givetian of Asturias in Spain figured by OLIVER & SORAUF (1988, figs. 6, 7). However the holotype of *S. altevogti* is different as it is characterized by numerous yardarm carinae throughout the dissepimentarium and by the occurrence of third order septa which are short or discontinuous. Indeed, this taxon was described as *Heliophyllum tricyclicum* CHENG, 1969 in an unpublished thesis by CHENG (1969). It must also be mentioned that *Spinophyllum altevogti* is the type species of the genus *Charisphyllum* OLIVER & SORAUF, 1988 and that the two transverse sections of its holotype are reillustrated herein (Pl. 3, figs. 1, 2).

Spinophyllum columellum (CAO, 1983 *in* CAO *et al.*, 1983, p. 74) from the Devonian of Northwest China and type species of *Spongielasma* CAO, 1983 *in* CAO *et al.* (1983) is also very close to *Spinophyllum spongiosum* though it has slightly fewer septa and rather thick septa like the paratypes of *S. altevogti*.

S. aiense (SOSHKINA, 1949) from the Givetian of the Urals in Russia is another taxon that resembles *S. spongiosum*. However, it is distinguished from it by weaker carinae and by major septa reaching systematically the centre of the tabularium. Mostly zigzag carinae characterize also:

- *S. puanense* (KONG, 1978) described in the subgenus *Cyathophyllum (Peripaedium)* EHRENBERG, 1834 by KONG & HUANG (1978, p. 103) and collected near the Lower-Middle Devonian boundary in the Guizhou Province, China;
- *Spinophyllum poshiense* (FONTAINE, 1966) from the Middle Devonian of the Yunnan Province in China which was also ascribed to *Peripaedium* by FONTAINE (1966, p. 55) and which differs additionally from *Spinophyllum spongiosum* by more septa and dissepiments;
- *S. trochoides* (HILL, 1942) from the Givetian of North Queensland in Australia which has slightly fewer septa than *S. spongiosum* and which was transferred to *Spinophyllum* by ZHEN & JELL (1996, p. 76).

As for *S. zhongguoense* (HE, 1978) from the Givetian of the Sichuan Province in China and assigned to *Spinophyllum* by BIRENHEIDE & LIAO (1985, p. 245), it is mainly separated from *S. spongiosum* by less dilated septa.

GEOGRAPHIC AND STRATIGRAPHIC OCCURRENCE

The material sampled by the author comes mainly from the top of the Terres d'Haurs Formation and from the lower part of the Mont d'Haurs Formation at Ave-et-Auffe and Resteigne, on the south side of the Dinant Synclinorium. One specimen has also been collected in the lower part of the Névremont Formation at Aisemont, on the south side of the Namur Synclinorium.

Outside Belgium and Givet in France, *Spinophyllum spongiosum* occurs in the middle part of the Givetian from several areas in Germany, that is to say in the Kerpen Formation from the Eifel Hills, in the Büchel Formation from the Bergisches Land and in the Schwelm Formation from the Sauerland.

Spinophyllum blacourti (ROHART, 1988)

Plate 3, Figures 8-14

* 1988 *Truncicarinulum blacourti* nov. sp. - ROHART, p. 277, pl. 35, figs. 3, 4.

Holotype

Pl. 35, fig. 3 *in* ROHART (1988). Specimen GFCL 4556 stored in the Department of Geology from the Faculté Libre des Sciences at Lille, France. Banc Noir quarry at Ferques, Boulonnais, France. Unit c of the Griset Member, Blacourt Formation, middle part of the Givetian.

Material and localities

Thirty-nine specimens with 58 thin sections. Personal sampling: Wellin MC-1988-6-A724, A756, B3, B7, B111B, B111C, B111O, B115, B168, B173 and B242; Wellin MC-1986-4-A535B, A535H and A544A; Beauraing MC-1975-3-

Z689; Gozée MC-47-C496 and C497; Nalinnes MC-1975-2-81; Tamines MC-1983-2-Z5521, Z5527, Z5528, Z5529, Z55214, Z55216, Z55217, Z55223, Z55228 and Z560. Old collection from the Institut royal des Sciences naturelles de Belgique: Agimont (Mont d'Haurs at Givet)-Gi-28379, 28555, 28556, 28574, 28617, 28702, 28850, 28858, 28940 and 29047; Olloy-sur-Viroin 12-Gid-11924.

DIAGNOSIS

A species of *Spinophyllum* with 56 to 68 septa at a diameter of 15 mm to 25 mm. Septa slightly carinate with rare yardarm carinae.

DESCRIPTION

The material consists of conical, trochoid, ceratoid and cylindrical coralla which are often fragmentary and show frequent longitudinal ribs. Their height varies between 1 cm and 5.5 cm, but may reach 7 cm or even 9.5 cm. Rare laterals offsets have been observed. The outer wall is not very well preserved and is encrusted by thin laminar stromatoporoids in only a few specimens.

The septa are non-carinate or bear in the outer part of the dissepimentarium some spinose, knobbly or yardarm carinae which are normally weak and sometimes stronger. The septa are more or less dilated in the dissepimentarium and become thinner or less thick in the tabularium. Occasionally, they are dilated throughout their length, but they may also be slender in the dissepimentarium or at least at the periphery of the corallum. In several specimens, there is locally a stereoplasmic thickening against the outer wall or on a layer of dissepiments rather near it.

The major septa reach the axis of the corallum or leave an open space in the centre of the tabularium. Their inner ends are sometimes rhopaloid, discontinuous, curved or fusing axially to form pseudofossulae or possibly a plane of bilateral symmetry. The minor septa traverse the entire dissepimentarium or enter occasionally into the tabularium where they may be contratingent; they are rarely shorter or discontinuous at their axial ends.

The dissepimentarium consists of 6 to 13 or even 2 to 14 rows of small dissepiments which are normally in horizontal layers at the periphery and inclined in its inner part. The tabulae are incomplete and intersecting laterally; in a few coralla, they are locally horizontal or concave.

There are 52 to 76 septa per corallum. The diameter of the corallum ranges from 12 mm to 22 mm or even from 9.5 mm to 26 mm. The width of the tabularium varies commonly between 6 mm and 10 mm and more generally between 4.7 mm and 11 mm.

DISCUSSION

The investigated material is very similar to that of ROHART (1988) though it is often characterized by slightly smaller coralla. The specimen from the Givetian Kerpen Formation in the Eifel Hills described by LÜTTE (1984, p. 186) as *Charactophyllum* sp. was assigned by ROHART (1988) to *Spinophyllum blacourti*; however, it is much more carinate and seems to be closer to *S. spongiosum*.

Two species from the same lithostratigraphic unit and area in Germany are more or less related to *S. blacourti*. Firstly, *S. arduum* (LÜTTE, 1985) is another taxon of *Spinophyllum* with poorly developed carinae that differs from *S. blacourti* by thinner septa. It was ascribed to the colonial genus *Cyathophyllum* GOLDFUSS, 1826 by LÜTTE (1985, p. 544) and transferred to *Spinophyllum* by ROHART (1988, p. 284) who found it together with *S. blacourti* in the Boulonnais. Secondly, the holotype of *Mictophyllum schlueteri* BIRENHEIDE & LÜTTE, 1990 resembles *Spinophyllum blacourti*, but the other coralla figured by the authors are different in having minor septa of highly variable length. It must also be mentioned that *Charactophyllum eguchii* MA, 1956 from the Middle Devonian of the Eifel Hills introduced by MA (1956, p. 43) is mainly separated from *Spinophyllum blacourti* by septa only locally dilated in the dissepimentarium.

S. spongiosum is easily distinguished from *S. blacourti* by its stronger and more numerous carinae which are frequently of the yardarm type; moreover, it has a few more septa. By the rather scarcity of its carination, *S. blacourti* occupies a marginal position in the genus *Spinophyllum*. This is also the case for *Keriophyllum temeniophylloides* WANG, 1948 from the Middle Devonian of the Yunnan Province in China which was referred to the subgenus *Temnophyllum (Temnocarinia)* YU & LIAO, 1978 by KONG & HUANG (1978, p. 100). However, *Temnocarinia* is a nomen nudum that was redescribed by YU & KUANG (1982, p. 253) as *Truncicarinulum* YU & KUANG, 1982 synonym of *Spinophyllum* according among others to MCLEAN (1993, p. 110) and WRZOLEK & WACH (1994, p. 53). As for *S. temeniophylloides*, it differs from *S. blacourti* by smaller size and septal number.

GEOGRAPHIC AND STRATIGRAPHIC OCCURRENCE

The material sampled by the author at Beauraing, Wellin and Ave-et-Auffe, on the south side of the Dinant Synclinorium, comes from the lower part of the Mont d'Haurs Formation. Moreover, several specimens have been collected in the lower part of the Névremont Formation at Aisemont, on the south side of the Namur Synclinorium and at Gerpinnes, on the north side of the Dinant Synclinorium. In the latter area, a few coralla have also been found close to the top of the Terres d'Haurs Formation at Cour-sur-Heure.

Outside Belgium and Givet in France, *Spinophyllum blacourti* occurs only in the lower part of the Griset Member from the Givetian Blacourt Formation in the Boulonnais, France.

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Explanation of Plates

All specimens are figured at magnification × 3.

PLATE 1

Temnophyllum latum WALTHER, 1929

Figs. 1, 2 — Holotype. Thin sections SMF WDKD 6972 and 6971 stored in the Forschungsinstitut Senckenberg at Frankfurt am Main, Germany. Transverse and longitudinal sections.

Temnophyllum majus WALTHER, 1929

Figs. 3, 4 — Lectotype. Thin sections SMF WDKD 6996 and 6997 stored in the Forschungsinstitut Senckenberg at Frankfurt am Main, Germany. Transverse and longitudinal sections.
Figs. 5, 6 — Paralectotype. Thin sections SMF WDKD 6992 and 6994 stored in the Forschungsinstitut Senckenberg at Frankfurt am Main, Germany. Transverse and longitudinal sections.
Fig. 7 — Holotype of *Temnophyllum clavatum* WALTHER, 1929. Thin section SMF WDKD 6977 stored in the Forschungsinstitut Senckenberg at Frankfurt am Main, Germany. Transverse section.
Fig. 8 — IRScNB a11722. Olloy-sur-Viroin MC-65-C867. Transverse section.
Figs. 9, 10 — IRScNB a11723. Beauraing MC-1975-3-Z703. Transverse and longitudinal sections.
Figs. 11, 12 — IRScNB a11724. Wellin MC-1986-4-A510E. Transverse and longitudinal sections.
Fig. 13 — IRScNB a11725. Wellin MC-1988-6-A723. Transverse section.

PLATE 2

Temnophyllum imperfectum n. sp.

Figs. 1, 2 — Holotype. IRScNB a11727. Olloy-sur-Viroin MC-64-C824. Transverse and longitudinal sections.
Fig. 3 — Paratype. IRScNB a11728. Olloy-sur-Viroin MC-65-C897. Transverse section.
Figs. 4, 5 — Paratype. IRScNB a11729. Han-sur-Lesse MC-1975-15-119. Transverse and longitudinal sections.
Figs. 6, 7 — Paratype. IRScNB a11730. Wellin MC-1986-4-A548. Transverse and longitudinal sections.
Fig. 8 — Paratype. IRScNB a11731. Beauraing MC-1975-3-Z704. Transverse section.
Figs. 9, 10 — Paratype. IRScNB a11732. Han-sur-Lesse MC-1975-15-110. Transverse and longitudinal sections.

Spinophyllum spongiosum (SCHLÜTER, 1889)

Figs. 11, 12 — Lectotype. Specimen Nr 174a of the SCHLÜTER collection stored in the Paläontologisches Institut from the University of Bonn, Germany. Transverse and longitudinal sections.

Temnophyllum majus WALTHER, 1929

Figs. 13, 14 — IRScNB a11726. Wellin MC-1986-4-A532P. Transverse and longitudinal sections.

PLATE 3

Spinophyllum altevogti (OLIVER & SORAUF, 1988)

Figs. 1, 2 — Holotype. Thin sections B2.28/1 and 2 stored in the Geologisch-Paläontologisches Institut und Museum from the University of Münster, Germany. Transverse sections. Fig. 2 was figured by OLIVER & SORAUF (1988, fig. 5A).

Spinophyllum spongiosum (SCHLÜTER, 1889)

Figs. 3, 4 — IRScNB a11733. Wellin MC-1974-95-Z841. Transverse and longitudinal sections.
Figs. 5, 6 — IRScNB a11734. Wellin MC-1974-95-Z847. Transverse and longitudinal sections.
Fig. 7 — IRScNB a11735. Wellin MC-1988-6-B241. Transverse section.

Spinophyllum blacourti (ROHART, 1988)

Figs. 8, 9 — IRScNB a11736. Wellin MC-1988-6-B7. Transverse and longitudinal sections.
Fig. 10 — IRScNB a11737. Tamines MC-1983-2-Z560. Transverse section.
Figs. 11, 12 — IRScNB a11738. Tamines MC-1983-2-Z55216. Transverse and longitudinal sections.
Figs. 13, 14 — IRScNB a11739. Beauraing MC-1975-3-Z689. Transverse and longitudinal sections.

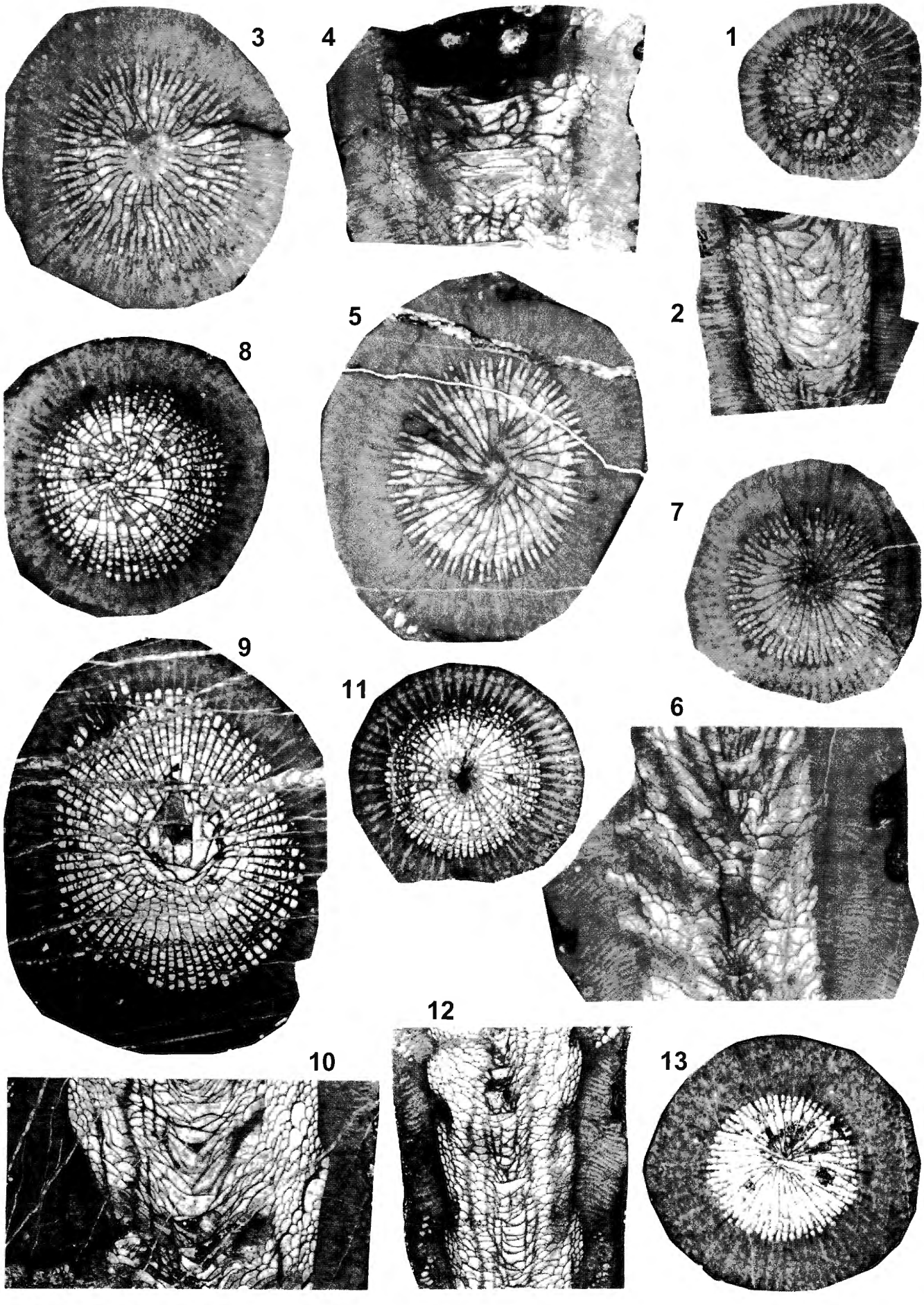

PLATE 1

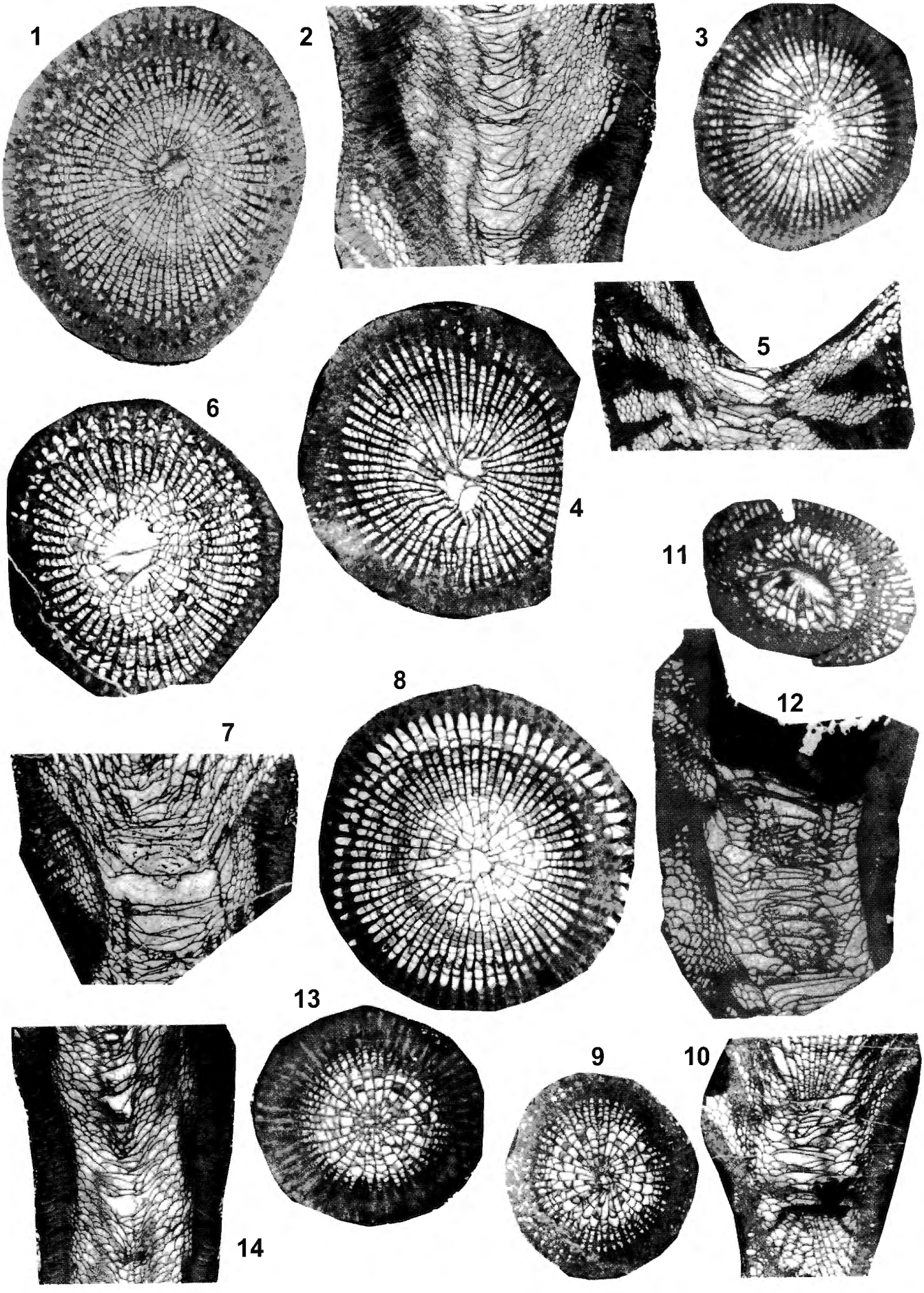

PLATE 2

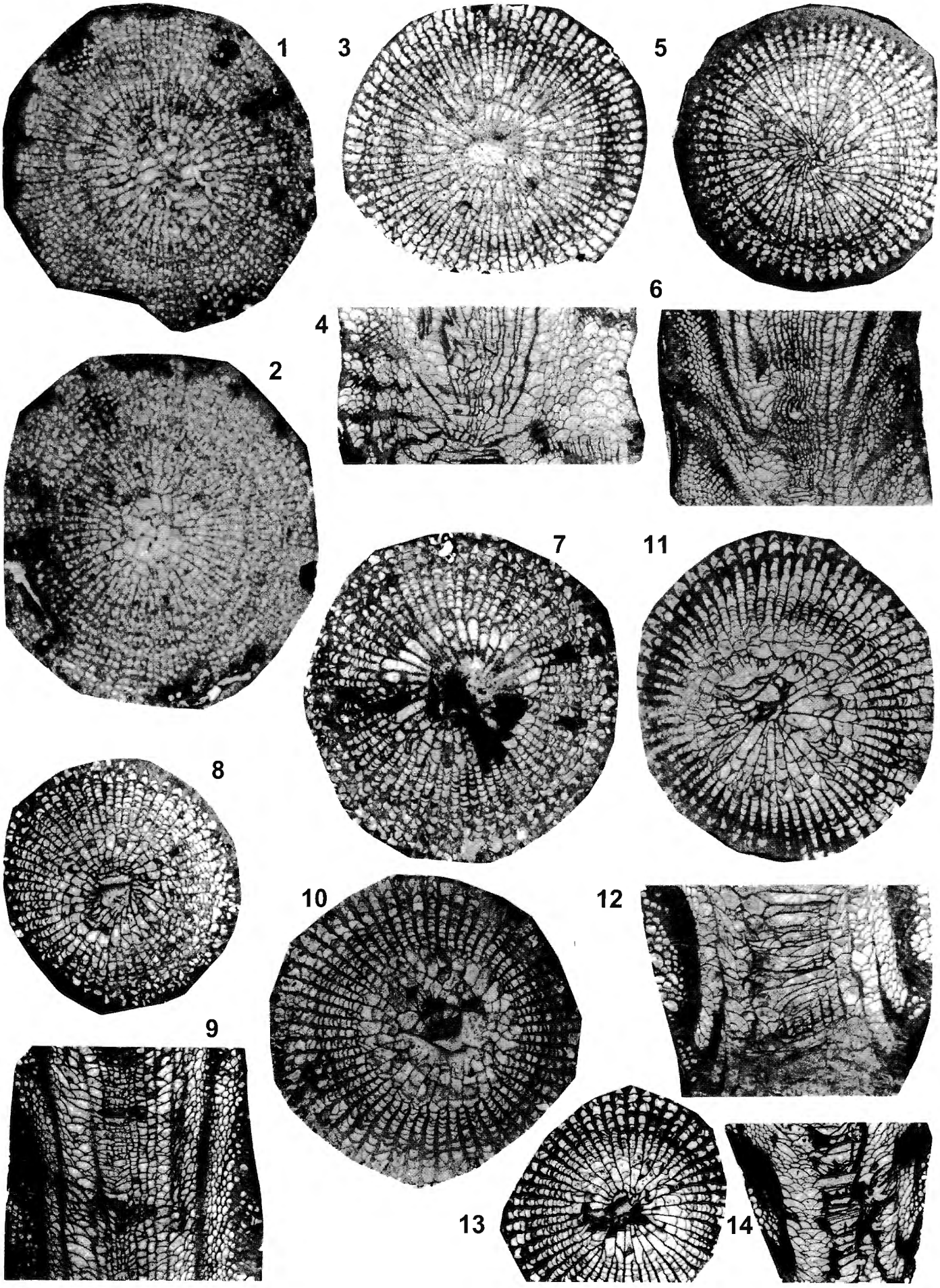

PLATE 3