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FAMENNIAN RUGOSA AND HETEROCORALLIA FROM SOUTHERN POLAND

(FAMEŃSKIE RUGOZY I HETEROKORALE
Z POŁUDNIOWEJ POLSKI)

by

BŁAŻEJ BERKOWSKI

(WITH 17 TEXT-FIGURES AND 17 PLATES)

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BŁAŻEJ BERKOWSKI

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Famennian corals (Rugosa and Heterocorallia) occur in three areas of southern Poland: the Holy Cross Mountains and the Kraków area situated along the south-western margin of the East European Platform, and the Sudetes located within the Variscan orogenic belt. In the deep-water Famennian environments of the Holy Cross Mountains (Kowala) the first corals appeared after the Frasnian–Famennian crisis in the *P. marginifera* to *P. trachytera* zones. They are represented by monospecific assemblages of *Circellia concava*, a species able to live on a soft muddy and dysaerobic bottom. On even more organic-rich sediment heterocorals *Oligophylloides* flourished; they are suggested to feed on suspended or dissolved organic matter. When the environment became more aerated in the *P. expansa* and *S. praesulcata* zones more diverse coral assemblages appeared, including large dissepimented solitary rugosans. In the extremely shallow-water limestone facies ("Stromatoporoid Rocks") of the Kraków region, two species of the colonial rugose coral *Pseudoendophyllum* and several solitary corals are represented. The shallow shelf carbonate facies of the Sudetes (Main Limestone) starts with assemblages dominated by three species of massive colonial *Scruttonia* followed by assemblages with a few species of solitary dissepimented corals. The colonial corals disappeared with the incursion of deeper-water cephalopod *Wocklumeria* Limestone facies and only solitary non-dissepimented rugose corals and heterocorals remained. The colonial Rugosa of Famennian age are almost unknown in other regions of the world. Their abundance in the Sudetes and the Kraków region suggests that these areas represented a refuge for corals during the high sea stand of the latest Devonian. Several Famennian corals reveal characters typical for those of either the Frasnian or Viséan. These characters are more likely to develop convergently than represent a continuity within lineages. *Pseudoendophyllum raclaviense* sp. n., *Scruttonia sudetica* sp. n., *S. fedorowskii* sp. n., and *Oligophylloides weyeri* sp. n. are proposed.

Key words: Rugosa, Heterocorallia, Late Devonian, Famennian, Poland.

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CONTENTS

INTRODUCTION

The latest Devonian was the time of a profound rebuilding of coral communities. After the Frasnian–Famennian crisis corals disappeared almost entirely from shelf environments of southern Poland, similarly as in other regions of the world. This almost complete extinction of corals can be correlated with the worldwide transgression in the latest Frasnian (*Palmatolepis gigas* conodont Zone). However, the decrease in diversity of corals started already much earlier (in the Givetian) and was cumulative in nature (Scrutton 1988). In the early Famennian only small non-dissepimented rugosans, represented by a few species, are known. The nature of subsequent events, which led to a partial rebuilding of the coral faunas, is a matter of controversy. It could have been either a result of immigration of still existing populations from unknown refugees (Lazarus taxa), or an evolutionary diversification (radiation) in re-established environments offering favourable life conditions to corals.

The first such re-entrance of the rugosans took place in the *Palmatolepis rhomboidea* and *P. marginifera* conodont zones (see summaries of e.g., Poty 1984, 1986, 1999, and Scrutton 1988). Presumably, the process of recovery started when the World's marine basins became more aerated and the epicontinental seas underwent shallowing. Corals of that age have been only documented from a few localities in Europe, mostly by rare small, solitary non-dissepimented taxa (Poty 1986, 1999).

The second immigration event (so-called "Strunian radiation") took place in the late Famennian (*Palmatolepis expansa–Siphonodella praesulcata* conodont zones) and was much more widespread. It has been documented in Europe (Różkowska 1969; Weyer 1971, 1973, 1989, 1995, 1997, 1999; Poty 1984, 1986, 1999; Berkowski 1996, 2001a, b), North Africa (Weyer 1997a, 1999), North America (Sorauf 1992), Asia (Onoprienko 1979a; Poty and Onoprienko 1983, 1984), China (Wu *et al.* 1981; Liao and Cai 1987; Poty and Xu 1996, 1997), and Australia (Dr. J. Jell, personal communication). Corals of that age were very diverse and endemic in nature. In some areas they are represented by rich assemblages, in others they are scarce. Some forms (mostly small non-dissepimented rugosans and heterocorals) reveal easily recognizable diagnostic characters but taxonomy of large solitary dissepimented corals is still controversial. They display characters typical of either the Frasnian or Viséan genera. The cause for this phenomenon is still not satisfactorily elucidated.

The Famennian colonial rugosans are extremely rare. Most likely, this was due to the persistence of conditions unfavorable to their growth. Only a few sites yielding colonial taxa are known in the world (see summary of Berkowski 2001a). Interestingly, they are abundant and diverse in southern Poland (Middle Sudetes). This region may have been one of the Late Devonian refugees of colonial corals.

The studied sites from the southern Poland, especially those from the Holy Cross Mountains, represent the most diverse assemblages of the Famennian corals known so far. Almost 53 species of the Rugosa and Heterocorallia were described from several exposures of the Holy Cross Mountains Famennian by Różkowska (1969). Famennian corals from the Kraków Upland are known since Gürich (1903, 1904). Some preliminary data were published also by Wrzołek (in Racki *et al.* 1989) and Berkowski (1996, 2001a), but their more detailed overview is given here. Another locality where Famennian corals occur is Dzikowiec in the Bardo Mountains (Middle Sudetes). Corals from the lower part of the Famennian section (Main Limestone) have been known since the nineteenth century (Kunth 1870; Schlütter 1881; Frech 1885; Różkowska 1953), although early authors considered these corals as Frasnian in age. These corals have been studied also by Fedorowski (1991) and more recently by Berkowski (2001a, b and this issue). Heterocorals and small solitary rugosans from the uppermost part of the Dzikowiec section have been described by Weyer (1989, 1995, 1999).

The main purpose of this paper is a taxonomic re-examination of the coral faunas from the Famennian of various facies and regions of southern Poland. Although the material investigated here is scarce, and thus often not precisely classified, it may help in understanding the pattern of the rugose coral evolution after one of the biggest world-wide biotic crises.

Abbreviations. — MB, Museum für Naturkunde, Paläontologische Abteilung (Zentralinstitut der Humboldt-Universität zu Berlin), Germany; UAM, Adam Mickiewicz University, Poznań, Poland; n/d, index of number of septa (n) to corallite diameter (d); n/dt, index of number of septa (n) to corallite tabularium diameter (dt).

Acknowledgements. — I express my warmest thanks to Professor Jerzy Fedorowski (Institute of Geology, Adam Mickiewicz University) for his guidance, help and valuable discussions during the years of writing and completing the present paper as the result of Ph.D. studies. I am deeply grateful to Professors Zdzisław Bełka, Elżbieta Morycowa, and Grzegorz Racki for the review of my Ph.D. thesis and for critical comments, which helped me to prepare the present paper. I want to express my special thanks to Dr Dieter Weyer (Museum of Magdeburg) for his kind help in lending me a lectotype and syntypes of *Scruttonia kunthi* from the Museum für Naturkunde, Humboldt-Universität Berlin, for donating to me a part of his collection of heterocorals from the Wapnica Quarry (Dzikowiec) and for constructive discussions about Famennian corals (1996–1997). Thanks are due to Professor Jerzy Dzik (Institute of Palaeobiology, Polish Academy of Science) for three specimens of *Campophyllum* from a Kowala trench. I want also to express my thanks to Professor Eddy Poty and Professor James Sorauf who kindly reviewed the manuscript and provided many interesting and helpful comments that greatly improved this paper. Dr Michał Kowalewski kindly improved the language of this paper. I am also indebted to Ms Marta Bartkowiak, Ms Bożena Stachowiak and Mr Kazimierz Fryś (Institute of Geology, Adam Mickiewicz University) for their technical assistance.

GEOLOGICAL SETTING

The Famennian corals described here come from three areas of southern Poland where the Famennian deposits are exposed (Text-fig. 1): the southern part of the Holy Cross Mountains, located at the northern margin of the Małopolska Massif (sections at Kowala and Gałęzice), the eastern part of the Dębnik anticline in the Kraków region (the Racławka Valley section), and the northern part of the Bardo Mountains in the Middle Sudetes (Wapnica Quarry at Dzikowiec). Stratigraphic correlations of the studied Famennian sequences are generally imprecise. Only the exposures at Kowala and Gałęzice in the Holy Cross Mountains are satisfactorily correlated with the standard conodont zonation by Szulczewski (in Dvořak *et al.* 1995) and Szulczewski *et al.* (1996). The shallow-water depositional environment of the late Famennian strata in the Kraków region does not allow for precise age determination (Baliński 1995). The Dzikowiec section has diverse facies, with the lower and middle parts of the succession revealing relatively shallow-water environment conditions. Dating of this part of the section is based on foraminifera. The uppermost part of the sequence is represented here by a cephalopod limestone, rich in conodonts (Freyer 1968) and cephalopods (Schindewolf 1937; Lewowicki 1959; Weyer 1965; Korn 1993), deposited in a deeper environment.

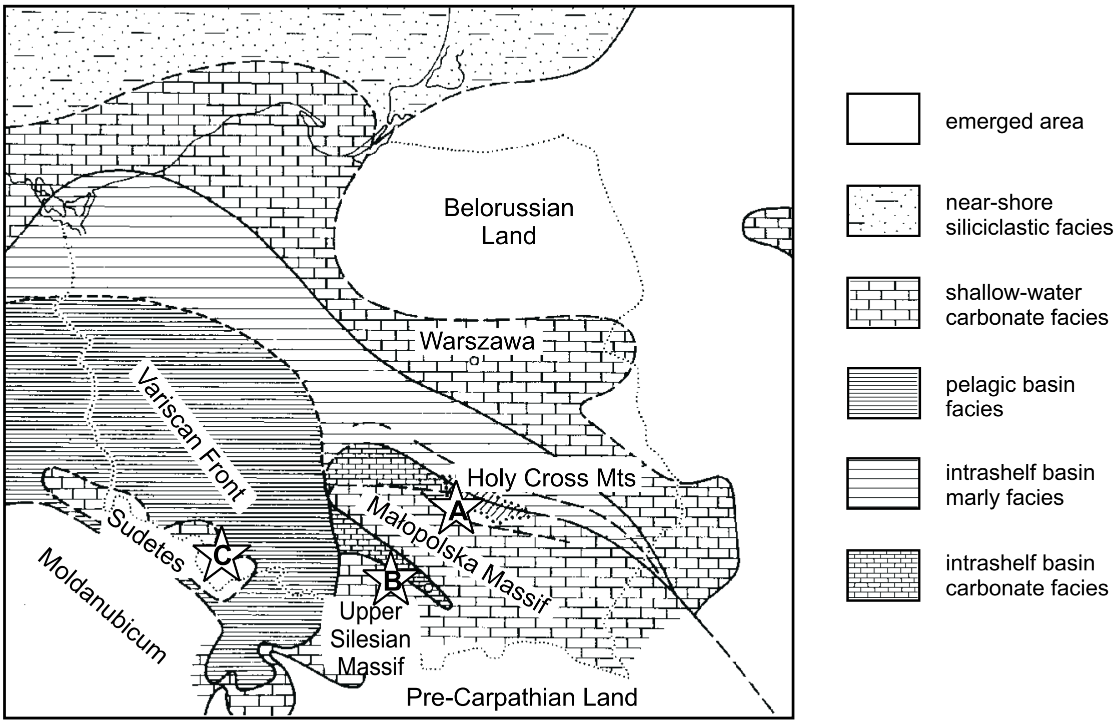

Fig. 1. Facies distribution in the Late Devonian of Poland (after Racki 1992). Localities investigated indicated as numbered stars: **A**. Holy Cross Mountains (Kadzielnia, Besówka). **B**. Kraków region (Racławka Valley). **C**. Sudetes (Dzikowiec, Zdanów IG-1).

THE HOLY CROSS MOUNTAINS

The Famennian deposits crop out both in the southern and northern parts of the Holy Cross Mountains, and in both regions they are dominated by basinal facies. The Famennian corals in these areas have been extensively studied by Różkowska (1969). Additional collecting of Famennian corals from the Holy Cross Mountains has been carried out for the present work in the southern part of the two localities: Kowala and Gałęzice which are situated within the Bolechowice-Gałęzice syncline (Text-fig. 2A).

In the northeastern part of the syncline, where the Famennian is developed in marly basinal facies, the Kowala Quarry (Text-fig. 2B) has yielded the most prolific material. This includes also specimens collected by J. Czarnocki, H. Makowski, and J. Dzik in trenches excavated north of the Quarry (Czarnocki 1928, 1933, 1989; Wolska 1967; Różkowska 1969; Malec in Racki *et al.* 1993; Olempska 1997). The lower part of the section (the Frasnian–Famennian boundary) was described in detail by Sartenaer *et al.* (1998). From the upper part of the section (*P. marginifera* to *P. expansa* conodont zones), brachiopods (Biernat and Racki 1986) and trilobites (Berkowski 1991) are known.

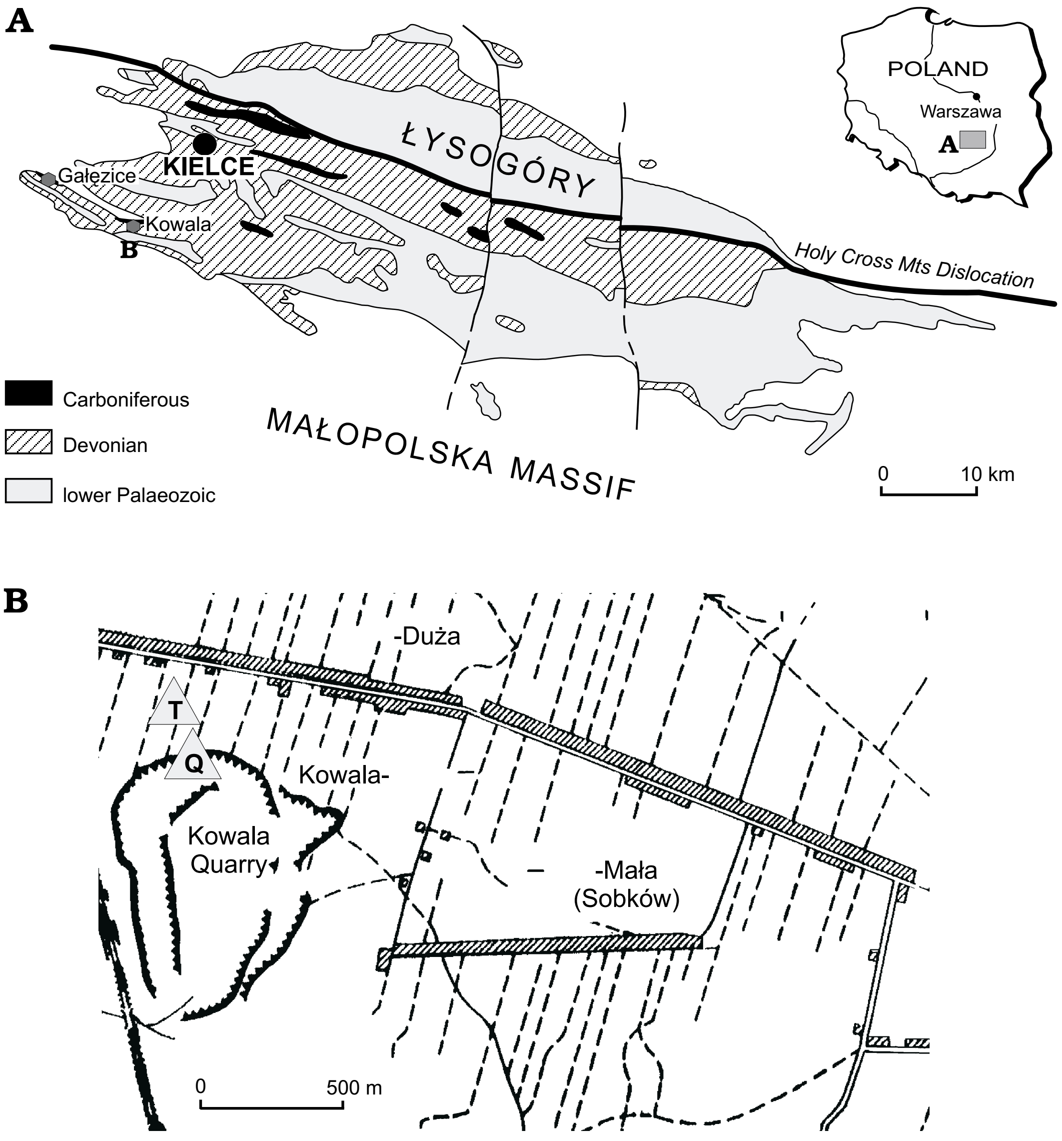

Fig. 2. **A**. Simplified geological map of the Palaeozoic core of the Holy Cross Mountains (after Szulczewski 1971) with the studied sites indicated. **B**. Topographic map of Kowala Quarry and surrounding area. Studied exposures of the Upper Famennian indicated by triangles: T, trenches; Q, quarry.

In the southwestern flank of the syncline, along the northeastern margin of Ostrówka Quarry in the vicinity of the Gałęzice Village there is a chain of outcrops of a stratigraphically condensed limestone of Famennian age. The stratigraphy and sedimentology of the limestone was presented by Szulczewski *et al.* (1996). The Famennian corals collected from the Besówka Hill were described by Różkowska (1969) and Fedorowski (1991).

The Famennian of Kowala. — The total thickness of Famennian deposits that crop out in the Kowala Quarry is about 180 m. The strata range from the Frasnian–Famennian boundary to the *P. expansa* Zone (conodont stratigraphy of Szulczewski in Dvořak *et al.* 1995).

The Frasnian part of Kowala section has been subdivided into informal lithological units (sets A to H of Szulczewski 1968, 1971) succeeded by Famennian lithological units H–L, briefly described below (Text-fig. 3A). Famennian corals have been noted only in the units (K and L; Text-fig. 3B).

Unit H is approximately 115 m thick. The strata are represented by thin-bedded black and grey marly limestone, alternating with black shale and, in the lower part, with intercalations of graded allodapic, partly crinoidal limestone. Fossils are very scarce, represented mostly by the lingulid *Barroisella* and *Orbiculoidea*, and locally by undetermined articulate brachiopods, the bivalve *Guerichia*, and fish bones. Conodonts, siliceous sponge spicules and radiolarian tests also occur. The strata range in age from the *Palmatolepis triangularis* to the *P. marginifera* conodont zones.

Unit I is approximately 20 m thick. It includes nodular limestone (with large marly nodules up to 30 cm in size) intercalated with black shale. Fossils are very rare, represented only by *Guerichia*. The strata were deposited within the late *P. marginifera* Zone.

Unit J is approximately 17 m thick. Knobby-nodular limestone is intercalated with black, bituminous shale and marl. Numerous fossils are represented mostly by *Guerichia*, articulate brachiopods of the *Rozmanaria magna* assemblage (Biernat and Racki 1986), the goniatites *Prolobites*, *Tornoceras*, and *Sporadoceras*, and small orthoceratids and gastropods. The strata are dated as latest *P. marginifera* Zone.

Unit K is approximately 28 m thick. Black bituminous shale alternates here with grey marly limestone and marl. The limestone is laminated and bioturbated. The fossil assemblage of the black bituminous shale is almost monospecific, dominated by *Guerichia* (up to 8000 shells per 1 m^2 of the bed surface). Other fossils are rare and include primarily cephalopods (mostly *Platyclymenia*). Fossils of the marly limestone and marl are much more diverse but not abundant. These are articulate brachiopods of the *Rozmanaria magna* assemblage, the blind trilobite *Trimerocephalus interruptus*, the goniatite *Sporadoceras*, and rare *Guerichia*. Corals are represented here by the solitary rugose coral *Circellia concava*. The unit extends from the early *P. trachytera* to early *P. expansa* zones.

Unit L is approximately 15 m thick. Only the basal 6 m was exposed in the Kowala Quarry during the author's study (since 1998 the exposure of this unit has been extended). Marly limestone, olive-green in the lower part and cherry red in the upper part, intercalates with marly shale. The limestone displays corrosional surfaces. Surface bioturbation of various types and U-shaped channels are present. Fossils occurring in this unit are the most diverse of all assemblages found within the Famennian Kowala succession. In the lower part (within the Kowala Quarry) these are the small solitary rugose corals (*Friedbergia bipartita*, *Nalivkinella rariseptata*, and *Neaxon regulus*), the tabulate *Yavorskia*, and bryozoans, brachiopods, clymeniids, goniatites, orthoceratids and large gastropods, the bivalve *Guerichia*, and echinoderm debris. Conodonts, agglutinating foraminifers, and ostracods are also present. The solenoporacean red algae occur. In the upper part of the section (exposed in trenches), numerous small solitary rugose corals *Gorizdronia soshkinae* and *Guerichiphyllum kowalense*, and the heterocorals *Oligophylloides pachythecus* occur, as well as other coral taxa described by Różkowska (1969). In addition, diverse large dissepimented rugose corals of the Strunian-type (*Campophyllum*, *Palaeosmilia*? ex. gr. *aquisgranensis*, and *Spirophyllum* sp.) also occur.

The Famennian of Gałęzice. — Famennian dark grey crinoidal-cephalopod limestone in the Ostrówka Quarry overlies with low-angle unconformity so called *Amphipora* Limestone of Frasnian age. The thickness of the Famennian is variable along the northeastern wall of the quarry, and reaches up to 1.5 m in its middle part (Todowa Hill). The conodont dating, presented recently by Szulczewski *et al.* (1996), reveals a strong stratigraphic condensation. The lowermost beds represent the *P. marginifera* and *P. trachytera* zones and the topmost beds belong to the *P. expansa*, and *S. praesulcata* zones. There is a gap in the middle part of the section covering at least the whole *P. postera* Zone.

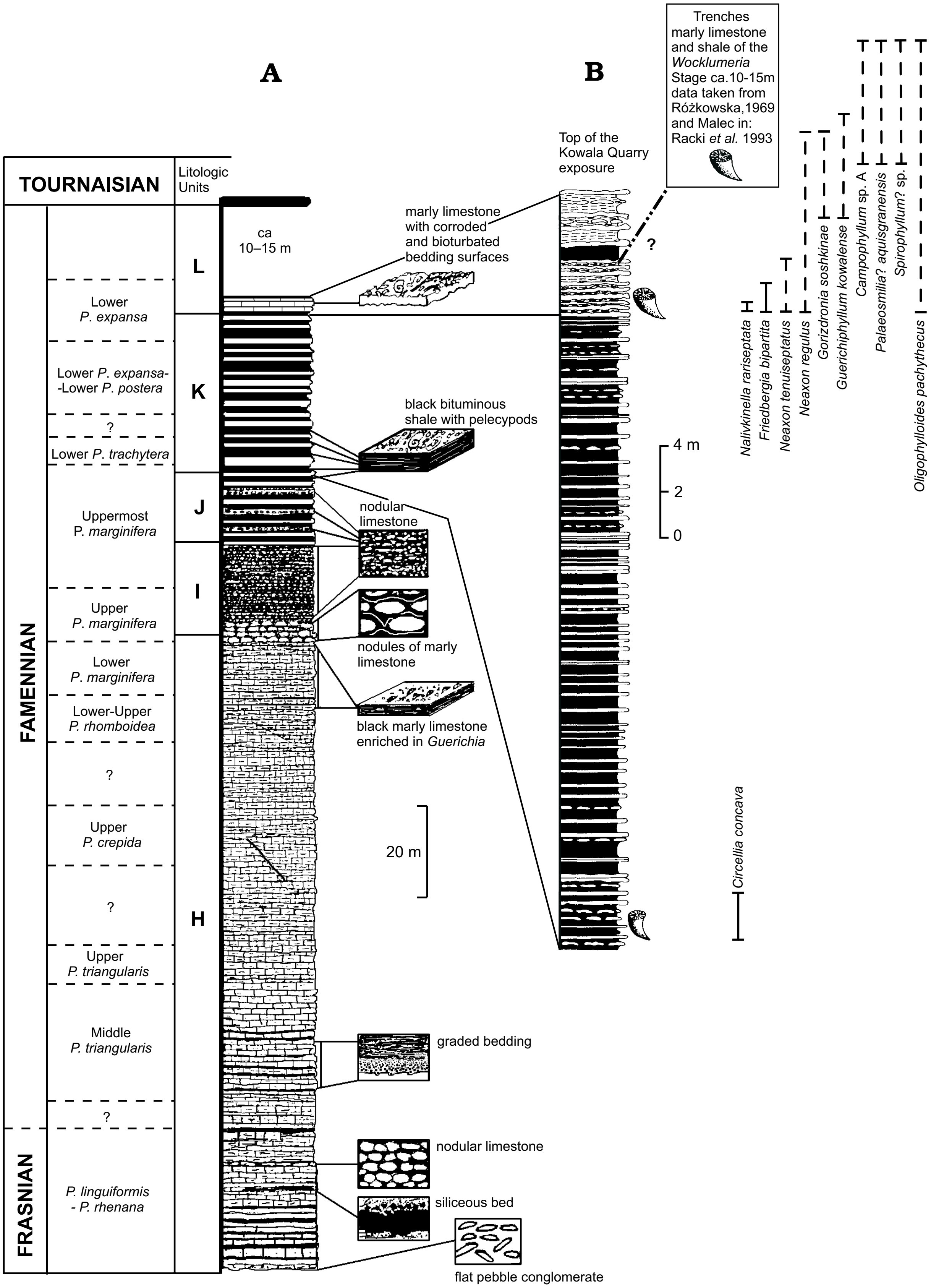

Fig. 3. **A**. Generalised lithologic column of the Famennian in the Kowala Quarry. Stratigraphy of Szulczewski (in Dvořak *et al.* 1995). Sedimentary structures diagrammaticaly shown. **B**. Detailed geological log of the Late Famennian in the Kowala Quarry and trenches. Stratigraphic ranges of the coral species shown.

Corals occurring in the cephalopod limestone at Ostrówka are mostly small, non-dissepimented rugosans and heterocorals, similar to those described by Różkowska (1969) from the Besówka Hill. The lower unit yields only thin-walled specimens of the heterocorals *Oligophylloides pachythecus,* whereas the upper unit contains the rugosans *Neaxon regulus*, *Cyathaxonia* sp., and *Syringaxon* sp., as well as thick-walled heterocorals *Oligophylloides pachythecus*.

THE KRAKÓW REGION

In the studied area, located about 30 km east of Kraków between Czernka Valley and Szklarka Valley, Devonian and Carboniferous rocks form a small structure (Dębnik Anticline), which is partially overlaped by Mesozoic strata. Outcrops of Famennian rocks are restricted to slopes of the Racławka Valley and the Żbik Ravine (Text-fig. 4).

The Early Famennian within this area was for the first time recognized by Gürich (1903, 1904), who also studied the so-called "Stromatoporoid Series" considered Early Carboniferous in age by him. This was challenged by Jarosz (1918, 1926), who realized that this unit belongs to the Late Famennian. Zajączkowski (1968, 1975, 1984) included the "Stromatoporoid Series" in the Etroeungtian (Strunian). More complete

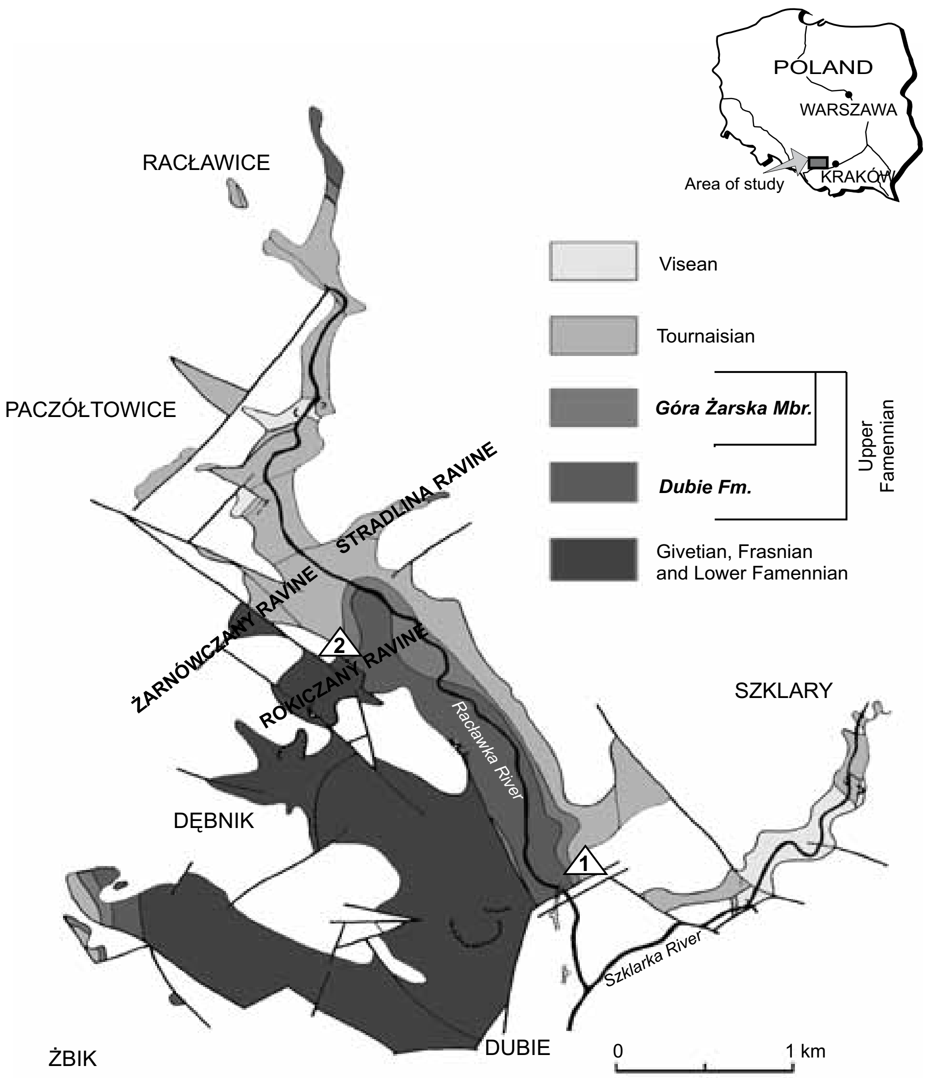

Fig. 4. Simplified geological map of the Dębnik area (Kraków region) (after Paszkowski 1997). Studied exposures of the Upper Famennian are indicated with triangles: **A**. "Stromatoporoid Rock" in Dubie. **B**. Rokiczany Ravine.

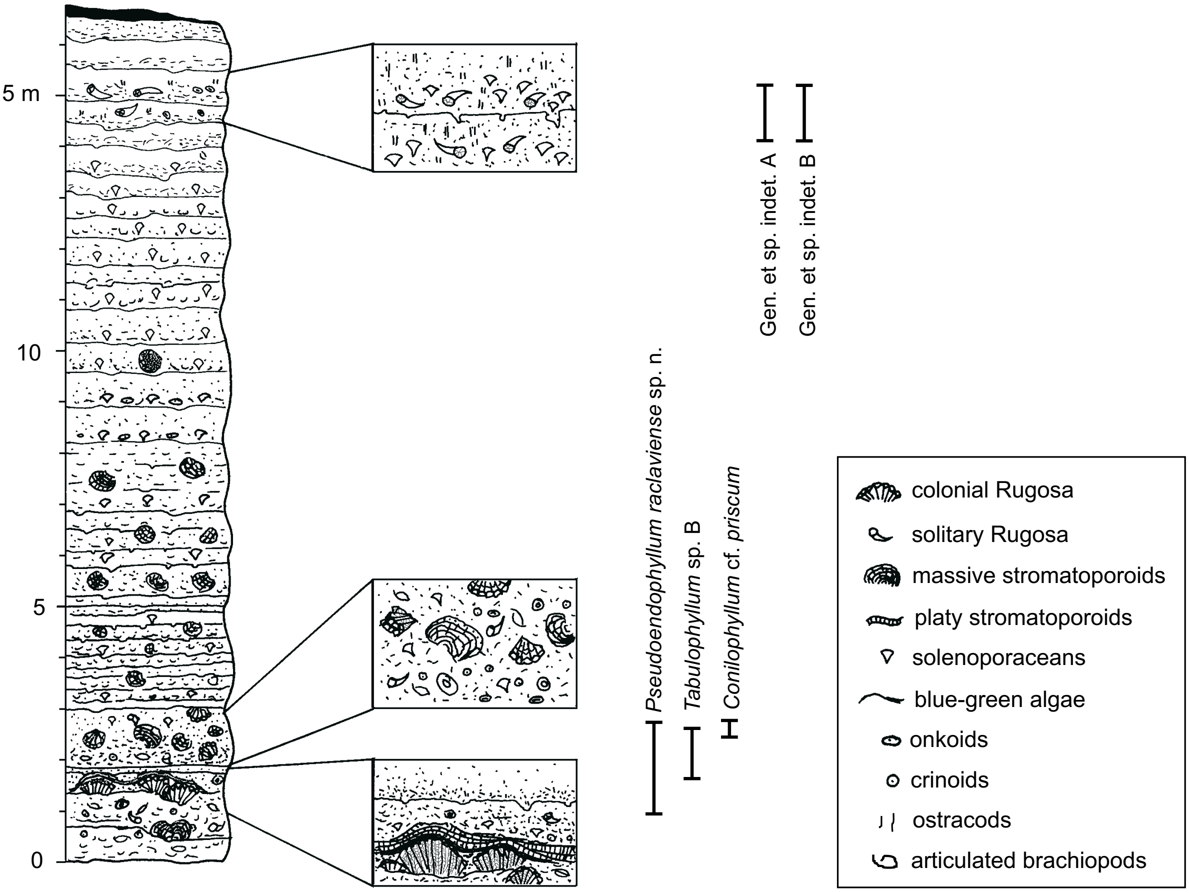

Fig. 5. Geological log of the "Stromatoporoid Rock" in Dubie (*Sphaenospira* sp. interval of Baliński 1995). Stratigraphic ranges of coral species shown.

biostratigraphic data assembled by Baliński (1989, 1995) now allows correlating his brachiopod interval with *Sphaenospira* with the latest *P. marginifera* to late *P. expansa* zones.

The lithology of the Famennian in the Dębnik area has been studied by Łaptaś (1982) and Narkiewicz and Racki (1984, 1985, and 1987) who distinguished informal lithostratigraphic units for the Devonian. Paszkowski (in Dvořak *et al.* 1995, 1997), in his lithostratigraphic division of the Carboniferous distinguished the Rudawa Group with a basal Dubie Formation assigned to the latest Famennian. The Góra Żarska Member within this formation corresponds to the "Stromatoporoid Series" of Gürich (1903, 1904) or "Stromatoporoid Rocks" of Jarosz (1926).

Rugose corals of the Dębnik area were described from the Frasnian (Różkowska 1979) and the Viséan (Fedorowski 1981). Nowiński (1976) described tabulates from the same strata. Famennian corals are very scarce and have been regarded previously only from the upper part of the Famennian strata in the Racławka Valley. Gürich (1903, 1904) described two solitary corals identified as a "Cyathophyllid Genus?" and *Zaphrentis*. They were not figured, however, and it is not possible now to identify them more precisely. Colonial corals were mentioned by Wrzołek (in Racki *et al.* 1989), Berkowski (1994, 2001a), and Paszkowski (in Dvořak *et al.* 1995, 1997), and figured by Berkowski (1996).

The Famennian in the Racławka Valley. — Famennian corals were found in two exposures in the Racławka Valley, in the Stromatoporoid Rock towering over the bridge at Dubie (exposure 1 on Text-fig. 4) and in Gürich's Stromatoporoid Rocks, a chain of small strongly overgrown isolated rocky outcrops forming the northern wall of the Rokiczany Ravine (exposure 2 on Text-fig. 4). Corals come here mostly from the scree. Two colonies were found by J. Fedorowski in the Stromatoporoid Rock on the eastern slope of the Racławka Valley (near Stradlina Ravine).

The Żarska Góra Member of the Dubie Formation is a massive peloid and intraclast grainstone lacking conodonts or any other fossil of correlative value. These strata were deposited in a very shallow marine environment. Only the long-ranging brachiopod *Sphaenospira* sp., belonging to "*Sphaenospira* interval" (*sensu* Baliński 1995), was correlated indirectly with the *P. marginifera* to *P. expansa* zones (Baliński 1995). The grainstone is mainly composed of peloids and broken skeletons of solenoporaceans, echinoderms, and bryozoans. The massive stromatoporoids *Pseudostromatoporella*, *Anostylostroma*, and *Actinostroma* often occur together with tabulates penetrated by *Caunopora*-tubes and the large solenoporacean *Parachetetes thalli*.

The thickness of the Żarska Góra member in the Stromatoporoid Rock in Dubie does not exceed 17 m. Corals occur there in three levels (Text-fig. 5), as follows:

Coral-stromatoporoid level A (thickness 30–40 cm), containing the colonial coral *Pseudoendophyllum raclaviense* sp. n. embedded in life position. Colonies are irregularly hemispherical in shape. Their upper surfaces are partly eroded and covered by thin laminae of stromatolites and tabular stromatoporoids. Within the coenostea of massive stromatoporoids *Caunopora*-tubes are present. No solitary corals were found at this level.

Coral-stromatoporoid level B (thickness 70–90 cm), in which massive, hemispherical stromatoporoids predominate. In addition, some overturned colonies of *P. raclaviense* sp. n. are present. Solitary corals, *Tabulophyllum* sp. B and *Conilophyllum* cf. *priscum*, are rare and badly preserved.

Coral level C (thickness 20–40 cm) is located in the upper part of the 12 m thick peloid and intraclast grainstone. The grainstone is strongly amalgamated and reveals hummocky cross stratification. In thin sections solenoporaceans and ostracods predominate. The coral assemblage restricted to this level is represented by two solitary forms of unknown systematic position, Gen. et sp. indet. A, and Gen. et sp. indet. B.

The coral assemblage found in the Gürich's Stromatoporoid Rocks at the Rokiczany Ravine contains the cerioid *Pseudoendophyllum raclaviense* sp. n.; solitary *Campophyllum*? sp., Gen. et sp. indet. C, and Gen. et sp. indet. D.

THE SUDETES

In the Sudetes, Famennian carbonate rocks outcrop within the Bardo structure at Dzikowiec, Łączna, Ścinawica, Gołogłowy, and Kłodzko. Famennian corals were earlier described from Dzikowiec (Kunth 1870; Schlütter 1881; Frech 1885; Schindewolf 1931; Różkowska 1953; Weyer 1989, 1995, 1999; Fedorowski 1991, 1993; Berkowski 1996, 2001a, b) and in the Zdanów IG-1 borehole (Fedorowski 1991; Chorowska *et al*. 1992) (Text-fig. 6A).

The Famennian of Dzikowiec. — Famennian strata are exposed in the abandoned Wapnica Quarry in Dzikowiec (Ebersdorf in German literature). Gürich (1902) carefully studied the geological sections from both the south and the north of the quarry, establishing a complete succession from the gabbro crystalline basement through (α) crustal limestone with gabbro debris, (β) dark-mottled limestone, (γ) crinoidal limestone, (δ) red limestone with gabbro gravel, (ε) dark-grey nodular limestone (Hauptkalk = Main Limestone), (ζ) *Clymenia* beds, and (η) lower gneissic sandstone of the "Kulm". Bederke (1924) presented a similar lithological subdivision. Only a part of the section is accessible now.

Most of the research done to date at Dzikowiec concerns its biostratigraphy. Schindewolf (1937) identified a *Gattendorfia* Stufe limestone and an underlying clymeniid limestone representing the *Wocklumeria* Stufe. Oberc (1957) and Lewowicki (1959) added some additional evidence on the stratigraphy of the area. Chorowska and Radlicz (1984), based on foraminifera, proposed that all the carbonates at Dzikowiec are olistolithes within the Carboniferous strata, but later abandoned that idea (Staniszewska 1991; Chorowska *et al*. 1992; Wajsprych 1997). Żakowa (1963), Mazur (1987), and Wajsprych (1986, 1997) placed these carbonates in the Wapnica Formation.

The dating of the base of the Wapnica Formation remains unclear. Initially (Tietze 1870; Gürich 1900, 1902, 1914; Dathe 1901; Bederke 1924, Schindewolf 1937) only the clymeniid limestone was attributed to the Famennian, whereas the gabbro-limestone breccia, basal limestone, and Main Limestone were considered to be of Frasnian age. In fact, the age of the lower part of the basal limestone (including units α, β, γ, and δ of

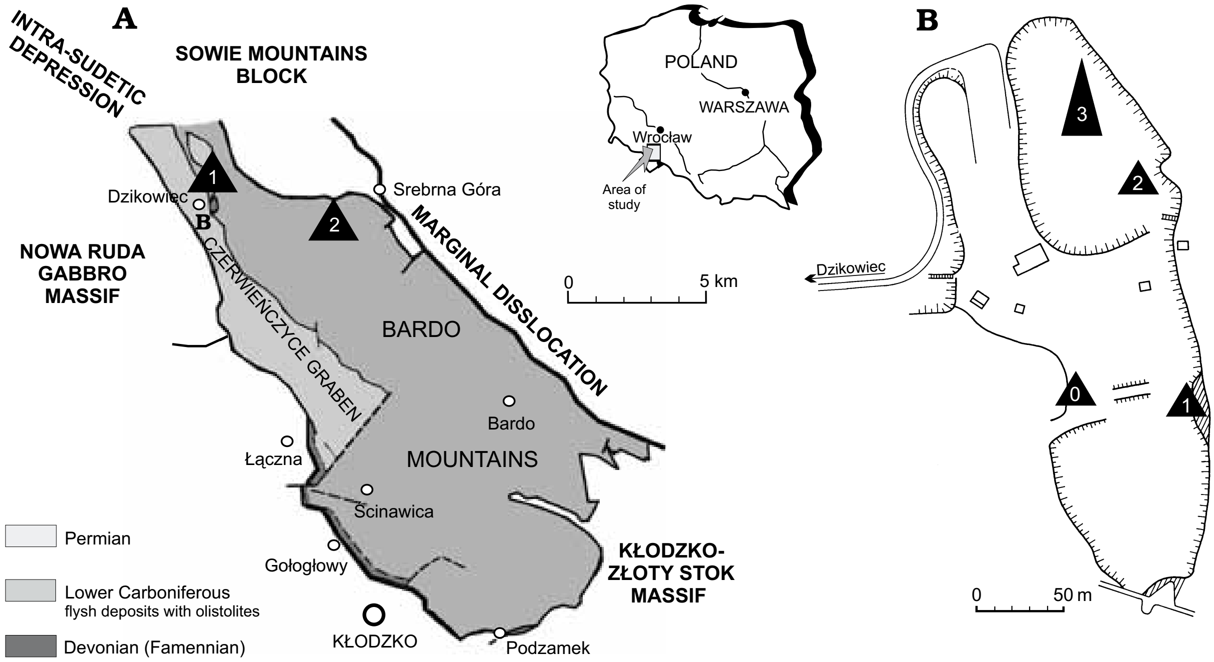

Fig. 6. **A**. Simplified geological map of the Bardo Mountains after Oberc 1972. Localities of the studied sites are indicated as triangles: 1, Dzikowiec Quarry; 2, Zdanów IG 1 borehole. **B**. Sketch of the Wapnica Quarry at Dzikowiec.

Gürich 1902) is difficult to determine because of the lack of well-preserved index fossils. Only the foraminifera *Quasiendothyra communis* and *Q*. cf. *kobeitusana* have been determined to species level (Staniszewska 1991). The upper part of the Main Limestone was dated with conodonts by Freyer (1968) and Chorowska and Radlicz (1987) as the *P. quadrantinodosa* to *P. styriacus* zones, which corresponds to the *P. marginifera* and *P. postera* zones of Ziegler and Sandberg (1990). However, data on foraminifera (Górecka and Mamet 1970; Chorowska and Emerle-Tubielewicz 1990) suggest that the deposition of the Main Limestone took place even later, within the *Quasiendothyra radiata* and *Q. kobeitusana* zones, which may correspond to the upper *P. expansa* or even lower *S. praesulcata* Zone. As only the lower part of the *S. praesulcata* Zone may be represented at Dzikowiec in the topmost part of the overlying *Wocklumeria* Limestone, the Main Limestone cannot be younger than the *P. expansa* Zone. The transition from *Q. communis communis* to *Q. communis radiata* seems to be represented in the first 2 m of the section in exposure 1 of the quarry (L. Hance, personal communication; Text-fig. 7). The occurrence of the problematic *Menselina*, typical for the Strunian, corroborates a late Famennian age of the Main Limestone. There is thus a contradiction between the correlation schemes of Freyer (1968) and Chorowska and Emerle-Tubielewicz (1990). This inconsistency may have resulted from the fact that Freyer's (1968) conodonts could came from Gołogłowy, where *P. marginifera* Zone species are apparently reworked from earlier deposited and eroded strata. Alternatively, the foraminiferal zones may differ in their ranges in the Moravo-Silesian Basin from their standards in the Ardennes.

The stratigraphy of the beds overlying the Main Limestone was investigated by means of cephalopods by Schindewolf (1937), Lewowicki (1959), Weyer (1965), Korn (1993), and Dzik (1997). Conodonts extracted from the limestone of the *Wocklumeria* Stufe were investigated by Freyer (1968), who distinguished the late *P. expansa* and early *S. praesulcata* zones. Conodonts from the *Gattendorfia* Limestone were studied by Dzik (1997). The Limestones of *Wocklumeria* Stufe and *Gattendorfia* Stufe are separated by a hiatus corresponding to the latest Famennian and earliest Tournaisian.

The *Gattendorfia* Limestone is covered by black siliceous shale. It often fills fissures between limestone blocks within the top beds. Conodonts coming from the black shale were examined by Haydukiewicz (1990) and identified as early Tournaisian in age. This unit is disconformably covered by sandstone and conglomerate composed mainly of gneissic detritus (Kulm facies "η" in Gürich 1902). In different parts of the quarry it lies upon the black shale, the *Wocklumeria* Limestone or even the Main Limestone. This is the lower part of the Nowa Wieś Formation (Wajsprych 1986, 1995, and 1997), deposited during the Viséan.

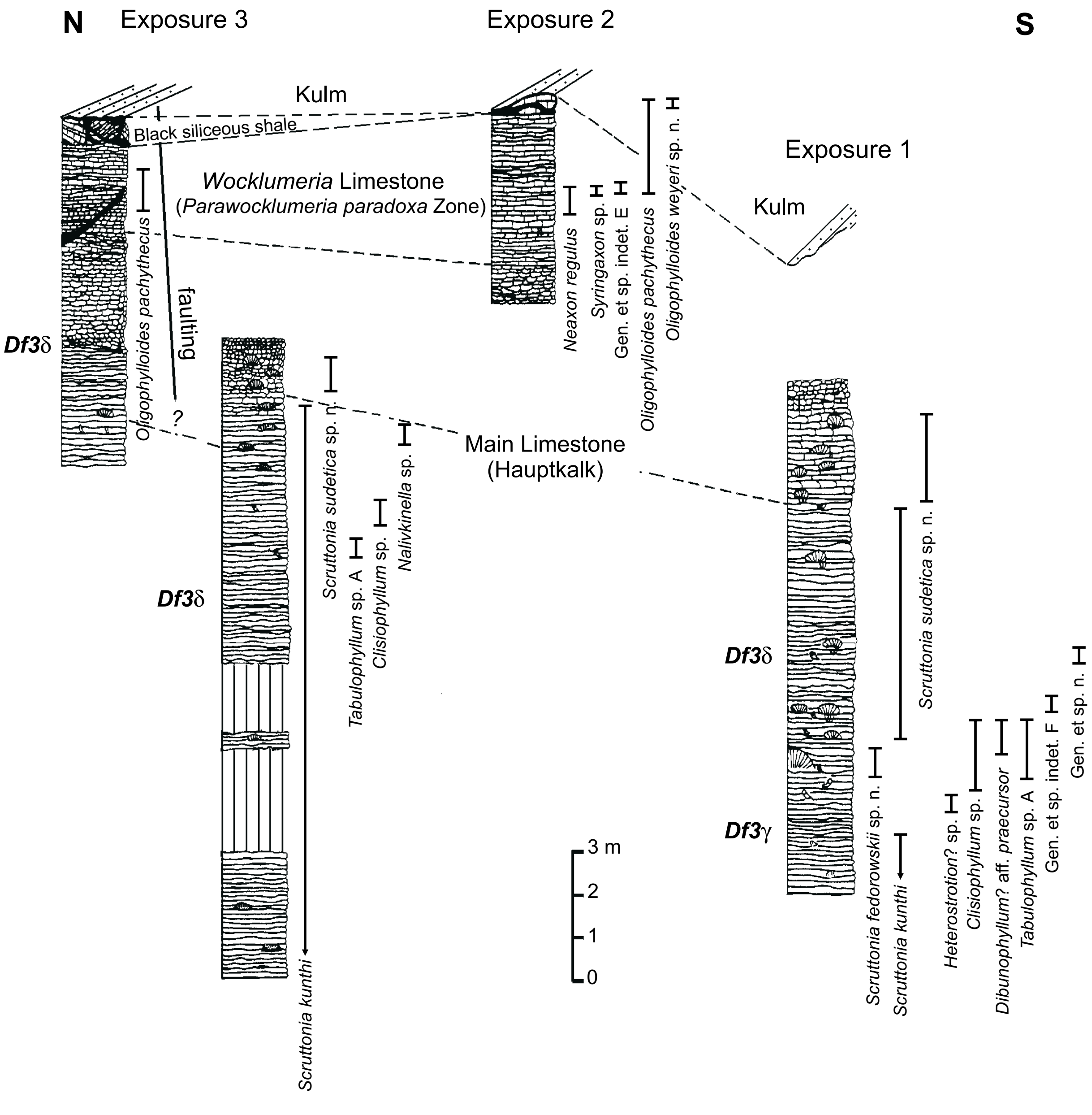

Fig. 7. Correlated lithology of the exposures situated on the eastern wall of the Wapnica Quarry. Ranges of the studied coral taxa are indicated. Stratigraphy of the Main Limestone based on foraminifers.

The Famennian sections are now accessible (see Text-fig. 6B) on both walls of the Wapnica Quarry. At the west wall, the base of the succession is exposed and includes a gabbro-limestone breccia (exposure 0) and the basal limestone beds. At the east wall, the upper part the Famennian and overlying Early Carboniferous strata are exposed. The Famennian part of the section consists of the upper part of the Main Limestone (exposures 1, 2, and 3) and the *Wocklumeria* Limestone (exposures 2 and 3). The exposures investigated are as follows:

Exposure 0 is in the middle of the west wall of the Wapnica Quarry (Text-fig. 6B). The lower part of the basal limestone of Bederke (1924) exposed here corresponds to the crustal limestone with gabbro debris of Gürich (1902). Chorowska and Radlicz (1987) described this unit as a limestone-gabbro conglomerate. The conglomerate consists of gabbro blocks and boulders of different sizes, reaching about 1 m in diameter. Apart from the gabbro boulders, limestone blocks up to 30 cm in diameter are also included in the matrix. The carbonate matrix consists of red organodetrital limestone, where solenoporacean detritus and badly preserved foraminifera predominate (Staniszewska 1991). Fissures filled with red limestone cut across the entire span of the unit were interpreted as neptunian dykes (Paszkowski *vide* Chorowska and Radlicz 1987).

The presence of corals and stromatoporoids within this lithological unit was already mentioned by Gürich (1902). Indeed, corals occur, but they are very rare and badly preserved. Only a single colony of *Scruttonia* cf. *kunthi* and two undetermined solitary corals were collected. Large massive actinostromatid stromatoporoids overgrow some gabbro blocks.

Exposure 1 is located in the middle of the east wall of the quarry (Text-fig. 6B). The upper 12 m of the Main Limestone is exposed there (Text-fig. 7). The top of the Main Limestone is disconformably covered by the "gneissic" sandstone and conglomerate of the "Kulm". The boundary between foraminiferal zones Df3γ and Df3δ was identified as occurring between 1 and 2 m up from the accessible base of the section (Text-fig. 7; L. Hance, personal communication).

The Main Limestone is a distinctly bedded, dark grey unit (bed thickness 5–26 cm). Limestone beds are wavy to nodular and alternate with thin (2–4 cm) beds of black marly shale. Microfacies are not diverse. Most commonly, they represent a packstone with the foraminifera *Quasiendothyra communis communis*, *Q. communis regularis*, *Q. radiata*, *Rectoavesnella*, and *Rectoglomospiranella* (L. Hance, personal communication). Apart from these foraminifera, the cyanobacteria *Girvanella,* kameneids, solenoporaceans, calcisphaeres, chinoderm columnals, and the problematic fossil *Menselina magna* are common. Less numerous are ostracods and small articulate brachiopods.

Corals occur within the whole section of the Main Limestone. Fifteen coral-bearing beds have been distinguished (Text-fig. 7). Colonial corals are embedded in life position. The thamnasterioid *Scruttonia kunthi*, the aphroid *Scruttonia fedorowskii* sp. n., and fragments of a presumably phaceloid colony of *Heterostrotion*? sp. are restricted to the lower and middle parts of the section. Thamnasterioid-aphroid colonies of *Scruttonia sudetica* sp. n. occur in the uppermost part. Solitary corals are less common and poorly preserved. They include the columellate *Clisiophyllum* sp., *Dibunophyllum*? aff. *praecursor*, Gen. et sp. n., the tabulophyllomorph *Tabulophyllum* sp. A, and incertae familiae Gen et sp. indet F.

The *Scruttonia* colonies are often growing on the tabulate *Syringopora*. Apart from corals, actinostromatid stromatoporoids are represented in their life position and the large gastropods *Serpulospira crassitesta* (Tietze 1870; Dzik 1994: p. 35), bivalves and articulated brachiopods occur sporadically.

Exposure 2 is in the northern part of the east wall of the quarry (Text-fig. 6B). The uppermost part of the Main Limestone (1.5 m) gradually passes there into the *Wocklumeria* Limestone (2.6 m in thickness; Text-fig. 7). The Famennian beds are covered by black siliceous shale (2–12 cm). A lens of a fossiliferous organodetrital limestone was found embedded within the black shale. The heterocoral *Oligophylloides* suggests its late Famennian age. The black shale is partly eroded and disconformably overlain by the "gneissic" sandstone and conglomerate of the "Kulm".

The uppermost part of the Main Limestone is nodular. Nodules are composed of dark grey marly and fine detrital limestone. No corals were found there. The *Wocklumeria* Limestone is reddish and grey-green in colour, nodular in the lower part and thin or medium bedded in the upper part. This is mostly wackestone and packstone with numerous and diverse cephalopods (goniatites, clymeniids, and orthoconic nautiloids), bivalves *Guerichia* and *Buchiola*, articulate brachiopods, the blind trilobite *Dianops anophtalmus*, and crinoid columnals. In thin sections foraminifera, entomozoid ostracods, bryozoans and the cyanobacterial *Girvanella* are common.

Within the *Wocklumeria* Limestone two beds with corals were identified (Text-fig. 7). However, corals are very rare and represented by the small non-dissepimented rugosans *Neaxon regulus*, *Syringaxon* sp., Gen. et sp. indet. E, and the heterocoral *Oligophylloides pachythecus*. The external walls of *O. pachythecus* are commonly overgrown by algae and calcareous tubules.

A lens of packstone within the black shale, 10 × 30 × 40 cm in size (Text-fig. 7), yielded the heterocorals *O. pachythecus* and *O. weyeri* sp. n. Thin sections obtained from the lens show also bryozoans, algae, foraminifera, small cephalopods, crinoid columnals, and small gastropods.

Exposure 3 is in the northern part of the Wapnica Quarry, on the east and northeast wall (Text-fig. 6B). The Main Limestone and *Wocklumeria* Limestone that crop out there display their greatest thickness in the quarry here, although even this exposure is truncated and does not represent the entire span of these units (Text-fig. 7). The exposure consists of two parts crossed by a fault. The lower one (exposure 3a) consists of the Main Limestone, the upper part (exposure 3b) includes the upper part of the Main Limestone and the overlying *Wocklumeria* Limestone covered by the black siliceous shale, the "gneissic" sandstone and conglomerate of the "Kulm".

The lowermost 3 m of exposure 3a consists of a dark-grey organodetrital limestone (a weakly sorted packstone with bed thickness 5–20 cm), alternating with black marly shale. Biotic elements visible in thin sections of the limestone are the foraminifer *Quasiendothyra*, cyanobacteria *Girvanella,* kameneids, solenoporacean red algae, crinoid columnals, calcisphaeres, and ostracods. Macrofossils are rather poorly preserved with stromatoporoids, gastropods, and clymeniids present. Thamnasterioid colonies of *Scruttonia kunthi* occur in life position.

The following 4.5–5.0 m of the section is covered and overgrown. Here and there single beds are visible. One thamnasterioid colony of *Scruttonia kunthi* was found there.

The uppermost part of the section in exposure 3a shows 8 m of the Main Limestone. Macroscopically it does not differ from strata occurring in the lower part, although thickness of the limestone beds is more variable. Starting from the base they increase upward in thickness, up to 26 cm, and then become increasingly thinner and more nodular. The limestone beds and nodules intercalate with black marly shale. Colonial rugosans embedded within the Main Limestone are here in life position. These are the thamnasterioid *Scruttonia kunthi* in the lower part and thamnasterioid-aphroid *Scruttonia sudetica* sp. n. in the uppermost part of the section. The solitary dissepimented rugosans *Tabulophyllum* sp. A and *Clisiophyllum* sp. have been found in the middle part of the section.

In exposure 3b, 5–6 m of the Main Limestone are separated from those of exposure 3a by a fault. Within the lower beds a colony of *S. kunthi* has been found, but *S. sudetica* is missing. In the upper part, the Main Limestone gradually becomes nodular and then passes into the *Wocklumeria* Limestone (about 2.5 m thick). Corals are less diverse there than in exposure 2; only two specimens of the heterocoral *Oligophylloides pachythecus* were found. The upper beds of the *Wocklumeria* Limestone is represented by large blocks embedded in black siliceous shale of early Tournaisian age. These are covered discordantly by the "gneissic" sandstone and conglomerates of the "Kulm".

SYSTEMATIC PART

The problem of Calyxcorallia. — The systematics of the Palaeozoic corals, especially in respect to higher taxonomic units, remains controversial. The Rugosa are defined as corals that reveal a serial insertion of septa in four quadrants during the ontogeny of their skeleton (Text-fig. 8A, G). The septa in most cases grew centripetally (Text-fig. 8D) with the exception of the axial parts of some columellate groups where the axial portions of septa grew centrifugally (Text-fig. 8E). A rank of subclass (Hill 1981; Fedorowski 1991) or order (Oliver 1996; Scrutton 1997) is given to the group. Another unit parallel to Rugosa in the rank of subclass, the Dividocorallia Fedorowski, 1991, or the order Heterocorallia Schindewolf, 1941 (Oliver 1996; Scrutton 1997), is usually distinguished. The heterocorals display a specific symmetry (the so-called heterocoral symmetry) of the septal apparatus due to the dichotomous division of the septa during ontogeny (Text-fig. 8H). The ontogeny began with one primary (oblique) septum, which divided outwards into two new pairs of septa. Each septum of the corallite was potentially creative and was able to divide (multiple division of one septum *sensu* Fedorowski 1991, 1993). Another skeletal character typical for the Heterocorallia is the inversion of calices (Text-fig. 8C, F), apparently indicating the partial (Wrzołek 1993a, b) or complete (Chwieduk 2001) coverage by soft tissue. The direction of septal growth in Heterocorallia was always centrifugal (Text-fig. 8F). Those characters clearly differentiate the Rugosa from Heterocorallia.

It is generally accepted that the Heterocorallia derived from Devonian Rugosa (Fedorowski 1991; Oliver 1996; Scrutton 1997), although it cannot be excluded that Heterocorallia had another ancestor (Scrutton 1997). Fedorowski (1991: fig. 16) suggested the idea that the Emsian genus *Pseudopetraia* (classified by him in a new order Calyxcorallia) and the genus *Tetraphyllia* (interpreted as a heterocoral) derived from a common caliculate ancestor (a rugosan). Both lineages continued to the Famennian when they diversified. Alternatively, Weyer (1991) proposed that the Heterocorallia originated from Famennian rugosans having an inverted calice; genera such as *Thecaxon* or *Kozlowskinia* (classified in the Thecaxonidae Weyer, 1978). He

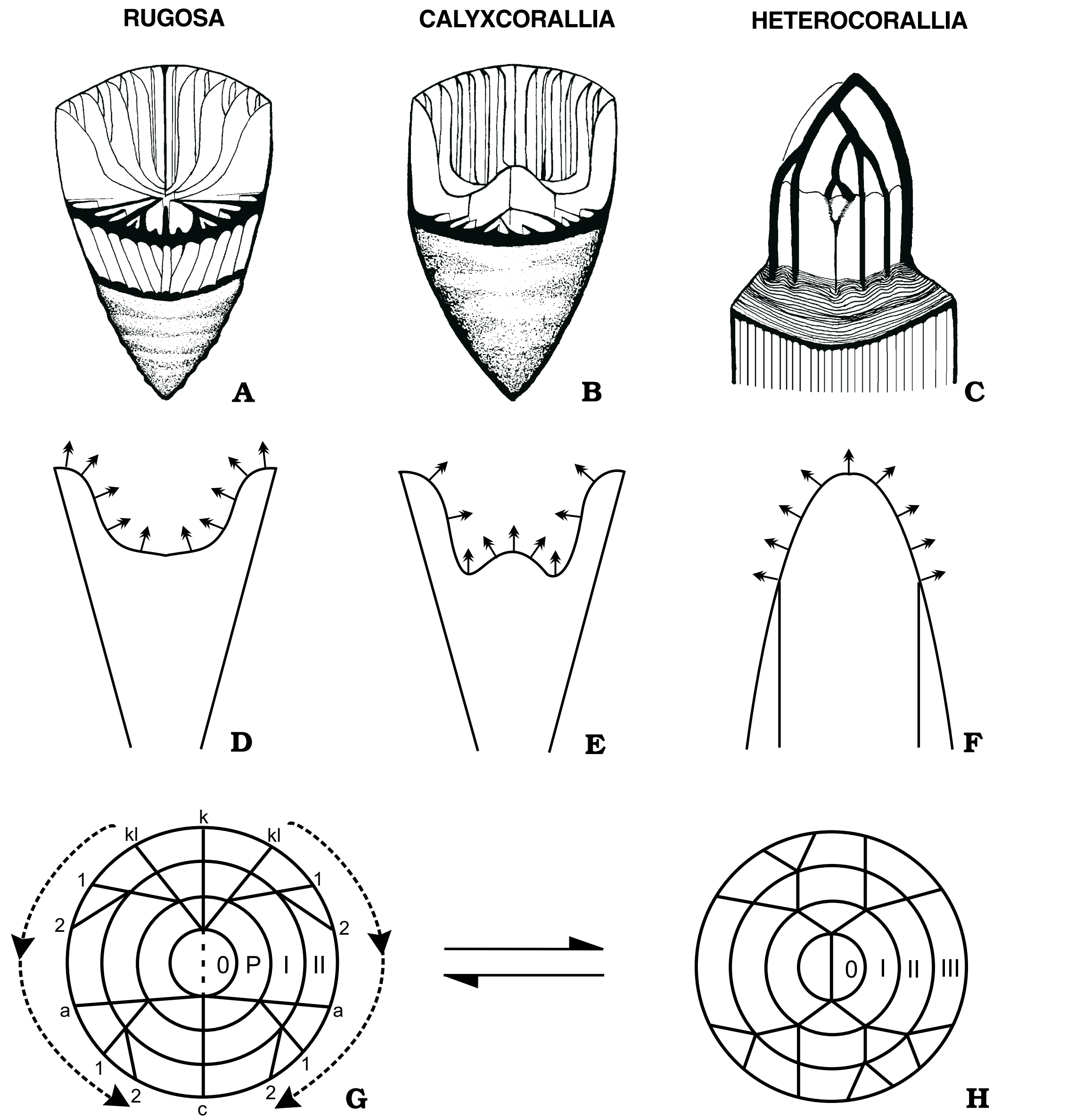

Fig. 8. Idealised schematic presentation of the solitary representatives of the discussed groups: Rugosa, Calyxcorallia, and Heterocorallia. **A**. Cardinal side view of Rugosa (frontal calical portion and upper part of external wall removed). **B**. Side view of Calyxcorallia (frontal calical portion removed). **C**. Reconstruction of the distal cone of Heterocorallia. **D**. Longitudinal section of non-columellate Rugosa showing centripetal directions of septal growth indicated by arrows. **E**. Longitudinal section of columellate Rugosa and Calyxcorallia showing mixed directions of septal growth indicated by arrows. **F**. Longitudinal section of Heterocoral distal cone showing centrifugal directions of septal growth indicated by arrows. **G**. Successive stages of rugosan septal insertion in cycles marked by circles: 0, one septal stage; P, protoseptal stage; I, II, successive metaseptal stages. Arrows show the direction of septal increase in cycles; protosepta: c, cardinal septum; a, alar septa; k, counter septum; and kl, counter-lateral septa, metasepta: 1, 2 in order of appearance in each sector. Minor septa omitted. **H**. Idealised successive stages of septal insertion in generations marked by circles: 0, one septal stage (oblique septum); I, II, III, successive generations.

stated (Weyer 1991: p. 20) that the morphology of *Pseudopetraia* displays “jedoch normales Rugosa-Genus mit einer Archaeotheca” (translated: nevertheless, normal rugosan-genus with archaeotheca). The Calyxcorallia, proposed by Fedorowski (1991) to be transitional between the Rugosa and Heterocorallia, had a heterocoral symmetry of the septal apparatus but concave calices typical for the Rugosa (Text-fig. 8B). They also show several other characters typical to the Rugosa but unknown in the Heterocorallia, e.g., second order septa, dissepiments, trabecular microstructure of the septa, and the external wall. The direction of septal growth is similar to that of columellate rugosans; i.e., centripetal near the wall and centrifugal at the axis

(Text-fig. 8E). Being thus anatomically transitional, they could be potentially classified either as the true heterocorals or within the Rugosa. Moreover, a possibility remains that the heterocoral-like characters of the Calyxcorallia could have been homoplasies, independently achieved by them. If this truly were the case, the heterocoral symmetry itself, as well as undifferentiated protosepta, would not be sufficient to prove affinities of the Calyxcorallia to heterocorals.

Most regrettably, almost all representatives of the Calyxcorallia (apart from one genus) described by Fedorowski (1991) are colonial. The identification of protocorallite ontogeny within the colony is very difficult because protocorallites are mostly not preserved in the fossil record. Studies of blastogeny in Calyxcorallia described by Berkowski (1997) have not offered any clear answer to the question of the nature of their first septum, mainly due to an ambiguous pattern of septal insertion in the first stages of blastogeny. The first septa of the offset were partly inherited from the parental corallite, and grew either on already existing skeletal structures of the parental corallite (Berkowski 1997: figs 1, 2) or on common skeletal tissue in amural colonies (Text-figs 12, 13 and Pl. 4: 4). The blastogenetic pattern of insertion of the septa may be interpreted either as rugosan, with disturbed youngest stages, or as heterocorallian. The only clear and recurrent process observed during blastogeny is the formation of new septa by the dichotomous division of existing septa. This division, however, takes place only once for each septum. The heterocoral symmetry considered by Fedorowski (1991) to be the diagnostic character that allows distinguishing Calyxcorallia from Rugosa, is unstable even during the ontogeny of a single corallite in the colony. Alternating disconnection and connection of the septa in axial part of the corallites as well as radial symmetry rather than heterocoral symmetry, in the corallite septal apparatus are both frequently observed in colonies of *Scruttonia* (Pls 4: 1, 3; 5: 1, 3, 5). Disconnection and connection of septa in the axial part of the corallite septal apparatus was also observed in the typical heterocoral *Radiciphyllia* (Sugiyama 1984), but the heterocoral symmetry there remained unchanged. In some cases (e.g., Pl. 4: 3) the heterocoral septal arrangement is reorganised into rugosan bilateral symmetry, where two opposite major septa (counter? septum and cardinal septum) become elongated. On both sides of one major septum (probably the counter septum) two elongated minor septa are observed. The rugosan pattern of septal arrangement may also be distinguished in some stages of blastogeny (Pl. 4: 4b–e). In this case one may distinguish the cardinal septum situated in a fossula, the alar septa and pinnately arranged major septa in four quadrants. In the last stage (Pl. 4: 4f), however, septa show a heterocoral symmetry.

These data on the morphology and blastogeny of the heterocoral-like colonial corals suggest that at least the massive amural genus *Scruttonia* (described as the calyxcoral *Sudetiphyllia* by Fedorowski 1991) may be a derivative of the Phillipsastreidae, typical Rugosa (Berkowski 2001a).

Thus, although direct evidence for the homeoplastic nature of heterocorallian characters in the Calyxcorallia is missing, it is safer given the present stage of knowledge, to classify these corals within the Rugosa. In any case, whether these are truly transitional forms between the Rugosa and Heterocorallia or not, they do not deserve an ordinal rank and there is no need to group them with the Heterocorallia in a separate subclass. In the present paper the subdivision of Palaeozoic corals used is with the Rugosa and Heterocorallia being equivalent units of the order rank, as proposed by Oliver (1996) and Scrutton (1997).

Homeomorphs and "connecting links". — Among the Famennian solitary rugosans, forms displaying a very wide morphological variations, even within single specimens, are very common. A good example of this phenomenon is offered by the assemblage of *Campophyllum flexuosum*, which is very common in the Late Famennian (Strunian) of the Ardennes region. Other taxa usually co-occurring with *Campophyllum* reveal characters rather typical for the Viséan corals, commonly classified in typically Carboniferous genera: *Palaeosmilia aquisgranensis*, *Clisiophyllum omaliusi*, *Dibunophyllum praecursor*, and *Spirophyllum* sp. These Famennian corals may appear ancestral for those of the Viséan, but there is a long gap in their occurrence (they are not known in the Tournaisian). This phenomenon has been already noticed by Fedorowski (1981). In the present paper these Famennian forms are considered to be homeomorphs of the Viséan taxa, not truly related to them. A similar phenomenon seems to be shown by the genus *Pseudoendophyllum*. Its morphology is very close to that of true *Endophyllum* as known from the Givetian and Frasnian. *Pseudoendophyllum* may thus be either a Lazarus taxon, a Famennian descendant of *Endophyllum*, or its homeomorph descending from solitary or phaceloid tabulophyllomorphic taxa (for detailed discussion see Berkowski 2001a).

There are also some Famennian taxa of a very unclear systematic position. They are described here as *incerte sedis*.

DESCRIPTIVE TAXONOMY

Order **Rugosa** Milne-Edwards *et* Haime, 1850

Family **Cyathaxoniidae** Milne-Edwards *et* Haime, 1850

Genus *Cyathaxonia* Michelin, 1847

Type species: *Cyathaxonia cornu* Michelin, 1847.

Diagnosis. — See Hill (1981: p. 186).

Cyathaxonia sp.
(Pl. 16: 1)

1969. *Cyathaxonia (Cyathocarinia) tuberculata* Soshkina, 1928; Różkowska: p. 56, text-figs 15D, E, 16; pl. 3: 3, 4 (with earlier synonymy).

Material. — Two poorly preserved specimens, from which five thin sections were made.

Description. — Solitary, small, subcylindrical and slightly bent corallites. The index of number of septa to corallite diameter (n/d) equals 13 per 3.4 mm (13/3.4). The columella is round in transverse section. Major and minor septa are carinated and slightly swollen, the major septa being rhopaloid, minor septa almost as long as major ones and contratingent; they fuse near columella. Any dissepimentarium is lacking.

Remarks. — The holotype of *C.* (*C*) *tuberculata* comes from the Permian of the Urals (Soshkina 1928). Specimens from the Ostrówka Quarry described here do not differ from the specimens described by Różkowska (1969: p. 56) from the Besówka Hill which she classified in this species. Because of possible homeomorphy between the Permian and Famennian taxa, Fedorowski (in press) has introduced the new species, *Cyathaxonia rozkovskae*, which should be used after publication.

Occurrence. — Ostrówka Quarry near Gałęzice in the Holy Cross Mountains, Poland. *P. expansa* or *S. praesulcata* conodont Zone.

Family **Laccophyllidae** Grabau, 1928

Subfamily **Laccophyllinae** Grabau, 1928

Genus *Syringaxon* Lindström, 1882

Type species: *Cyathaxonia siluriensis* M'Coy, 1850.

Diagnosis. — See Hill (1981: p. 195).

Syringaxon sp.
(Pl. 16: 2, 3)

Material. — Three poorly preserved specimens, from which five thin sections were made.

Description. — Corallites are small, solitary, subcylindrical, and slightly bent. Index n/d is 14/3–5 and 10/2.5–3 mm. Major septa are thickened distally and slightly rhopaloid at their proximal ends, connected near the axis and to form an aulos filled partly by stereoplasmatic sheets. Minor septa are contratingent, connected to each neighbouring major septum just in front of the aulos.

Remarks. — The specimens from the Ostrówka Quarry are morphologically very close to those from Kadzielnia and the Besówka Hill described by Różkowska (1969) as *Syringaxon* aff. *cyathaxoniaeformis*. The specimen from Dzikowiec (the Sudetes) is smaller but its morphology is also similar.

Occurrence.—Gałęzice (Besówka Hill, Ostrówka Quarry) and Kadzielnia in the Holy Cross Mountains, Dzikowiec in the Sudetes. *P. expansa* or *S. praesulcata* Zone.

Subfamily **Neaxoninae** Hill, 1981

Genus *Neaxon* Kullmann, 1965

Type species: *Neaxon regularis* Kullmann, 1965.

Diagnosis. — See Hill (1981: p. 197).

Neaxon regulus (Richter, 1848)
(Pl. 15: 2, 3)

Diagnosis. — See Weyer (1971; also synonymy).

Material. — Three specimens, of which seven acetate peels and two thin sections were made. The earliest stages are not preserved.

Description. — Corallites are solitary, small, horn-shaped. The external wall is smooth, with fine growth wrinkles. Septal index n/d counts 15/5 mm just below the calicular floor and 16/9 mm above. Major septa, thickened as long as 1/2–3/4 mm of the radius, their proximal ends form an aulos. Minor septa short and thickened. External wall thick 0.6 mm. Aulos thick 0.8–1 mm, partly filled with stereoplasmatic sheets. Dissepimentarium lacking.

Remarks. — Specimens described above do not differ from *Neaxon bulloides* Różkowska, 1969 from the Holy Cross Mountains, included by Weyer (1971) in *N. regulus*.

Occurrence. — Kowala Quarry, Kowala trenches and Gałęzice (Holy Cross Mountains), Wapnica Quarry in Dzikowiec (Sudetes). Apart from Poland the species is known from the Rheinish Slate Mountains and Thuringia (Germany). *P. expansa* or *S. praesulcata* Zone.

Neaxon tenuiseptatus Różkowska, 1969
(Pls 8: 3; 15: 1)

1969. *Neaxon tenuiseptatus* sp. n.; Różkowska: p. 59, text-figs 17A–G, 18F, 19B, pl. 8: 10.

Diagnosis. — See Różkowska (1969: p. 59).

Material. — Two specimens of which three thin sections and eight peels were made. Calices slightly broken.

Description. — Corallites solitary, small, subcylindrical, slightly bent, up to 1 cm in length, with the greatest diameter of the calice 0.8 cm. Small talon is recognisable on the convex side. The external wall is smooth, with fine growth wrinkles.

Transverse sections just below the calice show wall thickness of 0.7 mm, and index n/d counted at 16/5 mm. The major septa are as long as 2/3–3/4 of the corallite radius and are slightly wavy. Proximal ends of major septa bend to form an aulos of diameter 1.5 mm, partly filled by stereoplasmatic sheets. Major septum does not differ in length from the other septa, but is slightly thinner than the neighbouring major septa. Major septa are more densely packed in counter quadrants. Minor septa are very short.

The calice ontogeny starts with one thickened cardinal-counter septum. The aulos is formed before the six-septa stage (five septa stage with aulos was observed). In longitudinal section in the counter-cardinal plane the aulos is wide covering 1/3 of the corallite section. Tabulae are flat in the aulos, peripherally they decline into the wall. The aulos reaches the calicular floor on the counter side, on the cardinal side additional tabulae are developed above the aulos.

Remarks. — The species described here differs from the above-described *N. regulus* mainly in possessing thinner and undulated major septa (in *N. regulus* major septa are straight and thick). Aulos in *N. tenuiseptaus* is less thickened and has character of a phyllotheca (*sensu* Różkowska 1969), whereas in *N. regulus* it is thickened and posess character of stereotheca (for detailed comparisons see Różkowska 1969: p. 61).

Occurrence. — Kowala Quarry and trenches, Gałęzice, and Kadzielnia in the Holy Cross Mountains, Poland. *P. expansa* Zone.

Subfamily **Friedberginae** Różkowska, 1969
Genus *Friedbergia* Różkowska, 1969

Type species: *Friedbergia bipartita* Różkowska, 1969.

Emended diagnosis. — Solitary, small corallite; calice very deep; in young stages septa amplexoid, in adult stages zaphrentoid; proximal ends of septa rhopaloid, sometimes connected to form an aulos; cardinal septum thinner and slightly longer than the neighbouring septa; cardinal fossula well marked; alar septa in pseudofossulae; counter septum in wider loculi; minor septa visible only high in the calice.

Remarks. — Two new topotypes and additional studies of the holotype of the type species make a redefinition of the genus possible. Ontogeny reveals that one of the allegedly most important diagnostic characters, i.e., thickening of septa in cardinal quadrants of the young stages, is in fact variable and environmentally controlled. The thickening occurs at the corallite attachment, i.e., in the part where the talon is developed.

The genus is placed alone within its own subfamily. Among other rugosans only *Famennelasma* Weyer, 1973 and *Amplexizaphrentis conus* Różkowska, 1969 reveal morphological similarities to *Friedbergia*. Weyer (1973) transferred *A. conus* to *Famennelasma* (*F. rhenanum* Weyer, 1973 being its type species) of the Hapsiphyllidae. *Famennelasma* and *Friedbergia* are truly similar at adult ontogenetic stages, in the very deep calice, occurrence of minor septa high in the calice, cardinal septum being slightly longer than the adjacent septa, and in the alar septa being located in a well marked pseudofossulae. However, the early ontogeny of *Famennelasma* remains unknown, not allowing detailed comparison with *Friedbergia*. It cannot be excluded that *Famennelasma* is a junior synonym of *Friedbergia*.

Occurrence. — Kowala Quarry and trenches in the Holy Cross Mountains, Poland. *P. expansa* Zone.

Friedbergia bipartita Różkowska, 1969
(Pl. 13: 3)

1969. *Friedbergia bipartita* sp. n.; Różkowska: pp. 79–81, text-fig. 25.

Diagnosis. — *Friedbergia* possessing 26 septa at the calice diameter of 8 mm (at section across bottom of calice).

Material. — Two topotype specimens growing one on the other.

Description. — The holotype was described in detail by Różkowska (1969: pp. 79–81). Topotypes also represent solitary, horn-shaped corallites with their maximum diameter about 2 cm and length 2.3 cm. The calice is very deep, with a sharp margin. The external wall is thick with fine growth wrinkles.

The earliest stage investigated as identified in serial transverse sections as apical, possesses six amplexoid major septa, which are only developed on the counter side. The side where the cardinal quadrants are developed is attached to the base formed by the other corallite. The septal apparatus consists of an elongate counter septum, counter-lateral septum, one metaseptum, and a septum, which can be an alar septum or another metaseptum. The last one can be the next metaseptum or the cardinal septum. On the attached side of this first section only one septum is developed. At the next stage the septal apparatus possesses 16 septa present in all four quadrants. It is possible to distinguish the slightly longer cardinal, counter and alar septa. The septa in the cardinal quadrants are thickened and rhopaloid. In the following thin section the septal apparatus consists of 25 major septa, which are rhopaloid and form an incomplete aulos. The cardinal septum is slightly thinner and longer than the neighbouring septa. The cardinal fossula is long and not well developed. At the adult stage (thin section just below the calicular floor) all septa are wavy and rhopaloid (26 major septa at diameter 8 mm). Fossula and aulos are still not well developed. Minor septa occur high in the calice.

Occurrence. — Kowala Quarry in the Holy Cross Mountains, Poland. *P. expansa* Zone.

Subfamily **Guerichiphyllinae** Różkowska, 1969
Genus *Guerichiphyllum* Różkowska, 1969

Type species: *Guerichiphyllum skalense* (Gürich, 1986).

Diagnosis. — See Różkowska (1969: p. 71)

Guerichiphyllum kowalense Różkowska, 1969
(Pl. 14: 5)

1969. *Guerichiphyllum kowalense* sp. n.; Różkowska: pp. 71–73; text-fig. 21.

Diagnosis. — See Różkowska (1969: p. 71).

Material. — Three fragmentary specimens, with their calices and proximal pits not preserved. Five thin sections were made.

Description. — Corallites are solitary, subcylindrical, strongly bent as a result of rejuvenescence.

In transverse sections septal indices n/d are 22/14, 22/13, 24/13, and 27/17. The major septa are amplexoid, their length covering 1/2–2/3 of the corallite radius. They are thickened at their distal and proximal ends. The cardinal septum is shorter than neighbouring septa and occurs within an open fossula. Dissepimentarium consists of small, broad lonsdaleoid dissepiments. Minor septa are short or absent.

In longitudinal section tabulae are flat, broad, widely spaced (6/5 mm). Dissepimentarium consists of almost vertically arranged dissepiments.

Occurrence. — Kowala Quarry and trenches in the Holy Cross Mountains, Poland. *P. expansa* or *S. praesulcata* Zone.

Genus *Circellia* Ye *et* Wang, 1983

Type species: *Circellia planotabulata* Ye *et* Wang, 1983.

Diagnosis. — Emended diagnosis in Yu (1988: p. 189).

Remarks. — The genus *Circellia* Ye *et* Wang, 1983 was initially assigned to the family Cyathopsidae (see Yu 1988). The ontogeny of the type species is not well known, but reinvestigated ontogeny in Chinese specimens assigned to the genus *Circellia* (see discussion in Poty and Boland 1996 and Boland 1997) display an aulos in the early stages. Hence, the ontogeny of *Circellia* seems to be similar rather to the ontogeny of typical representatives of the subfamily Guerichiphyllinae, included within the family Laccophyllidae, than to the family Cyathopsidae as stated by Yu (1988). The genus *Circellia* is thus regarded here as a member of the subfamily Guerichiphyllinae.

Circellia concava (Różkowska, 1969)
(Pls 8: 1, 2; 14: 1, 2, 3)

1969. *Guerichiphyllum concavum* sp. n.; Różkowska: pp. 75–78, text-figs 23a–d, 24a, c, d, pl. 8: 8, 11.

Emended diagnosis. — *Circellia* with range of septal indices n/d 18–26/10–23 mm; minor septa shortened; lonsdaleoid dissepiments very big and strongly developed; axial tabulae somewhat concave; periaxial tabulae and dissepiments vertically arranged.

Material. — Five specimens of which three thin sections and 11 peels were made. The material of Różkowska (1969) was also investigated.

Description. — Corallites are solitary, subcylindrical, horn-shaped or irregularly bent, often displaying rejuvenescence. Their external wall is smooth, with growth ridges of variable thickness. The calice is deep and bell-like with a sharp rim and a slightly convex bottom.

In transverse section the wall is thick. Lonsdaleoid dissepimentarium consists of very large vesicles, which can fill almost 1/2–2/3 of the corallite lumen. Major septa most commonly occur in the tabularium as septal crests on the lonsdaleoid dissepiments. Axial ends of the septa are slightly thickened and inclined to each other. Sometimes the septal crests disappear and only large dissepiments are seen in the lumen. The cardinal septum is not distinguishable at adult stages. Minor septa are visible only on the internal side of the thickened wall.

Index n/d in specimens from Kadzielnia (*vide* Różkowska 1969) is 20/10, 18/9.6, and 18/10 mm; from Kowala 0/18, 26/23, and 20/11.

In longitudinal section tabulae are broad and flat or slightly concave, packed 3–4/5 mm. Dissepimentarium consists of 2 or 3 rows of almost vertical, large dissepiments.

The variability of the species is great, being expressed mostly in the development of the lonsdaleoid dissepimentarium.

Ontogeny. — In early stages the septa are bent to form an incomplete aulos, for comparisons see Różkowska (1969: pp. 76–77).

Remarks. — Różkowska (1969) introduced the species *Guerichiphyllum concavum*. Weyer (1994) assigned it to the genus *Hebukophyllum* Liao *et* Cai, 1987 which is a junior synonym of *Circellia* Ye *et* Wang, 1983 (see the discussion in Yu 1988 and Poty and Boland 1996).

Occurrence. — Kowala and Kadzielnia in the Holy Cross Mountains, Poland. *P. marginifera* or early *P. trachytera* conodont Zone.

Subfamily **Amplexocariniinae** Soshkina, 1941
Genus *Gorizdronia* Różkowska, 1969

Type species: *Gorizdronia soshkinae* Różkowska, 1974.

Nomenclatorial comment. — Originally Różkowska (1969) choose *Nalivkinella profunda* Soshkina, 1951 non Soshkina, 1939 as the type species of her genus, thus redefining Soshkina's species to refer only to the specimens illustrated in Soshkina (1951). Subsequently Różkowska (1974) introduced the name *G. soshkinae* with its holotype being chosen from among the specimens of Soshkina (1951). As the name of any species is attached to its holotype, and consequently to the genus which the species serves as type, this action does not strictly follow the rules of the International Code of the Zoological Nomenclature. However, as it is clear that Różkowska (1969) from the beginning wanted a separate species to be established for the material she used to propose the genus, I use this generic name in the sense given to it by Różkowska (1969, 1974).

Diagnosis. — See Różkowska (1969: p. 89).

Gorizdronia soshkinae Różkowska, 1974
(Pl. 14: 6, 7, 8)

1969. *Gorizdronia profunda profunda* (Soshkina, 1951, non 1939); Różkowska: pp. 90–92; text-figs 31a–e, 34, pl. 4: 1, 2 (with earlier synonymy).

non 1969. *Gorizdronia profunda longiseptata* subsp. n.; Różkowska: p. 93, text-fig. 32d.

1969. *Gorizdronia profunda longiseptata* subsp. n.; Różkowska: pp. 92–94; text-fig. 32a–c, e, pl. 8: 12.

Emended diagnosis. — Cylindrical *Gorizdronia*; septal index n/d is 20/10 mm; minor septa may occur within the wall.

Material. — Four incomplete specimens, four thin sections and 10 peels were made.

Description. — Corallites are solitary, cylindrical. The external wall is thin, with fine growth lines and striated. Rejuvenescence is frequent.

In transverse sections the major septa are amplexoid, n/d 20/10 (see also Różkowska 1969: p. 96). The axial ends of the septa are thin or in places rhopaloid. Minor septa are embedded in the wall and occur only below the base of the calice. The cardinal septum may be slightly shorter than the adjacent septa.

In longitudinal section tabulae are complete, flat or slightly convex in their axial part, spaced 6–7/5 mm. On the periphery they are small and accessory convex tabellae occur. Some septa correspond to tabulae and form a part of an incomplete aulos. Ontogeny and the rejuvenescence were described in detail by Różkowska (1969: pp. 90–94).

Remarks. — The status of *G. soshkinae* subspecies is debatable. Weyer (1978) moved the holotype of *G. soshkinae longiseptata* into the genus *Kielcephyllum* as *K. longiseptatum*. Sorauf (1992) elevated *G. soshkinae tenuis* to species level as *G. tenuis*.

Gorizdronia is highly variable in respect to length and number of major septa. The length of major septa within the amplexoid septal apparatus seems thus to only be of secondary taxonomic value. *Amplexus coralloides* Różkowska, 1969 from the Famennian of Kowala is very close to species of *Gorizdronia* at adult ontogenetic stages, especially in its amplexoid septal apparatus and slightly shortened cardinal septum. As its early ontogeny stages remain unknown, it is not impossible that this is actually a species of *Gorizdronia.*

Species of *Gorizdronia* are abundant in the Famennian of the Holy Cross Mountains; especially numerous specimens were described from the Kadzielnia trenches (Różkowska 1969). Apart from the Holy Cross Mountains, they are known in the Famennian of the Urals (Soshkina 1951), the Omolon Massif (Poty and Onoprienko 1984), North China (Liao and Cai 1987), and New Mexico (Sorauf 1992).

Occurrence. — Kadzielnia and Kowala in the Holy Cross Mountains, Poland. *P. marginifera* or *P. expansa* Zone.

Genus *Nalivkinella* Soshkina, 1939

Type species: *Nalivkinella profunda* Soshkina, 1939.

Diagnosis. — See Soshkina (1939: p. 43) and Różkowska (1965: p. 99).

Nalivkinella rariseptata Różkowska, 1969
(Pl. 15: 4)

1969. *Nalivkinella rariseptata* sp. n.; Różkowska: p. 102, text-figs 37a, c, f, 38a–e, 39, pl. 8: 5.

Diagnosis. — See Różkowska (1969: p. 102).

Material. — Two well-preserved specimens, 8 acetate peels were made.

Description. — Corallites are solitary, small and subcylindrical, at younger stages horn-shaped. At the youngest stage the septal index n/d is 14/3.5–4 mm. Major septa are short, their length covers about 1/2 of the corallite radius. They are very thin and amplexoid, here and there they bend to form an aulos. At adult stages the septal index n/d is 16/6 mm, major septa mostly form a poor aulos. Minor septa are very short and thickened; they appear cyclically. Dissepimentarium is lacking. The external wall is 0.5 mm thick.

In longitudinal section tabulae are flat, spaced 4/5 mm, outwards they are steeply inclined into the corallite wall. The aulos is limited to half of the space between tabulae.

Remarks. — *N. rariseptata* was originally found in Kadzielnia trenches within the *P. marginifera* Zone (Różkowska 1969). Specimens described here come from the *P. expansa* Zone in Kowala Quarry, significantly extending the stratigraphic range of the species.

Occurrence. — Kadzielnia and Kowala in the Holy Cross Mountains, Poland. *P. marginifera* or *P. expansa* Zone.

Nalivkinella sp.
(Pl. 15: 5)

Material. — One small, fragmentary specimen embedded in limestone, two thin sections have been made.

Description. — Major septa are short, reaching about 1/3–1/2 of the corallite radius. They form a half-aulos in counter quadrants. Cardinal septum may be slightly elongated. Septal index n/d is 18/4 mm. Minor septa present as septal furrows within the thickened wall.

Remarks. — The specimen is poorly preserved and seems to represent younger stages of ontogeny only, so it is impossible to identify it more precisely.

Occurrence. — Uppermost part of the Main Limestone in exposure 3a of the Wapnica Quarry in Dzikowiec, the Sudetes, Poland. Df3δ foraminiferal Zone, which corresponds to the *P. expansa* Zone.

Family **Kyphophyllidae** Wedekind, 1927
Genus *Tabulophyllum* Fenton *et* Fenton, 1924

Type species: *Tabulophyllum rectum* Fenton *et* Fenton, 1924.

Tabulophyllum sp. A
(Pl. 12: 3)

Material. — Three incomplete specimens from which nine thin sections were made.

Description. — Corallites are solitary and ceratoid. Septal index n/d is 38/16 mm. In transverse sections the major septa are wavy. Their proximal ends are thickened and meet or almost meet the axis. They may form an irregular and loose axial structure. The cardinal and counter septa do not differ from adjacent septa in their length. Minor septa are fragmental in a lonsdaleoid dissepimentarium. The dissepimentarium consists of broad lonsdaleoid vesicles, which gradually are replaced by herringbone dissepiments. The whole dissepimentarium may reach 2/3 of the corallite radius.

At younger stages of growth major septa are wavy and irregularly thickened. They are connected at the axis or just before the axis. The cardinal septum is longer than adjacent septa. The arrangement of the septa at young stages is zaphrentoid. Minor septa occur when septal index n/d is 28/7 mm.

In longitudinal section, tabularium consists of flat tabulae packed 8/5 mm, somewhat concave in the axis of the corallite. Near the dissepimentarium they are slightly elevated, small concave tabellae occur also there. The outer dissepimentarium consists of elongated and steeply sloping lonsdaleoid dissepiments. Inner dissepiments are smaller and bulbous.

Occurrence. — Uppermost part of the Main Limestone in exposures 1 and 3a of the Wapnica Quarry in Dzikowiec, the Sudetes, Poland. Df3δ foraminiferal Zone, which corresponds to the *P. expansa* Zone.

Tabulophyllum sp. B
(Pl. 12: 4)

Material. — Two fragmentary preserved specimens from which four thin sections were made.

Description. — The corallite is solitary and cylindrical. Septal index n/d is 26/11 mm. In transverse section the major septa are irregularly thickened, somewhat wavy and amplexoid, reaching or almost reaching the axis. The cardinal and counter septa do not differ in their length from the adjacent septa. Minor septa are short, reaching 1/4–1/2 of the length of major septa. Dissepimentarium occupies 1/4 of the corallite lumen and consists of different type of dissepiments, concentric near the tabularium, herringbone in the middle part, and some lonsdaleoid vesicles near the external wall. The innermost portion of the dissepimentarium has thickened skeletal elements.

In longitudinal section the tabularium consists of rarely packed tabulae 6/5 mm. They are flat or slightly concave in the middle part and bend downward near the dissepimentarium.

Occurrence. — Góra Żarska Member of the Dubie Formation at the Stromatoporoid Rocks in Racławka Valley near Kraków, Poland. *Sphaenospira* sp. interval of Baliński (1995).

Genus *Pseudoendophyllum* Onoprienko, 1979

Type species: *Pseudoendophyllum nalivkini* (Gorsky, 1935).

Emended diagnosis. — Colonies cerioid; peripheral dissepimentarium lonsdaleoid, axially interseptal; major septa long on tabulae but shortened between the tabulae; reaching or nearly reaching the axis to form radial or heterocoral-like pattern; in such case the cardinal and counter septum are connected; minor septa short; tabulae flat or axially slightly convex, at periphery are bent downwards.

Remarks. — Onoprienko (1979b) introduced the genus *Pseudoendophyllum* for species described by Gorsky (1935, 1938) as the Late Famennian (Etroeungtian) *Endophyllum*. He classified this genus together with *Endophyllum* in the family Petalaxidae Fomitchev, 1953 only because of their colonial character. The morphology and microstructure of *Endophyllum* and *Pseudoendophyllum* seems, however, to be similar rather to tabulophyllomorphic rugosans, especially those of the family Kyphophyllidae. There is a general agreement that both colonial and solitary corals can be placed within one family Hill (1981). Sando (1983) regarded taxa described by Gorsky (1935, 1938) as non-columellate species of *Stelechophyllum* Tolmatchev, 1933. He concluded that these Famennian "*Stelechophyllum*" could derive from the Middle Devonian *Endophyllum* and in fact are ancestral to Tournaisian *Stelechophyllum*. A detailed discussion of the phylogeny is given by Berkowski (2001a).

The only colonial Rugosa from the Famennian of western Europe was a cerioid colony (subsequently lost) from near Aachen in Germany described by Wulff (1923) as "Stockkoralle, nov. gen. oder subg."

Species assigned. — *Pseudoendophyllum nalivkini* (Gorsky, 1935), *P. alferovi* (Gorsky, 1935), *P. plativesiculosum* (Gorsky, 1935), and *P. raclaviense* sp. n.

Pseudoendophyllum plativesiculosum (Gorsky, 1935)
(Pl. 6: 1–6; Text-fig. 10)

1935. *Endophyllum plativesiculosum* sp. n.; Gorsky: p. 56, figs 23 and 24, pl. 10: 1–3.

Emended diagnosis. — *Pseudoendophyllum* possessing 18–22 major septa with tabularium diameter 3–5 mm; lonsdaleoid dissepimentarium consisting of large irregular vesicles.

Material. — Two small fragmentary colonies embedded in limestone, collected by J. Fedorowski on the east side of the Racławka Valley near Rokiczany Ravine; 15 thin sections and 50 peels were made.

Description. — In transverse section corallites are irregularly polygonal. The walls are thickened, 0.15 mm. The external dissepimentarium consists of large, irregular lonsdaleoid vesicles, which occupy approximately 1/2–2/3 of the greatest corallite diameter. The inner dissepimentarium consists of 1–2 rows of small interseptal dissepiments, which form a thickened internal wall. Major septa are long on the tabulae, shortened between tabulae. They are radially arranged or display heterocoral-like pattern. Septal index n/d is shown on Text-fig. 9. The cardinal septum does not differ from adjacent septa. The counter septum may be longer than other septa. Minor septa short, sometimes contraclined. The minor septa situated near counter septum (Km) are elongated on tabulae, almost reaching the axis.

In longitudinal section the dissepimentarium occupies approximately 4/7 of the corallite section. Interseptal dissepiments are bent towards the axis. They are globose and packed 15/5 mm. Lonsdaleoid vesicles are large and bulbous gently declined to subhorizontal. Tabulae flat, slightly convex, bent downwards at the margins; packed 16/5 mm.

Blastogeny. — Increase is strictly lateral. Offsets are mostly solitary, but double and triple offsets may occur. At the first stage increase is initiated near the parental corallite wall on lonsdaleoid dissepiments. The incipient septal apparatus may consists of four or eight major septa (Text-fig. 10A and B, respectively); all belong to the cardinal and counter quadrants of one side of the offset. Septa are zaphrentoid and all are newly in-

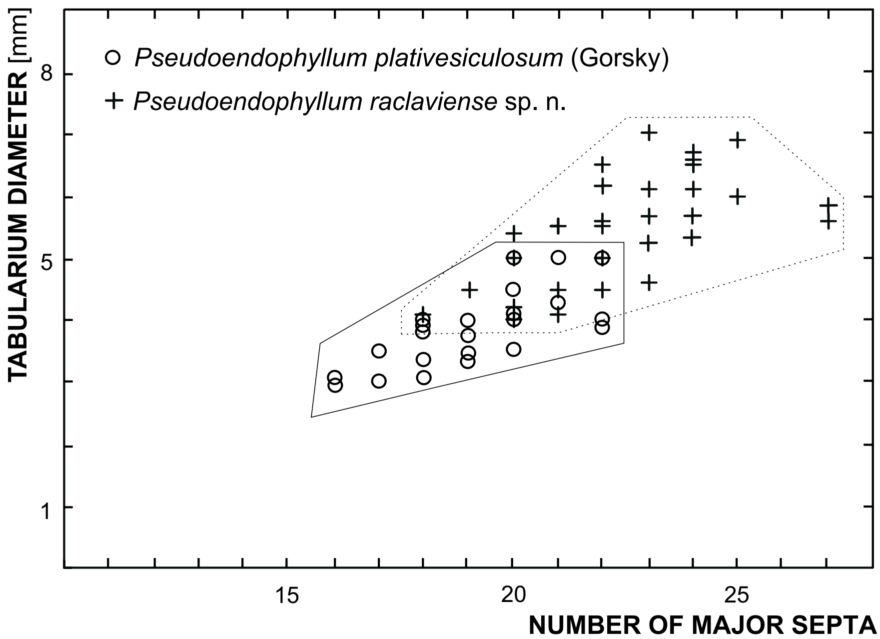

Fig. 9. Scatter diagram of number of septa (n) *versus* tabularium diameter (dt) for *Pseudoendophyllum plativesiculosum* (Gorsky, 1935) and for *Pseudoendophyllum raclaviense* sp. n. Both species from the Famennian of the Racławka Valley.

serted. Nothing in the structures of the daughter septal apparatus suggests any inheritance of the parental septal apparatus. At the second stage (Text-fig. 10C) all quadrants are visible with the cardinal, counter and alar septa clearly distinguishable. The offset starts to separate from the parental corallite with a new wall at the subsequent stage (Text-fig. 10D–G). Septa remain zaphrentoid. Then a complete dividing wall develops (Text-fig. 10H, I), and the septa become radially arranged.

Occurrence. — Novaya Zemlya, Arctic Russia (Gorsky 1935, 1938), Late Famennian, and the Góra Żarska Member of the Dubie Formation (Stromatoporoid Rocks) in the Racławka Valley near Kraków, Poland, *Sphaenospira* sp. interval of Baliński (1995).

Pseudoendophyllum raclaviense sp. n.
(Pl. 7: 1–4)

Holotype: UAM Tc-B/03/9 (Pl. 7: 2).

Type horizon: Góra Żarska Member, Racławka Formation (*sensu* Paszkowski in Dvořak *et al*. 1995). Brachiopod *Sphaenospira* sp. interval (Baliński 1995), Late Famennian.

Type locality: Stromatoporoid Rock in the Rokiczany Ravine near Dębnik village (western slope of the Racławka Valley), Kraków region, Poland.

Derivation of the name: Named after the Valley of Racławka River, where the holotype was found.

Diagnosis. — *Pseudoendophyllum* possessing 22–25 major septa at a diameter of tabularium of 4–7 mm; minor septa straight or contraclined; tabulae flat with down-turned edges; external dissepimentarium consisting of small lonsdaleoid dissepiments (1–2 mm chord length); inner dissepimentarium consists of 2–3 rows of small dissepiments.

Material. — 19 fragments of large colonies of which 21 thin transverse and longitudinal thin sections were made. Colonies are very often strongly altered diagenetically.

Description. — The holotype is a fragmentary cerioid colony with dimensions 15 × 5 × 9 cm, calices are not filled with sediment. In transverse sections corallites are mostly pentagonal or hexagonal, regular in shape, with a diameter ranging from 10 to 15 mm. The wall is dividing and 0.25 mm thick. The external dissepimentarium occupies 2/5–1/2 of the largest corallite diameter, consisting of small lonsdaleoid dissepiments. Small septal crests occur very rarely on lonsdaleoid dissepiments in the innermost part of the lonsdaleoid dissepimentarium. The inner dissepimentarium consists of 2–3 rows of small interseptal dissepiments. Major septa are amplexoid, straight or slightly wavy, almost reaching the axis. If they connect on the tabulae, the symmetry of the septal apparatus is radial or heterocoral-like. Septal index n/dt is shown on Text-fig. 9. The

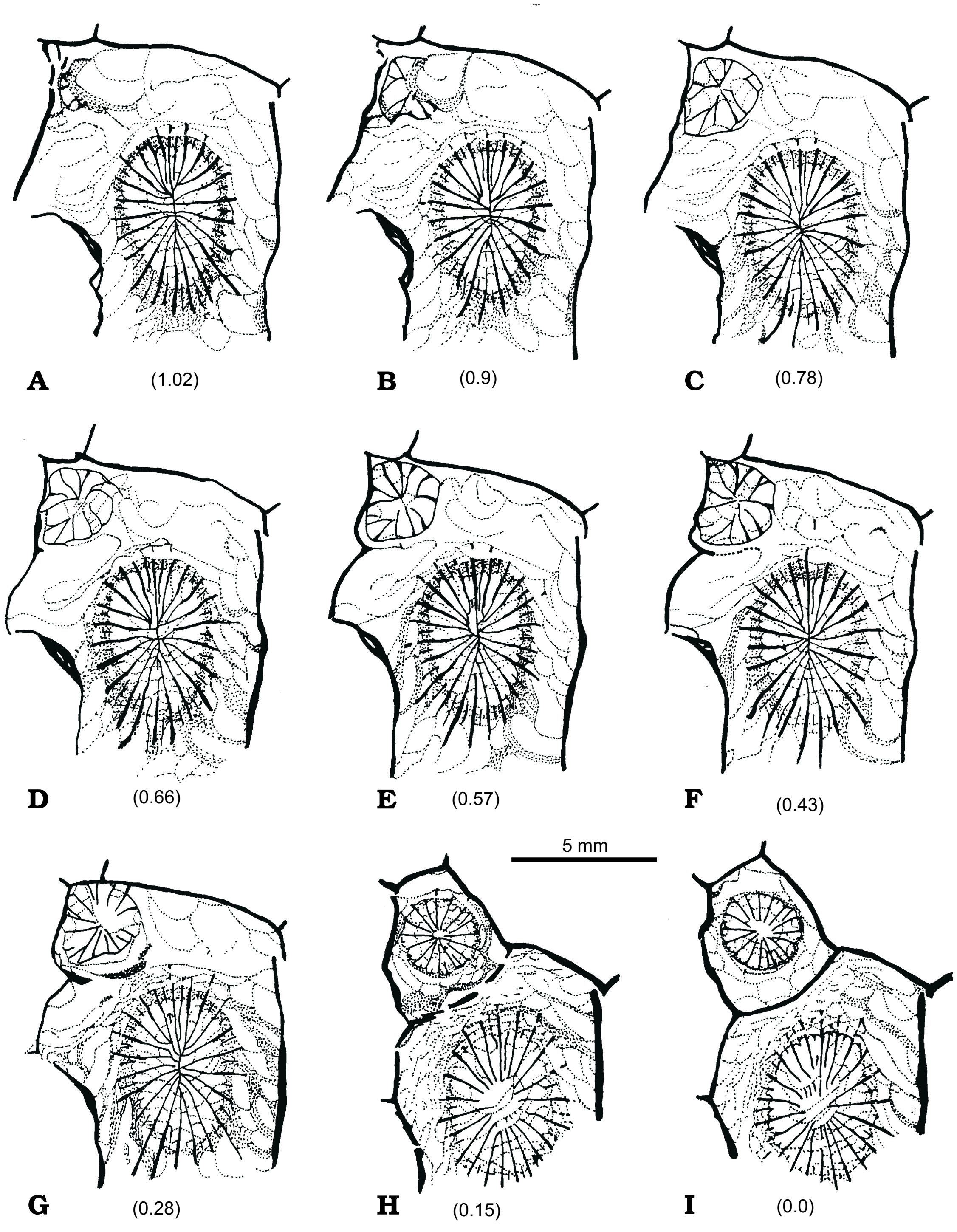

Fig. 10. Transverse serial sections of the parent and daughter corallites of *Pseudoendophyllum plativesiculosum* (Gorsky, 1935) showing successive stages of blastogeny. Numbers in brackets refer to distance in mm from the last (I) section.

cardinal septum does not differ from adjacent septa in length. It may be situated in a small fossula. The counter septum is longer than or equal to the adjacent septa. Minor septa are short and contraclined.

In longitudinal section the lonsdaleoid dissepimentarium occupies 4/9 of the corallite section. Dissepiments are slightly convex and densely packed 22/5 mm gently declined inwards to subhorizontal at the periphery. Tabulae are flat or slightly concave in the axial part, on the margin they bend downward, being packed 19/5 mm.

Budding is lateral.

Intercolonial variability. — The specimens collected do not display any remarkable variability between colonies, except for diagenetic changes.

Remarks. — Colonies of *P. raclaviense* resemble *Pseudoendophyllum alferovi* (Gorsky, 1935) which differs, however, in the presence of well developed septal crests on the lonsdaleoid dissepiments and in much more convex tabulae. Indices n/dt for *P. alferovi* are 30–32/10/18, whereas in *P. raclaviense* 22–25/4–7. *P. alferovi* corallites are bigger than those of *P. raclaviense*. The type species, *P. nalivkini*, as described by Gorsky (1935,1938) differs markedly from *P. raclaviense* in the index n/dt which is 18–21/6 mm. *P. plativesiculosum* (Gorsky, 1935) differs from *P. raclaviense* in possessing a dissepimentarium consisting of larger and less regular lonsdaleoid dissepiments and in the indices of n/dt (see Text-fig. 9).

Occurrence. — Góra Żarska Member of the Dubie Formation, Stromatoporoid Rocks in the Rokiczany Ravine and in Dubie village (Racławka Valley near Kraków). *Sphaenospira* sp. interval of Baliński (1995).

Family **Phillipsastraeide** Roemer, 1883
Genus *Scruttonia* Tcherepnina, 1974

Type species: *Smithia bowerbanki* Milne-Edwards *et* Haime, 1951.

Diagnosis. — See Hill (1981: p. 284; there synonymy; *Sudetiphyllia* Fedorowski, 1991 is here also enclosed in the genus).

Scruttonia kunthi (Frech, 1885)
(Pls 1: 1, 2; 2: 1–7; 3: 1, 2, 4–7; Text-figs 12, 13)

1870. *Phillipsastrea hennahi* Lonsdale; Kunth: p. 30, pl. 1: 4.
1881. *Smithia hennahi* Lonsdale; Schlütter: p. 82, pl. 6: 7.
1885. *Phillipsastrea kunthi* sp. n.; Frech: pl. 7: 4.
1953. *Phillipsastrea kunthi* Frech; Różkowska: pl. 8: 1, 2.
1991. *Sudetiphyllia prima* sp. n.; Fedorowski: pp. 75–77, pls 8: 1a–f; 9: 1a–d; 10: 1a–c; text-figs 28: 2, 3a, b, 9.

Diagnosis. — Thamnasterioid *Scruttonia*; with diameter of tabularia 2.2–3.3 mm; number of major septa 12–15; symmetry of the septal apparatus heterocoral-like or radial; septal carinae well developed.

Material. — Apart from the newly collected material (14 specimens from different levels of the Main Limestone in Dzikowiec) all available material described by previous authors has been examined, especially the type specimens (unnumbered) housed in the Museum für Naturkunde, Berlin). Among them there are three thin sections by Kunth (1870) and the colony from which Frech (1885) made a large transverse section. The second specimen is that figured by Kunth (1870: pl. 1: 4a, b). Other specimens mentioned by Tietze (1870) and Kunth (1870), as well as the thin section of Schlütter (1881), are lost. The shape of the colony on Kunth's (1870) thin sections do not match the colony used later by Frech (1885) to make his thin section. Probably they made their sections from different specimens. The specimen and the transverse thin section of Frech (1885) are thus the lectotype. The topotype mentioned by Różkowska (1952: pl. 8: 1, 2) and two colonies described by Fedorowski (1991) as *Sudetiphyllia prima* were also examined.

From 14 colonies collected recently at the type locality, 37 thin sections and 300 acetate peels were made.

Description. — The lectotype is a fragmentary colony of dimensions 11 × 8 × 5 cm (unnumbered, Pl. 2: 1). Calices are not preserved in it. About one half of the upper surface is polished (the place where F. Frech took the thin section), three thin sections were made in it. 26 corallites are visible in the thin section of F. Frech (unnumbered, Pl. 2: 2). Distances between the axes of corallites are 6–8 mm. The number of major septa is 12–15, diameter of tabularia 2.8–3.3 mm. Major septa connect in the axis forming a heterocoral-like or, less commonly, radial symmetry (Pl. 2: 3). Connected septa form a pseudocolumella. Near the margin of the tabularium all septa commonly thicken and are carinate. Minor septa are short, but in places one or two minor septa are markedly elongate. These minor septa are situated in broader loculi, which seem to be placed between the counter and counter-lateral septa. The cardinal and alar septa are difficult to identify. Outside the tabularium the major and minor septa are wavy and connected to the septa of neighbouring corallites, either directly or with each septum split into two. The internal dissepimentarium consists of 1–3 rows of small concentric dissepiments. Tabulae seen in the axial part are moderately elevated.

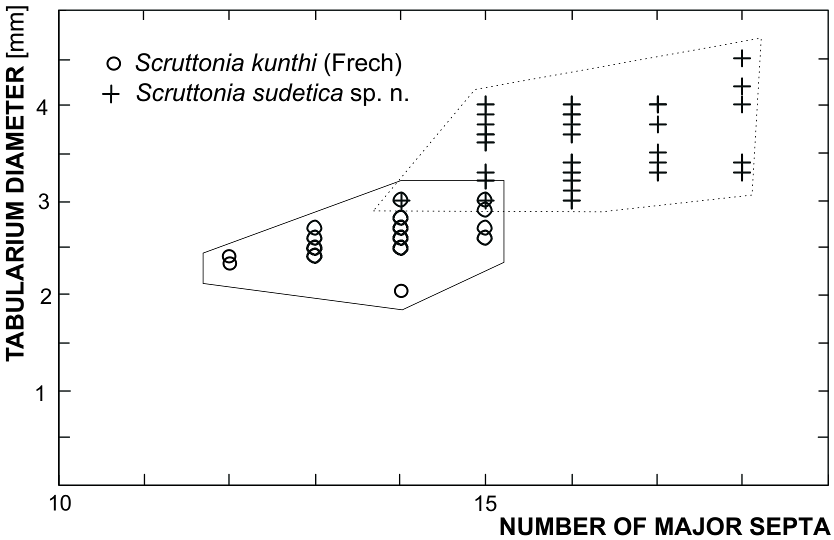

Fig. 11. Scatter diagram of number of septa (n) *versus* tabularium diameter (dt) for *Scruttonia kunthi* (Frech, 1885) and for *Scruttonia sudetica* sp. n. Both species from the Wapnica Quarry (exposures 1 and 3).

The tabularia of the lectotype has a diameter of 3 mm (Pl. 2: 6). Tabulae are densely packed 22/5 mm; in longitudinal section they are flat or slightly concave near the margin, convex at the axis. The shape and size of the dissepiments differ depending on their place of occurrence. Near the tabularium they are slightly convex and strongly bent downwards; in coenosteum they are horizontally arranged, flat or convex and densely packed.

Kunth's (1870) thin sections are labelled MB.-K.372. In transverse thin section (MB.-K.372.-1) eight tabularia (Pl. 2: 7) are visible, six of them fairly well preserved. The corallites have a tabularium diameter of 2–2.5 mm and major septa 11–13 in number. In the longitudinal section the tabularium diameter is about 2.5 mm (Pl. 2: 5). Apart from lower values of the index n/dt, the corallites do not differ markedly from the lectotype.

Variability. — Additional material of ten colonies reveals only insignificant variation. Within a single colony the number of septa does not differ by more than one septum. Differences in the average diameters of tabularia are also insignificant and vary ± 0.5 mm. The only differences are in the distribution of dark and light seasonal bands. Skeletal elements of the dark bands are markedly thickened and septa are here strongly carinate.

Intercolonial variation is expressed in the number of septa, 13–15, and average diameters of tabularia 2.2–3.3 mm (Text-fig. 11).

The arrangement of septal apparatus is stable and reveals commonly the heterocoral-like symmetry and only rarely the radial symmetry.

Astogeny. — Astogeny (and blastogeny) was studied, with two thin sections and 185 acetate serial peels, on two small well-preserved colonies. The colony of *S. kunthi* is strictly thamnasterioid. The preferred direction of growth was lateral, so the shape of the colony is domal and circular (Pl. 3: 7). It started from a single protocorallite (obliquely cut), that bent within the muddy sediment. At the initial growth stage very rare septa were secreted between the corallites, so new offsets were formed on dissepiments within the marginarium. This kind of growth is characteristic also for the peripheral paths of the colony (near the holotheca) at later stages of astogeny. On the periphery, offsets appear cyclically; sometimes up to 3 offsets one near another. Very often they started to grow on top of the darker band which probably reflect less favourable conditions (see Berkowski 2001b). The direction of offset growth is oblique to the general direction of corallite growth at the beginning of the formation of offset. The offsets grew outwards to spread the colony. Later, they became parallel to other corallites. Internal budding is very rare and occurs mostly in places where colony was partly damaged (rejuvenescence within the colony) or where colony growth became more hemispherical. In each case the identification of the parent corallite is not possible. It seems that at least the peripheral offsets did not use the skeletal elements of individual parent corallites and built their skeleton on the common skeletal tissue (mostly on dissepiments).

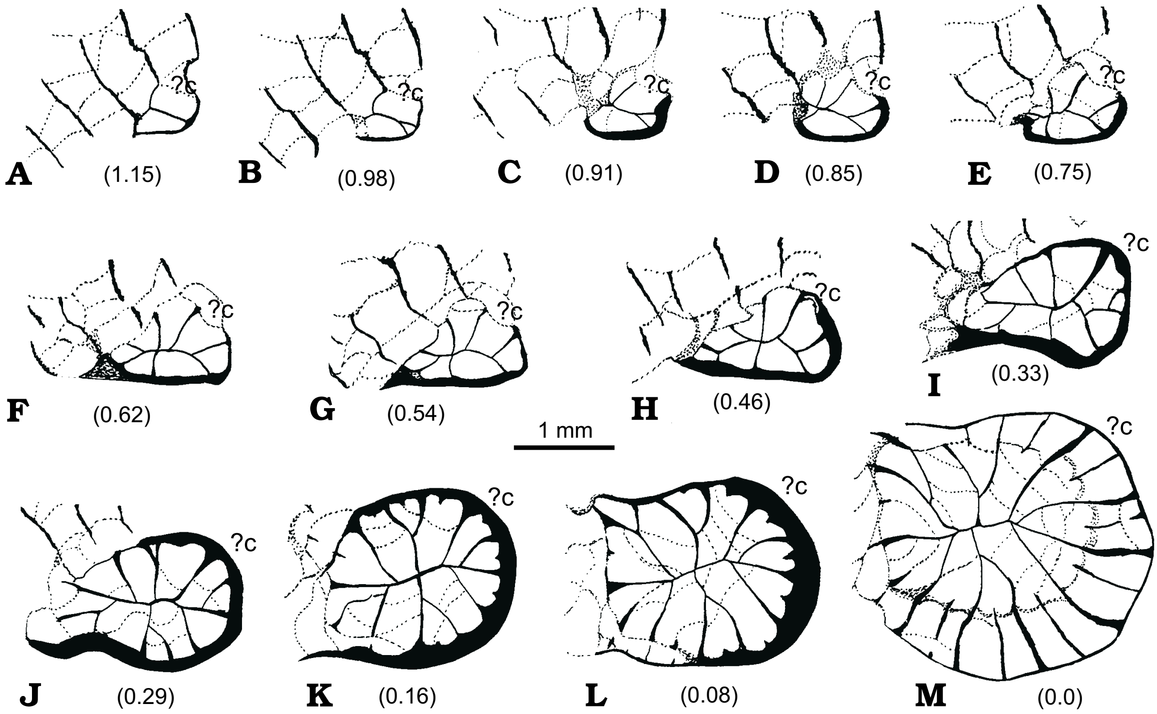

Fig. 12. Transverse serial sections of the peripheral part of the colony of *Scruttonia kunthi* (Frech, 1885) (specimen NR UAM Tc-B/02/DIII/12a, offset A) to show successive stages of peripheral blastogeny. Numbers in brackets refer to distance in mm from the last (M) section; c, proposed position of cardinal septum.

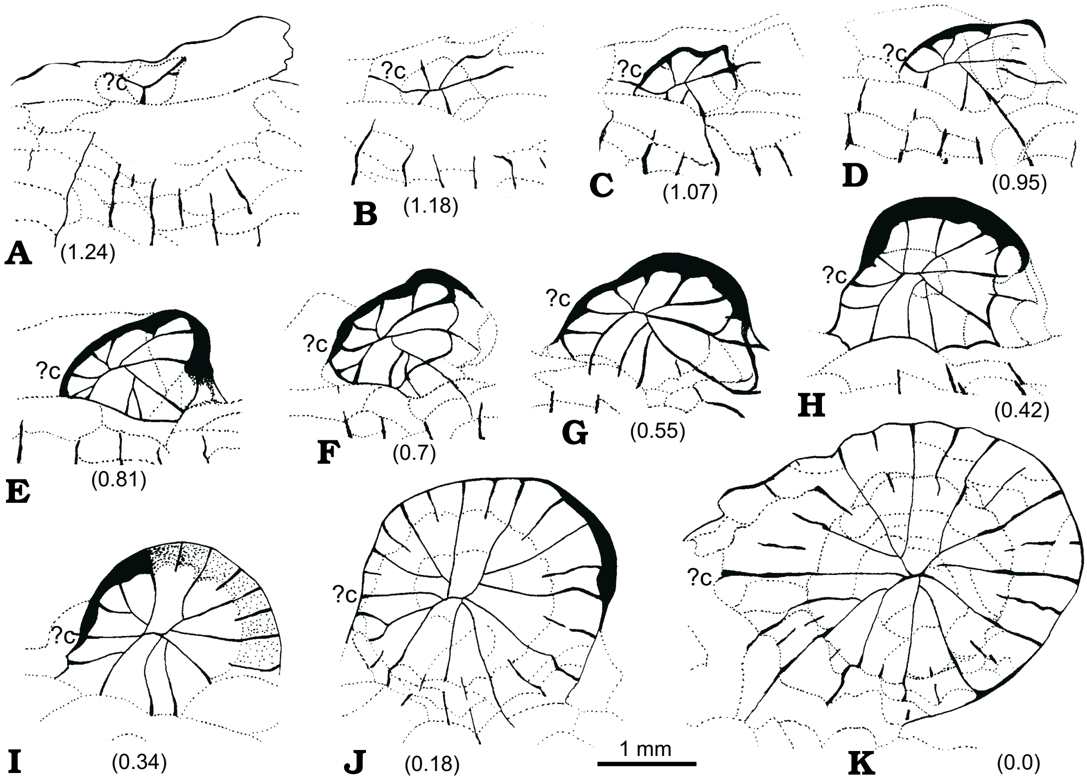

Fig. 13. Transverse serial sections of the peripheral part of the colony of *Scruttonia kunthi* (Frech, 1885) (specimen NR UAM Tc-B/02/DIII/12a, offset B) to show successive stages of peripheral blastogeny. Numbers in brackets refer to distance in mm from the last (K) section; c, proposed position of cardinal septum.

Blastogeny. — Two kind of budding were distinguished. The one (1), proceeding on the periphery of the colony near the holotheca causing the peripheral growth of the colony, the second (2), less frequently developed and occurring in the inner parts of the colony.

(1) Offsets form within the periphery of the colony, near holotheca. They grew at their youngest stages obliquely outwards to the general direction of colony growth. This was in order to keep a stable distance between corallites to enable lateral spreading of the colony. As a result, the external parts of the offsets (Text-figs 12 and 13) are more advanced in growth. At later stages the offset growth was accelerated in their external part, so the direction gradually became more or less parallel to the adjacent (?parent) corallite.

At the first stage of the offset integration with the colony, the offset septal apparatus was formed on a peripheral dissepiment within the common tissue of the colony (Text-figs 12A–E and 13A–D). Both offsets investigated are initiated near holotheca and between the existing septa within the marginarium. The mode of the earliest insertion of the septal apparatus is unclear. It seems that the first septa were inserted independently, i.e., the septal apparatus of the offset did not inherit the existing septa of the parent corallite. The only character clearly distinguishable at this stage is the axial connection of all major septa. New septa of the offset were inserted due to the division of the existing offset septa near the wall. This kind of insertion probably took place also in the area where offset did not have the wall (Text-fig. 13B, C).

At the second stage a temporary wall was formed separating offset from the colony (Text-figs 12F–K and 13E–I). Wall secretion probably resulted in forming an offset calice, as the base for the development of septal apparatus allowing investigate details of septal insertion. The next major septa were mostly inserted due to division of the already existing septum. However, division of each septum took place only once. Division began with the swelling of the distal end of septum near the wall. Afterwards, the swollen distal part of the septum divided. The point of connection of two septa was shifted in the direction of the offset axis. The sequence of insertion may resemble the rugosan style (the offset on Text-fig. 12), but may be less regular (Text-fig. 13). In both cases, there is only one septum, probably the cardinal one, which never divides (marked on Text-figs 12 and 13 as "?c").

At the last stage the wall disappears gradually and the offset was probably fully integrated into the functional system of the colony (Text-figs 12L, M and 13J, K). The dissepimentarium develops instead. No septal insertion has been observed at this stage, thus it represents an adult stage of the corallite.

(2) The increase, with offsets formed in the inner parts of the colony, is very rare. Initiation of increase was most commonly caused by the influx of sediment or elevation of the upper part of the colony (Pl. 3: 1, 2). An offset inherits parts of the marginarium elements (septa and dissepiments) to build their own septal apparatus. Its most characteristic feature is the axial connection of the septa and heterocoral-like symmetry of the septal apparatus.

Occurrence. — Main Limestone in exposures 1 and 3a of the Wapnica Quarry in Dzikowiec, the Sudetes, Poland. Df3δ or Df3γ foraminiferal Zone, which corresponds to the *P. expansa* Zone.

Scruttonia cf. *kunthi* (Frech, 1885)
(Pl. 3: 3)

Material. — One small fragment of poorly preserved, recrystallised colony found by J. Fedorowski within the basal limestone in Dzikowiec (Wapnica Quarry). One transverse thin section and two longitudinal thin sections were made.

Description. — Corallites in this thamnasterioid colony are small, 2–2.5 mm of tabularia diameter. The number of major septa is 12–14. Septa meet in the axis and form heterocoralloid symmetry. Minor septa are short. Septa are thickened in the external part of tabularia, here and there relics of carinae are visible.

In longitudinal section structures of the common tissue (septa and dissepiments) are arranged similarly to those described in *Scruttonia kunthi.* Tabulae poorly preserved.

Occurrence. — Basal limestone in exposure 0 of the Wapnica Quarry in Dzikowiec, the Sudetes, Poland. Probably late Famennian.

Scruttonia sudetica sp. n.
(Pl. 4: 1–4)

Holotype: UAM Tc-B\02\DI\12 (Pl. 4: 1–4).

Type horizon: Uppermost part of the Main Limestone; Famennian, *P. expansa* Zone.

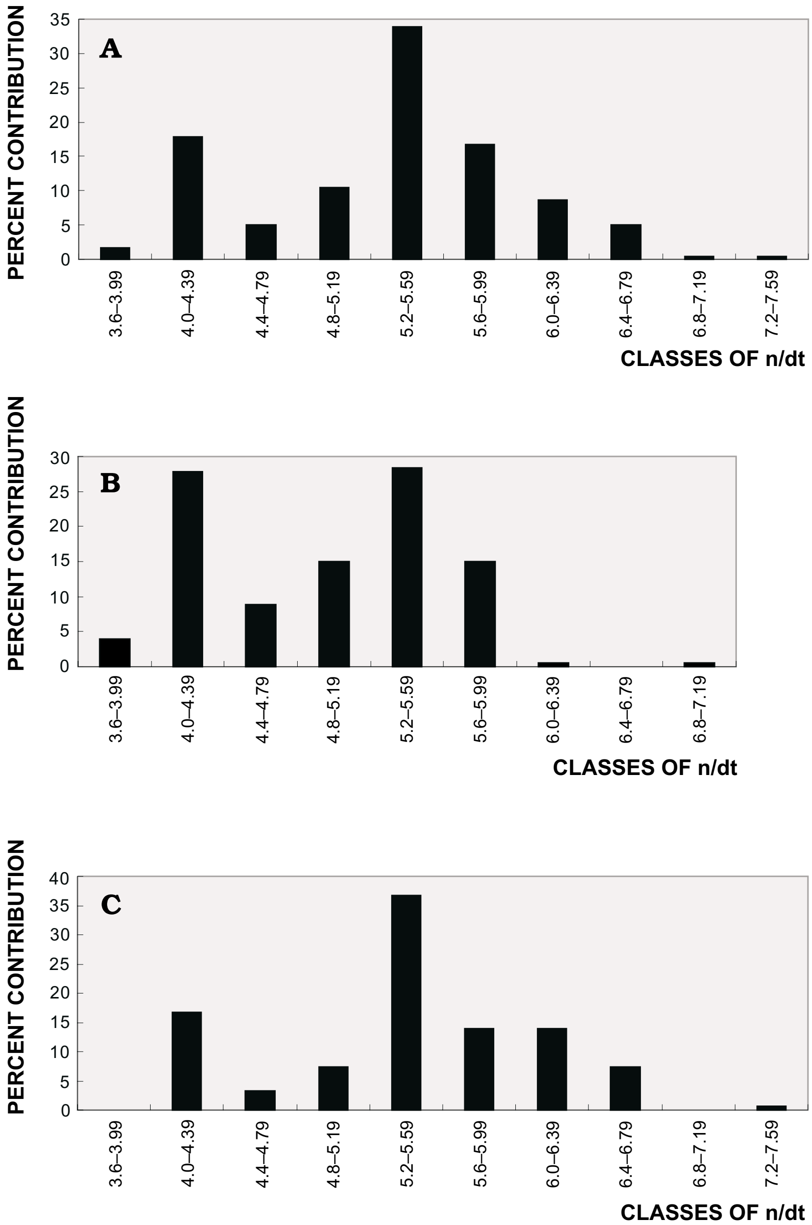

Fig. 14. Frequency distribution of index n/dt measured among corallites of the thamnasterioid colonies of *Scruttonia* showing their bimodal character, which allowed distinguishing two species *S. kunthi* and *S. sudetica* described here. **A**. Fourthteen colonies (420 corallites), exposures 1 and 3 in the Wapnica Quarry. **B**. Six colonies (180 corallites), exposure 1 in the Wapnica Quarry. **C**. Five colonies (150 corallites), exposure 3 in the Wapnica Quarry.

Type locality: Exposure 1 on the eastern wall of the Wapnica Quarry in Dzikowiec, the Sudetes, Poland.

Derivation of the name: Named after the Sudetes, where the specimens were found.

Diagnosis. — Thamnasterioid or slightly aphroid *Scruttonia*; tabularia 3.6–4.5 mm in diameter; number of septa 15–18; septa arranged radially or twisted in the counterclockwise direction; meeting in the axis or withdrawn.

Material. — Six almost complete colonies. 15 transverse thin sections and four longitudinal sections were made.

Description. — The holotype is a large fragment of the thamnasterioid colony, of 16 × 8 × 6 cm dimensions. The upper surface of the colony is fairly well preserved. Calices are 2 mm deep, the axial part of the calice being elevated, forming an axial structure

In transverse section the distance between axial parts of tabularia is 8–13 mm. The major septa are long, connected with each other in the axis or withdrawn. When connected, the septal apparatus is often twisted in the counterclockwise direction, very rarely reveals a heterocoral-like symmetry. When disconnected radially arranged or bilateral symmetry occurs. In this case two minor septa are markedly elongated (almost to the axis); probably they represent Km septa. Other minor septa are short. The cardinal septum is mostly difficult to identify; but sometimes is possible to identify it as the septum connected with the opposite major septum (K-counter septum) situated in the loculi between two elongated minor septa (Km). Major and minor septa are sometimes thickened near the tabularium margin. Fossulae do not develop. The inner dissepimentarium consists of 2–3 rows of small interseptal dissepiments. The most external row is often thickened. Septa in the common tissue are thamnasterioid, partly interrupted by dissepiments; small carinae are developed near tabularium. Dissepiments within marginarium are irregularly elongated.

In longitudinal section the tabularium varies between 3.6 and 4.5 mm in width. Tabulae are densely packed, 20/5 mm, trapezoid, somewhat concave on periphery and arranged obliquely near the axis; at the axis they make a small plateau. The dissepimentarium consists of dissepiments of different shape and size depending on place where they occur. Near the tabularium they are mostly small, globose, and almost vertically arranged. In the marginarium dissepiments are irregular, flat or moderately convex.

Variability. — Colonies of *Scruttonia sudetica* are more variable than *S. kunthi*. The number of septa ranges from 15 to 18, the diameter of tabularium from 3.5 to 4.2 mm (see also Text-fig. 11). The arrangement of septal apparatus is also variable. In the same corallite on different sections the septa may connect at the axis and arrange in either a radial or heterocoral-like symmetry, may be partly disconnected (with only two opposite septa merging in the axis), or totally disconnected. The common skeleton reveals variability in the development of cenostenal elements. In some places they may be well developed, in others they may disappear forming more aphroid style of colony.

Blastogeny. — Six serial transverse sections of an internally located offset taken at distance of 0.1–0.2 mm show successive stages in corallite increase (Pl. 4: 4). Increase starts on an irregular dissepiment, which interrupts septa connecting two adjacent corallites within marginarium. The first septa appear irregularly on the dissepiment (Pl. 4: 4a). They do not appear to connect at the axis. This is probably caused by the elevation of the dissepiment on which they grew. At the second stage septa are arranged radially, but still not connected at the axis (Pl. 4: 4b). Counter quadrants are distinguishable, the major septa longer than in the opposite quadrants. Next bilateral symmetry develops, the cardinal fossula appears and the minor septa are inserted (Pl. 4: 4c–e). The cardinal septum is long, but not yet connected with the opposite counter septum. The other septa form four bunches, minor and major septa being difficult to separate. Septa tend to arrange in more radial manner. At the last stage the offset is completely grown up, with the entire major and minor septa are clearly developed (Pl. 4: 4f).

Remarks. — The distinction of *S. sudetica* from *S. kunthi* is substantiated by statistical distribution of the number of major septa (n) and diameter of the corallite tabularium (dt), as well as the analysis of the morphological characters. For the statistical study 14 colonies coming from two exposures (1 and 3) in Wapnica Quarry were used, 30 corallites being measured in each. The septal index n/dt seems to show bimodal distribution (Text-fig. 14A), with one peak representing *S. sudetica* (values 4.0–4.39) and the second *S. kunthi* (values 5.2–5.59). If the analysis is done for each exposure separately (Text-fig. 14B and C) results are the same. The number of colonies of *S. kunthi* is larger.

S. fedorowskii sp. n. differs from *S. sudetica* sp. n. in the aphroid character of the colony.

Occurrence. — Uppermost part of the Main Limestone in exposures 1 and 3a of the Wapnica Quarry in Dzikowiec, the Sudetes, Poland. Df3δ or Df3ε foraminiferal Zone, which corresponds to the late *P. expansa* Zone.

Scruttonia fedorowskii sp. n.
(Pls 1: 3; 5: 1–6)

1991. *Sudetiphyllia* sp.; Fedorowski: p. 79, pl. 12: 1a–e, text-figs. 28: 1a–c, 31.

Holotype: UAM Tc-B\02\DI\5a (Pl. 5: 1, 2).

Type horizon: Bed DI/5 in the upper part of the Main Limestone; Famennian, *P. expansa* Zone.

Type locality: Exposure 1 in the eastern wall of the Wapnica Quarry in Dzikowiec, the Sudetes, Poland.

Derivation of the name: Named in honour of Professor Jerzy Fedorowski, who first described the species as *Sudetiphyllia* sp.

Diagnosis. — Aphroid *Scruttonia*; corallites of 3.5–4.2 mm diameter and with 15–20 major septa; distance between the corallite axes 6–12 mm; septa arranged radially and mostly not reaching the axis; sometimes only two opposite septa connected in the axis.

Material. — Four large colonies from which 15 thin sections were made. The colony UAM Tc-3/8 and thin sections described by Fedorowski (1991) were also studied.

Description. — The holotype is a large fragmentary colony, 40 × 30 × 20 cm. The basal part of the colony is not preserved but calices are recognisable in places. Transverse section of the colony shows that the common skeleton consists of large irregular dissepiments. Septa within the marginarium occur very rarely. Corallites are large, distances between axes of tabularia are 6–12 mm. The major septa are long, arranged radially, here and there connected at the axis. If connected, they form a kind of pseudocolumella. Sometimes two opposite septa are united and the calice becomes bilaterally symmetrical. Minor septa are generally short; in places two minor septa situated near counter septum are elongated. The cardinal septum does not differ from the adjacent septa, sometimes being connected with the counter septum. All septa near the margin of the tabularium are thickened. The interseptal dissepimentarium surrounding tabularium consists of 1–3 rows of small concentric or pseudoherringbone dissepiments. Their inner, thickened rows often make the inner wall of the corallite.

In longitudinal section the common skeleton consists mostly of different in size horizontal and flat dissepiments. Length of their chords is of 1–8 mm. They become steeply sloping near the tabularia. Very rare remnants of septa occur within marginarium. Tabulae are regularly spaced, trapezoidal and packed 14–16/5 mm. Their axial parts are mostly flat and supplemented by elongated tabellae. At the periphery tabulae are concave and supplemented by small tabellae.

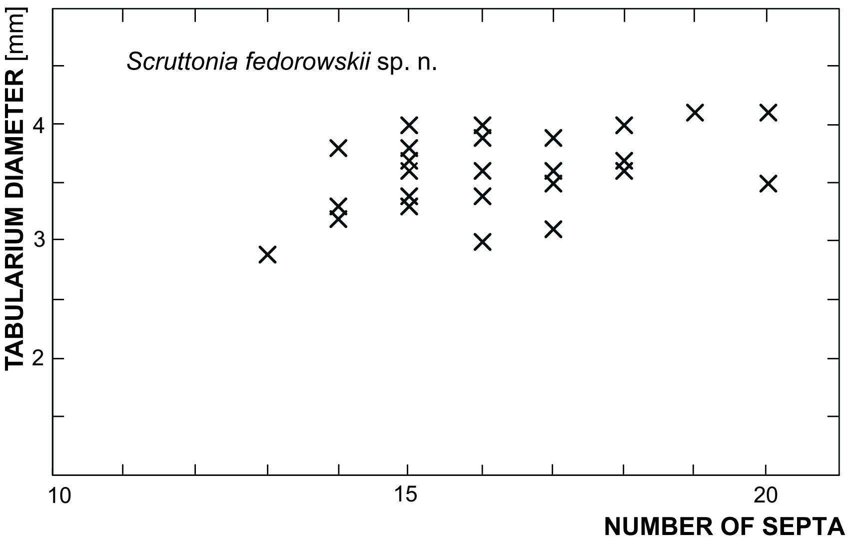

Fig. 15. Scatter diagram of number of septa (n) *versus* tabularium diameter (dt) for *Scruttonia fedorowski* sp. n. from the Wapnica Quarry (exposure 1).

Variability. — There is a significant variability in the diameter of the tabularium (3.5–4.2 mm) and number of septa between corallites within colonies of *S. fedorowskii* (Text-fig. 15). They may differ also in arrangement of septa, which happens to be almost bilaterally symmetrical when two opposite septa unite and two minor septa backing them are elongated. These are presumably the cardinal and counter septum and minor septa situated on each side of counter septum. When septa are disconnected a radial symmetry develops; neither cardinal nor counter septum are then distinguishable. Very rarely the heterocoral-like symmetry is observed. The differences between colonies concern mostly the common skeleton of the colony, i.e., in the development of dissepiments, which may be more or less irregular.

Blastogeny. — Corallites in large colonies of *S. fedorowskii* are very long, reaching 20 cm. Their youngest stages are not preserved in the specimens studied but some offsets were observed within the common skeleton of the colony on large dissepiments.

Remarks. — *S. fedorowskii* is most similar to the Famennian *Scruttonia aphroides* (Fedorowski, 1991), described from the borehole Zdanów IG-1, which belongs to the same tectonic structure within the Bardo

Mountains (Fedorowski 1991). Skeletons of both species are aphroid, but they differ markedly in dimensions of the tabularia and the number of septa. Those characters, as well as the arrangement of the septal apparatus, bring *S. fedorowskii* closer to *S. sudetica* which occurs higher in the Dzikowiec section, but the latter differs in the anatomy of its common skeleton: in *S. fedorowskii* it is aphroid but thamnasterioid in *S. sudetica*.

Occurrence. — Main Limestone at exposure 1 in the Wapnica Quarry, Dzikowiec, Sudetes, Poland. Df3γ or δ foraminiferal Zone which correspond to the late *P. expansa* Zone.

Family **Campophyllidae** Wedekind, 1921
Genus *Campophyllum* Edwards *et* Haime, 1850

Type species: *Cyathophyllum flexuosum* Goldfuss, 1826.

Diagnosis. — See Hill (1981: p. 306)

Discussion. — Genus *Campophyllum* is the only representative of its own family (Hill 1981). According to Hill and Jull (1965) the type species, originally described by Goldfuss (1826), comes from the Late Famennian of the Stollberg area near Aachen. Numerous Frasnian species were also classified in the genus. Studies by Hill and Jull (1965) and Poty (personal communication) on the Famennian species of the genus revealed characters making it basically different from those of Frasnian species earlier included in *Campophyllum*. Apart from the type species its only one named European species is the Late Famennian *Campophyllum gosseleti* from the Etroeungt Formation of Avesnois, Northern France (Weyer 1997b). Specifically unidentified *Campophyllum* is known from Bergische Land near Cologne (Weyer, personal communication), and from boreholes in the West Pomerania (Chwieduk 1999). Outside Europe *C. cylindricum* Poty *et* Onoprienko, 1984 comes from the Omolon Massif (Poty and Onoprienko 1984); the genus was reported also from New Mexico (Sorauf 1992).

Campophyllum is widely distributed and numerous in the Late Famennian of the Ardennes. It displays a wide morphological variability between specimens in the population and in ontogeny. Poty (personal communication) distinguished two varieties ("morphotypes") of *C. flexuosum*. The typical forms of the species, with small corallites and long septa, which almost reach the axis, is restricted to shallow shelf facies. The corallites of the second variety are larger and with shorter amplexoid septa. It is known from deeper facies of the Etroeungt area. In this same area the other species of the genus, *C. gosseleti*, occurs. Both varieties had a common ancestor in the Fa2d strata in Ardennes, which differs from *C. flexuosum* in having not contratingent minor septa and in the lack of septal carinae (Poty, personal communication).

The small collection of *Campophyllum* described below comes from the Kowala trenches in the Holy Cross Mountains. One specimen of questionable affinities is from the Stromatoporoid Rock in the Rokiczany Ravine of the Dębnik anticline in the Kraków area. The characters common for all these specimens are mostly contrajunted or contraclined minor septa, a biform tabularium, and the lack of carinae. Two last characters make the specimens from Kowala more similar to the Ardennes ancestor of *C. flexuosum*. This is consistent with the apparently older age of the Polish populations than that of the type species. The specimens described below show a wide variability during their ontogeny, what is typical for *Campophyllum* taxa. The material is too small to allow a formal introduction of new species. They are described below in open nomenclature.

Campophyllum sp. A
(Pls 8: 10, 9; 10: 2–5)

Material. — Four specimens without proximal ends and calices from which two thin sections and 26 acetate peels were made. External walls worn off. Two more specimens of problematic affinities are also described below.

Description. — Corallites are subcylindrical, up to 8 cm in length, of maximum diameter 3 cm. In transverse section the major septa are amplexoid, reaching axis or almost reaching axis on tabulae. Septa are short below the tabulae, reaching only 1/3–1/2 of the corallite radius. They are thickened in all quadrants. The cardinal septum is thin and shortened, but on tabulae may be longer than the two adjacent septa, which form the walls of the fossula. The cardinal fossula is open and shallow. The counter septum is longer than the adjacent septa below tabulae, but on the tabulae it is equal in length with the adjacent septa. Minor septa are short, mostly contraclined or contrajuncted. The preserved dissepimentarium consists of several (1–5) rows of small concentric dissepiments. Tabularium is biform.

The tabularium consists of tabulae, which are generally flat or slightly concave in the central part and in cardinal fossula, bent downward on the periphery. Tabulae are packed 7–8/5 mm and dimorphic in shape. Small globose dissepiments steeply slope towards the tabularium.

Ontogeny. — Early ontogenetic stages of typical representatives are not preserved. However, it was possible to study growth stages in two specimens of problematic affinities to typical representatives of the population.

Corallite UAM Tc-B\01\04 (Pls 8: 8; 10: 3), 9 cm long, differs from the typical specimens of the population in typical (flexuous) external shape, less regularly elongated major septa and longer minor septa. At the youngest preserved stage its section is oval, elongated in the counter-cardinal plane. The septal index n/d is 45/9–12 mm. All the major septa are markedly thickened and long, almost reaching the axis, thus caninoid. The proximal ends of the septa are bent toward the cardinal septum, which is thick and slightly shortened. The cardinal fossula is closed. The counter septum is long and reaching the axis. Minor septa appear first near the counter septum and remain longer than other minor septa are inserted. No dissepimentarium is developed.

In subsequent development the septal index n/d changes to 52/14–15 mm. All the septa are arranged radially, thickened mostly in their distal parts and thin on the proximal end. The cardinal septum is slightly shorter and thinner than adjacent septa. The cardinal fossula partly opens. The counter septum does not differ from adjacent septa in its length. Minor septa are almost contratingent, i.e., they are connected to the major septa only by stereoplasmatic sheets. Minor septa near the counter septum are elongated.

Later in development the septal index n/d reaches 64/23–24 mm. At this stage the major septa are thickened, still almost reaching the axis. Their proximal ends are wavy and bent toward the cardinal septum, which is markedly shortened and thinner. Cardinal fossula well marked by three pairs of longer and longer major septa. Counter septum is straight and still longer. Minor septa are contraclined or contrajuncted, minor septa near the counter septum are longer and straight. Dissepimentarium consists of small concentric dissepiments.

At older stages the septal index n/d is 68/25–28 mm, major septa are slightly shortened and even more thickened in cardinal quadrants. The cardinal septum remains short while the counter one is long. Other structures do not change.

Similarly problematic is the species affiliation of the corallite UAM Tc-B\01\01 (Pl. 10: 2), 7 cm long, which may represent a separate species because their septal arrangement is keyserlingophylloid in nature i.e., thickened major septa of opposite quadrants are united and forming clear bilateral symmetry. At the youngest preserved stages the septal index n/d is only 34/10 mm. The major septa are arranged radially and amplexoid, reaching 1/2–2/3 of the corallite radius. The cardinal septum is thinner but longer than adjacent septa; also the counter septum is elongated. At older stages the septal index n/d is still low, 36/16–20 mm. Major septa become longer and arranged in a manner characteristic rather for the genus *Keyserlingophyllum*. The cardinal and alar septa are shortened. The cardinal fossula is closed and bordered by two pairs of major septa of which only the inner pair is slightly shortened. The counter septum continues to be longer than the adjacent septa. Minor septa are short, contrajuncted and thickened in the tabularium; in the dissepimentarium they are thin. At the adult stage (just below the calice) the septal index n/d is 42/20–25 mm. The keyserlingophyllum-like manner of septal arrangement is hardly visible, but is again clear in the calice. The cardinal septum is slightly shortened and thin below the calice and very short in the calice; the counter septum is elongated. Minor septa are almost contratingent, thin and wavy within dissepimentarium. The dissepimentarium consists of small concentric dissepiments, in external portion some irregular lonsdaleoid dissepiments are visible. The tabularium is biform.

Occurrence. — Kowala trenches in the Holy Cross Mountains, Poland. *P. expansa* or *S. praesulcata* Zone.

Campophyllum? sp.
(Pl. 10: 6)

Material. — One fragmentary specimen embedded in limestone, from which two acetate peels were made. External wall worn off.

Description. — The septal index n/d is 30/8–11 mm. The major septa are long, almost reaching the axis; their proximal ends are wavy, distal ends thickened. The cardinal septum is shortened, located in the fossula. The counter septum does not differ in length from adjacent septa. Minor septa are short, thickened in their distal portion and contratingent. Dissepimentarium is lacking at this stage.

Remarks. — The specimen resembles morphologically the intermediate ontogenetic stages of *C. flexuosum*. Its poor preservation does not allow any reliable determination.

Occurrence. — Góra Żarska Member of the Dubie Formation, Stromatoporoid Rocks in the Rokiczany Ravine (Racławka Valley near Kraków). *Sphaenospira* sp. interval of Baliński (1995).

Family **Clisiophyllidae** Nicholson, 1889

Genus *Clisiophyllum* Dana, 1846

Type species: *Clisiophyllum keyserlingi* McCoy, 1849.

Clisiophyllum sp.
(Pl. 11: 1)

Material. — Two specimens embedded in limestone, from which eight thin sections were made.

Description. — Corallites are solitary, at young stages horn-shaped, later subcylindrical. At young stages the septal index n/d is 23/5 mm. The major septa are thick, arranged in a zaphrentoid-like pattern. Cardinal septum is long, connected with the counter septum. The alar septa lay in the alar pseudofossulae. Other major septa are connected to each other just near the axis. Minor septa and dissepiments are not yet developed at this stage.

At adult stages the septal index n/d is 34/13 mm, the cardinal and counter septum are difficult to distinguish. The axial structure occupies 1/4 of the corallite diameter and is irregular in shape (Pl. 11: 1a–e). It consists of irregularly connected and wavy axial ends of the major septa. Minor septa are short and thickened. The dissepimentarium consists of 1–2 rows of small concentric dissepiments. The most inner row of dissepiments is markedly thickened.

Remarks. — Specimens described above are close to *Clisiophyllum omaliusi* (Haime, 1855) described by Salee (1913), Dehe (1929), and Poty (1984) from Etroeungt in Ardennes. They differ in a less complex axial structure. The lack of information about the ontogeny of the type species does not allow more detailed comparison of the Polish specimens.

Occurrence. — The Main Limestone at exposure 1 and 3 in the Wapnica Quarry, Dzikowiec, Sudetes, Poland. Df3γ or δ foraminiferal Zone, which correspond to the *P. expansa* Zone.

Genus *Spirophyllum* Fedorowski, 1970

Type species: *Spirophyllum sanctacrucense* Fedorowski, 1970.

Spirophyllum? sp.
(Pl. 11: 3)

Material. — One fragmentary specimen (distal part preserved) from which one thin section and two acetate peels were made. External wall worn off.

Description. — Solitary corallite with the septal index n/d 34/11 mm. The major septa are spirally arranged, thickened in the distal portion of the tabularium, thin just before the axial structure and again thick within the axial structure. Minor septa are small, visible only within the (partly worn off) dissepimentarium, which consists of herringbone-type dissepiments. Numerous and regularly spaced sections of tabulae within the axial structure and near the axial structure visible in transverse section suggest that it is broad and laterally protruding.

Remarks. — Described specimen is the only Famennian one resembling genus *Spirophyllum* originally based on Late Viséan material (Fedorowski 1970). Similarly as the other Famennian Clisiophyllidae, i.e., *Dibunophyllum praecursor* and *Clisiophyllum omaliusi*, it seems to be a homeomorph of the Viséan species.

Occurrence. — Kowala trenches in the Holy Cross Mountains, Poland. *P. expansa* or *S. praesulcata* Zone.

Genus *Dibunophyllum*? Thomson *et* Nicholson, 1876

Type species: *Dibunophyllum bipartitum* (McCoy, 1849).

Dibunophyllum? aff. *praecursor* Frech, 1885
(Pl. 11: 2)

Material. — Four fragmentary specimens embedded in limestone; nine thin sections were made.

Description. — Corallites are subcylindrical with the septal index n/d 34/15 mm. Major septa form a broad axial structure, spider-web in shape, of *Dibunophyllum*-type which occupies 1/3 of the corallite diameter. It consists of a thin irregular median plate, 10–12 septal lamellae and axial tabellae are developed between the septal lamellae. At the young stages the axial structure is less regular. The major septa are interrupted by tabellae in proximity of the axial structure. Minor septa are short and only slightly entering the tabularium. The dissepimentarium consists of 3–5 rows of concentric interseptal dissepiments, their innermost row is thickened.

Remarks. — The specimens described above resemble *Clisiophyllum* (*Dibunophyllum*) *praecursor* Frech, 1885, which occurs in the Late Famennian of the Stollberg area near Aachen (Frech 1885; Poty 1984). They have a narrower and more regular inner part of the axial structure than the topotypes. They differ also in the structure of dissepimentarium, which is closer rather to the dissepimentarium of *Clisiophyllum omaliusi*.

Occurrence. — Main Limestone at exposure 1 in the Wapnica Quarry, Dzikowiec, Sudetes, Poland. Df3γ or δ foraminiferal Zone which correspond to the *P. expansa* Zone.

Gen. et sp. n.
(Pl. 11: 4)

Material. — Two fragmentary preserved specimens embedded in limestone; six thin sections were made. Proximal ends and calices not preserved.

Description. — Corallites are solitary and subcylindrical with the septal index n/d 32/15 mm. The major septa are long and reach the axis or are slightly withdrawn. The cardinal septum is longer than the adjacent septa, the counter septum does not differ in length from it. In some sections the proximal ends of the septa are connected and form an incipient irregular axial structure. Minor septa are long, reach 1/3 of the corallite radius, are slightly contraclined in counter quadrants. The dissepimentarium is interseptal, consists of small concentric dissepiments.

In longitudinal section the tabularium is biform, its periaxial portion consists of long tabellae, slightly elevated at distal ends of septa. Lateral portions of those tabellae are bent steeply downward. The peripheral tabellae in position II are horizontal, in position I are bent downward, locally resembling dissepiments. Tabellae are widely spaced 8/5 mm in the axial portion. The dissepimentarium consists of globose dissepiments of variable size; mostly small and arranged into steep or even vertical rows.

Remarks. — The scarce material does not allow its precise taxonomic identification. The specimens are very similar in transverse section to those of the genus *Temnophyllum* Walther, 1928. The closest species is *T. turbinatum* Hill, 1954, described also by Różkowska (1979) from the Late Frasnian of the Holy Cross Mountains. The differences manifest in the presence of an incipient axial structure. It cannot be excluded, however, that the Famennian species belongs to a lineage transitional to other Famennian taxa with the axial structure, like *Clisiophyllum omaliusi* or *Dibunophyllum*? aff. *praecursor*.

Occurrence. — Upper part of the Main Limestone in exposures 1 of the Wapnica Quarry in Dzikowiec, the Sudetes, Poland. Df3δ foraminiferal Zone, which corresponds to the *P. expansa* Zone.

Family **Palaeosmiliidae**? Hill, 1940
Genus *Palaeosmilia*? Milne, Edwards, *et* Haime, 1848

Type species: *Palaeosmilia murchisoni* Milne, Edwards, *et* Haime, 1848.

Palaeosmilia? *aquisgranensis* (Frech, 1885)
(Pls 8: 4–7; 9: 1–4; 10: 1)

Material. — Five specimens from marly shale with external wall worn off.

Introductory remarks. — This Famennian species reveals morphological characters strikingly similar to those of the Viséan genus *Palaeosmilia*. It was first described as *Cyathophyllum aquisgranense* by Frech (1885) from the latest Famennian of the Aachen area and Conil (1961) transferred it to *Palaeosmilia*. The differences between the Late Viséan species of the genus (the type *P. murchisoni* and other species) and the Famennian *P. aquisgranensis* are truly difficult to trace. Poty (personal communication) suggests some important differences in microstructure, but these can be diagenetic. The main argument in favour of the view that the Famennian *P. aquisgranensis* is homeomorphic rather than ancestral to the Viséan *Palaeosmilia* is that no *Palaeosmilia*-like corals are known until the latest Tournaisian (RC4b rugose coral Zone of Poty in Conil *et al.*

1990). Fedorowski (personal communication) proposes a relationship between *P. aquisgranensis* and large Famennian *Campophyllum*, but this is only a hypothesis until the ontogeny of both genera is studied.

The specimens studied from Kowala are sparse and reveal a strong morphological variability, which makes species determination rather risky. Therefore, they are described separately within questionable informal group of *Palaeosmilia*? *aquisgranensis* (Frech, 1885) without attempts to identify possible separate species.

Decription. — All specimens are solitary, large, and cylindrical in shape. Their external walls and proximal ends are invariably worn off. Calices are shallow with narrow marginal zone built with dissepiments. Their major septa are numerous, septal indices of adult stages are variable in different specimens: UAM Tc-B\01\12 – n/d 50/18–20, UAM Tc-B\01\11 – n/d 64/23–26, UAM Tc-B\01\03 – n/d 76/32 and 84/35, UAM Tc-B\01\10 – n/d 92/40–48, UAM Tc-B\01\13 – n/d 90/27–37. Major septa are long, slightly wavy or straight. They are reaching or almost reaching axis. They are most commonly radially arranged, except for specimen UAM Tc-B\01\13 where they display more advanced bilateral symmetry (Pl. 10: 1a). Cardinal septum is long situated in a long fossula, which is narrow in outer portion of tabularium and slightly wider near the axis (keyhole-like). Counter septum commonly does not differ in length from adjacent septa, but may be longer and thickened. Alar septa are long and situated in more or less distinct pseudofossulae. Minor septa are situated within dissepimentarium, free, contraclined or contrajuncted. Dissepimentarium is regular and consists of small globose dissepiments. In longitudinal section dissepimentarium is narrow, consists of small, flat or slightly globose dissepiments steeply sloping toward the axis. Tabularium is wide consisting of irregularly packed incomplete tabulae (8–18/5mm). Tabulae are flat or slightly concave, near dissepimentarium bent downward. It consists of broad and more or less flat incomplete tabulae slightly sagging at axis and with upturned edges. Within the tabularium the sections of septa are clearly visible displaying trabecular microstructure (Pl. 9: 3a).

Ontogeny. — Ontogeny has been studied in specimens UAM Tc-B\01\12 (Pl. 9: 4) and UAM Tc-B\01\03 (Pls 8: 6; 9: 1).

In specimen UAM Tc-B\01\12 (Pl. 9: 4), at the youngest identified ontogenetic stages (Pl. 9: 4a, b), the septal index n/d is 24/2–5 mm. Major septa are arranged irregularly. The cardinal septum is longer than adjacent septa, located in the fossula, which is broad near the axis. Alar septa are long meeting cardinal septum and forming clearly cardinal quadrants. Septa in counter quadrants are arranged irregularly. Counter septum does not differ from adjacent septa. At the next stage of growth (Pl. 9: 4c) shape of the section is irregular (diameters vary 7–10 mm), number of major septa is 38, their axial ends bent and forming a structure that is closely resembling aulos. Cardinal septum and fossula are elongated markedly. Counter septum is slightly elongated. Acceleration of septal increase in counter quadrants is visible. At adult stage (Pl. 9: 4d) the septal index n/d is 50/18–20 mm. Major septa are pinnately arranged meeting or almost meeting axis. Axial ends of septa are wavy and bent toward the cardinal septum. Cardinal fossula is keyhole-like in shape. Counter septum is slightly elongated and thickened. Acceleration of septal increase in counter quadrants still persists. Minor septa are short, embedded within dissepimentarium. Dissepimentarium consists of small densely packed concentric dissepiments.

In transverse section of specimen UAM Tc-B\01\03 (Pls 8: 6; 9: 1), the youngest studied stage section is in the shape of triangle (Pl. 9: 1a). The longest diagonal is situated in counter-cardinal plane (4mm). Major septa (44) are arranged pinnately and meeting axis. Their axial ends are thickened and bend toward cardinal septum. Cardinal septum is elongated and surrounded by fossula, which is slightly brooded near axis. Counter septum is longer and thicker than adjacent septa. Alar septa are situated within alar fossulae. Minor septa are thickened and contraclined. At the next studied stage shape of the section is crescent (Pl. 9: 1b). Cardinal septum is situated in one of the angles, diagonal in the counter-cardinal plane of 23 mm, number of major septa 60. Major septa are long reaching or almost reaching axis, their axial ends are wavy and sometimes connected. Cardinal septum is longer than adjacent septa. Minor septa are short, contraclined, contrajuncted or free. Dissepimentarium narrow, 1–2 rows of small concentric dissepiments. At adult stages (Pl. 9: 1c, d) septal indices n/d are 32/76 and 35/84 mm. Major septa are arranged radially, almost meeting axis. Their axial ends wavy and sometimes thickened. Cardinal septum long situated within keyhole-like fossula. Counter septum do not differ in length from the adjacent septa. Minor septa extend to the tabularium only slightly, apart from Km septa which are markedly elongated. Within corallite axis numerous cross-sections of tabulae (irregular in shape) are visible, dissepimentarium occupies 1/4 of the corallite radius and consists of small concentric dissepiments. In longitudinal section made in counter-cardinal plane. Dissepimentarium consist of small convex dissepiments steeply sloping (45°) toward the axis. Tabularium consists of incomplete tabulae, densely packed (15/5 mm). In the axis tabulae are less densely packed and more concave. In marginal part of the tabularium they are slightly convex and steeply sloping toward dissepimentarium. Cardinal and counter fossulae do not differ.

Remarks. — Among specimens studied three, UAM Tc-B\01\11 (Pls 8: 7; 9: 3), UAM Tc-B\01\12 (Pl. 9: 4), and UAM Tc-B\01\03 (Pls 8: 6; 9: 1) reveal close morphological affinity to typical representatives of *P. aquisgranensis* (Frech, 1885). They are similar in the radial arrangement of their numerous and long septa, keyhole-like fossula and a hat-shape of incomplete tabulae in longitudinal section. Two other specimens, UAM Tc-B\01\10 (Pls 8: 4; 9: 2) and UAM Tc-B\01\13 (Pls 8: 5; 10: 1) display more differences. They lose the radial symmetry of septal arrangement; their septa are still very long but markedly thickened. Additionally two alar fossulae are very well developed. Whether they are conspecific with three above mentioned specimens could be clarified if additional material is available or the type species is revised. Here they are left within a single taxon.

Occurrence. — Kowala trenches in the Holy Cross Mountains, Poland. *P. expansa* or *S. praesulcata* Zone.

Family **Lithostrotionidae**? d'Orbigny, 1852

Subfamily **Heterostrotioninae** Poty *et* Xu, 1996

Genus *Heterostrotion* Poty *et* Xu, 1996

Type species: *Diphyphyllum*? *vesicotabulatum* Yu, 1934.

Heterostrotion? sp.
(Pl. 11: 5)

Material. — Two fragmentary specimens embedded in limestone; six transverse sections were made.

Description. — Septal index n/d is 26–27/5–7 mm. The major septa are arranged in a heterocoral-like pattern, but in places they are disconnected. The cardinal septum and other protosepta are difficult to distinguish. Minor septa are short, slightly entering the tabularium. The dissepimentarium is interseptal and consists of 1–2 rows of small concentric dissepiments.

Remarks. — The internal morphology of the specimens closely resembles *Stylostrotion sudeticum* Fedorowski, 1991, described by Fedorowski (1991) and Berkowski (1997) from the Famennian of the Zdanów IG-1 borehole and transferred by Poty and Xu (1996, 1997) to their genus *Heterostrotion*. It remains unknown whether the specimens represent broken stems of a phaceloid colony or fragments of solitary corals. Their internal structure (the arrangement of septa, which is clearly heterocoral-like, the dissepimentarium and minor septa morphology) are developed in the same manner as in *Heterostrotion*. The main difference is the number of septa, only up to 21 major septa in *H. sudeticum* and 26–27 in the specimens described here.

Occurrence. — Main Limestone in exposure 1 of the Wapnica Quarry in Dzikowiec, the Sudetes, Poland. Df3δ foraminiferal Zone, which corresponds to the *P. expansa* Zone.

Rugosa *incerte familiae*

Genus *Conilophyllum* Poty *et* Boland, 1996

Type species: *Conilophyllum streeli* Poty *et* Boland, 1996.

Diagnosis. — See Poty and Boland (1996: p. 203 and Boland 1997).

Conilophyllum cf. *priscum* (Münster, 1840)
(Pl. 14: 4)

Material. — One fragmentary specimen. The calice and proximal end are not preserved.

Description. — The corallite is solitary, its external wall is marked with septal ridges. Dissepimentarium consists of large lonsdaleoid vesicles. The major septa are short, length about 1/3–1/2 of the corallite radius, thickened. Index n/d 38/22 mm. Minor septa almost not distinguishable, visible only as septal ridges on the external wall. The cardinal septum if distinguishable, being slightly shortened and placed in a small fossula. The rejuvenated septal apparatus and tabulae are markedly thickened.

Remarks. — The described specimen at its adult stages is very close to the types of *Conilophyllum priscum* revised by Weyer (1994).

Occurrence. — Góra Żarska Member of the Racławka Formation, Stromatoporoid Rocks in the Dubie village (Racławka Valley near Kraków). *Sphaenospira* sp. interval of Baliński (1995).

Gen. et sp. indet. A
(Pl. 12: 1)

Material. — Five strongly silicified specimens embedded in limestone. Seven thin sections were made.

Description. — Corallites are solitary, horn-shaped. At the adult stage the septal index n/d is 34/7 mm. Septa are arranged pinnately. The cardinal septum is long and connected with the counter septum to make an axial septum. Alar septa are long, connected to the axial septum at different points and forming alar pseudofossulae. Other major septa are connected to the axial septum or to other neighbouring septa. Minor septa are short. No dissepimentarium is developed.

Tabulae are densely packed, flat and bent downward near the wall.

Ontogeny. — The youngest preserved stage displays a zaphrentoid arrangement of the septa, with the cardinal septum markedly elongated and in a fossula. At later growth stages bilateral symmetry is interrupted due to a more advanced development of one of the alar pseudofossulae. The cardinal septum is still markedly long and placed in a broad zaphrentoid cardinal fossula. An acceleration of the septal insertion is noted in counter quadrants. At early adult stage the axial septum (connected cardinal counter septa) partly disappears. The major septa in counter quadrants are connected to each other or by a section of tabula.

Remarks. — Zaphrentoid young stages in the ontogeny of the corallite are typical of numerous families included in the Rugosa, being markedly advanced in the Hapsiphyllidae or Zaphrentoidae. The specimens described here differ from those families at adult stages where the axial septum and the arrangement of major septa are developed.

Occurrence. — Góra Żarska Member of the Racławka Formation, Stromatoporoid Rocks in Dubie village (Racławka Valley near Kraków). *Sphaenospira* sp. interval of Baliński (1995).

Gen. et sp. indet. B
(Pl. 12: 2)

Material. — Five incomplete and strongly silicified specimens embedded in limestone; six thin sections were made.

Description. — Corallites are solitary, horn-shaped; the calice deep with sharp edge and a flat bottom.

The septal index n/d is 37/8 mm. Septa are arranged pinnately. Axial ends of the septa are connected to each other, leaving an empty axial space. The cardinal septum is connected with the counter septum. Insertion of the major septa in the counter quadrants is accelerated. Minor septa are short. The dissepimentarium is developed only at adult stages, it consists of small concentric dissepiments.

Remarks. — Specimens described here resemble those of Gen. et sp. indet. A at the adult stage (arrangement and length of septa). They differ in possessing dissepimentarium. However, it cannot be excluded that these taxa are closely related.

Occurrence. — Góra Żarska Member of the Racławka Formation, Stromatoporoid Rocks in Dubie village (Racławka Valley near Kraków). *Sphaenospira* sp. interval of Baliński (1995).

Gen. et sp. indet. C
(Pl. 11: 6)

Material. — One fragmentarily preserved specimen, from which three thin sections and one acetate peel were made.

Description. — Corallite is solitary, horn-shaped. Septa are arranged radially, amplexoid. The septal index n/d is 29/10 mm. At the youngest studied stage the major septa do not meet the axis, being here and there connected to each other and forming an aulos-like structure. In subsequent growth the axial ends of the septa meet the axis, making a loose axial structure and are thickened in their distal part to form a septotheca. The septotheca is replaced by a dissepimentarium in more advanced corallite. The cardinal septum is long and meets the axis during whole ontogeny. Minor septa are short and thickened. They do not reach the tabularium. The dissepimentarium consists of 2–5 rows of small concentric dissepiments. The outermost row may be partly lonsdaleoid.

Tabularium is broad. Tabulae are complete and trapezoidal in shape. Rare flat axial tabellae and short horizontal tabellae are present.

Remarks. — Specimen described above reveals some affinities to the tabulophyllids in the character of tabularium and development of lonsdaleoid vesicles at adult stages.

Occurrence. — Góra Żarska Member of the Racławka Formation, Stromatoporoid Rocks in the Rokiczany Ravine (Racławka Valley near Kraków). *Sphaenospira* sp. interval of Baliński (1995).

Gen. et sp. indet. D
(Pl. 12: 5)

Material. — One specimen, from which three transverse thin sections were made.

Description. — The corallite is solitary, ceratoid. The septal index n/d is 22/7 mm. The major septa are long, almost reaching the axis, being thickened in their axial ends. At the young stage septa are arranged pinnately. The cardinal septum does not differ in length from other septa. In further growth the septa are disconnected and radially arranged. The cardinal septum is shortened in the uppermost part of the corallite. The counter septum is also somewhat shortened at this stage. Minor septa are very short. No dissepimentarium is developed. Small peripheral rejuvenescence took place at the early adult stage.

Remarks. — The specimen is somewhat similar to representatives of the family Plerophyllidae Koker, 1924.

Occurrence. — Góra Żarska Member of the Racławka Formation, Stromatoporoid Rocks in the Rokiczany Ravine (Racławka Valley near Kraków). *Sphaenospira* sp. interval of Baliński (1995).

Gen. et sp. indet. E
(Pl. 13: 1)

Material. — One specimen from which five acetate peels and two thin sections were made.

Description. — The corallite is solitary, horn-shaped, distinctly bent, with a broad and deep calice. The septal index n/d just below calice is 22/12–15 mm. The major septa are irregularly thickened and form an interrupted aulos. The cardinal septum is somewhat elongated and rhopaloid at adult stages, situated in a shallow fossula. The deepest part of the fossula is located near the wall. Minor septa are short in the cardinal quadrants, longer in the counter ones. The external wall is thick, with visible septal furrows. Dissepiments are lacking.

The tabularium is almost flat in the aulos and sloping in the direction of the cardinal septum. On the counter side additional vesicular tabellae occur.

Remarks. — The specimen reveals some affinities to the genus *Czarnockia* Różkowska, 1969 recently revised by Weyer (1999).

Occurrence. — *Wocklumeria* Limestone in exposure 2 of the Wapnica Quarry in Dzikowiec, the Sudetes, Poland. *P. expansa* or *S. praesulcata* Zone.

Gen. et sp. indet. F
(Pl. 13: 2)

Material. — Four fragmentarily preserved specimens; 20 thin sections were made.

Description. — Corallites are small, ceratoid or subcylindrical. The major septa are long, thickened and arranged pinnately. The cardinal septum is connected with the counter one giving a clear bilateral symmetry. The cardinal fossula is weakly developed; alar pseudofossulae are more advanced. The increase of septa is accelerated in the counter quadrants. Minor septa are short and thickened, appearing simultaneously when the septal index n/d reaches 24–26/4 mm. Dissepimentarium is lacking. Tabulae in transverse section make 3–5 concentric rings. A rejuvenescence took place.

Ontogeny. — The septal index at the youngest studied stages n/d is 19/2–22/3 mm. The major septa are arranged zaphrentoidally. The cardinal septum is somewhat longer, connected with the counter septum. In later development septal index n/d is 26/4.5 and 29/7 mm. The major septa are arranged pinnately in four quadrants built of connected counter-cardinal septum and alar pseudofossulae. The symmetry of septal arrangement resembles the heterocoral-like symmetry. Minor septa are present, dissepimentarium lacking.

Remarks. — Young stages of the specimens are close to the young stages of the genus *Rotiphyllum*. However, at later growth stages they reveal a heterocoral-like symmetry.

Occurrence. — Upper part of the Main Limestone in exposure 1 of the Wapnica Quarry in Dzikowiec, the Sudetes, Poland. Df3δ foraminiferal Zone, which corresponds to the *P. expansa* Zone.

Order **Heterocorallia** Schindewolf, 1941

Incertae familiae

Genus *Oligophylloides* Różkowska, 1969

Type species: *Oligophylloides pachythecus* Różkowska, 1969.

Emended diagnosis. — Solitary or weakly colonial Heterocorallia. Protoheterotheca well developed.

Remarks. — *Oligophylloides* is widely distributed in the Famennian cephalopod limestone. Since the first description (Różkowska 1969) it was a subject of extensive studies (reviewed in Weyer 1997a). In the original diagnosis the number of septa near the wall was considered to be an important character. Fedorowski (1991) emended the diagnosis and included the genus in the family Tetraphyllidae Yoh *et al*., 1984 characterised by more than one generation of septa. Weyer (1995) questioned this, stressing the differences in the wall structure of the tetraphyllids and *Oligophylloides*. Indeed, the presence of more than one generation of septa is a character typical for all Heterocorallia (perhaps except for the youngest developmental stages), so it should not be treated as an index character of the genus. Moreover, the number of septa or the generations of septa formed during life of a heterocoral can be higher than those identifiable in the corallite lumen (Chwieduk 2001). They may split outwards within the protoheterotheca, but diagenesis easily obliterates their marks.

Oligophylloides pachythecus Różkowska, 1969
(Pls 16: 4–7; 17: 4–11)

1968. Heterophyllid new genus K; Różkowska: p. 752, pl. 1: 12A, B.
1969. *Oligophylloides pachythecus pachythecus* subsp. n.; Różkowska: p. 161, text-figs 67A–L, 68A–K, 69A, B, 70F, pls 6: 6, 7; 7: 4, 15.
1969. *Oligophylloides pachythecus pentagonus* subsp. n.; Różkowska: p. 167; fig. 70A–E; pl. 6: 14.
1969. *Oligophylloides tenuicinctus* sp. n.; Różkowska: pp. 168–170, fig. 71A–F; pl. 6: 10.
1980. *Oligophylloides pachythecus*; Sutherland and Forbes: p. 497, figs 1, 2; pls 40: 1–17; 41: 1–17.
1980. *Oligophylloides pachythecus*; Wrzołek: p. 513, fig. 1A–H, pl. 49: 1–3.
1980. *Oligophylloides tenuicinctus*; Różkowska: p. 608.
1987. *Oligophylloides pachythecus*; Karwowski and Wrzołek: p. 321, figs 1A–E, 2A–D, 3A–F, 4B, D, G, H, A–C, E, G.
1993. *Oligophylloides pachythecus*; Wrzołek: p. 179, figs 1: 1–7, 2.
1995. *Oligophylloides pachythecus*; Weyer: pp. 114–117; figs 7:1–9, 8:1–5, pls 1: 1–7; 2: 1–4.
1995. *Oligophylloides tenuicinctus*; Weyer: figs 9/1–5, 10–16, pl. 3: 1–5, 9–12.
2001. *Oligophylloides pachythecus*; Chwieduk: pp. 1191–1224, text-figs 2, 4–14, 18, 20–23, pls 1–6.

Emended diagnosis. — *Oligophylloides* with smooth or delicately longitudinally striped external surface of the wall.

Material. — 21 fragmentary specimens; 37 thin sections were made.

Description. — Corallites are tube-like. The external surface of their wall is smooth or stripped. Talon-like structures may occur at the proximal end. Dimensions of corallites vary between 0.5 and 5 mm. In transverse section the wall is of protoheterotheca-type (*sensu* Fedorowski 1991), thick, ranging from 1/4 to the entire radius of the corallite. Within the wall remnants of septa may occur as zigzag-like path. Their number is equal or higher than the number of septa within the lumen. Wall is built from a lamellar tissue. In the lumen septa are of diverse arrangement and number of generations. Symmetry of septal apparatus is clearly heterocoralloid, septum oblique in some cases well defined, in other fossae occurs and the structure of an open aulos is marked; in this case the oblique septum is not distinguishable. The so-called "shifting" of septa is observable as in *Hexaphyllia* (see Sugiyama 1997).

Two offsets were observed. The process of blastogeny is similar to that observed by Wrzołek (1980) and Chwieduk (2001).

Intraspecific variability. — Variability is very wide, as already documented by Chwieduk (2001) in a population from Łagów in the Holy Cross Mountains, including morphologies earlier considered a separate species, *O. tenuicinctus*. In the material from Dzikowiec the variability manifests in variable thickness of the protoheterotheca, variable number of septa in generations and variable number of generations, in the lack or presence of septal zigzag-like structures within protoheterotheca, and in the lack or presence of free spaces within the protoheterotheca.

Occurrence. — Studied specimens come from three sites in Poland: the cephalopod limestone of the *Wocklumeria* Stufe, exposures 2, 3 in the Wapnica Quarry in Dzikowiec, the Sudetes, *P. expansa* and *S. praesulcata* zones; Kowala in the Holy Cross Mountains, *P. expansa* Zone; Gałęzice in the Holy Cross Mountains, Poland, *P. marginifera* to *P. trachytera*, and *P. expansa* to *S. praesulcata* zones. Other sites where *O. pachythecus* was described are Jabłonna, Łagów, Zaręby, Kadzielnia, and Dalnia in the Holy Cross Mountains, Poland, *P. marginifera* to *P. trachytera* and *P. expansa* to *S. praesulcata* zones; Rhenish Slate Mountains, Upper Franconia, Germany, *Platyclymenia* and *Wocklumeria* Stufe.

Oligophylloides weyeri sp. n.
(Pl. 17: 1–3)

Holotype: UAM Tc-B\02\101\3\1 (Pl. 17: 1).

Type horizon: Lens of organodetrital limestone embedded within black shale just above the *Wocklumeria* Limestone; Famennian, *P. expansa* or early *S. praesulcata* Zone.

Type locality: Exposure 2 on the eastern wall of the Wapnica Quarry in Dzikowiec, the Sudetes, Poland.

Derivation of the name: Named to honour Dr. Dieter Weyer, who extensively studied Famennian Heterocorallia and kindly gave the specimens of *Oligophylloides* from Dzikowiec for study.

Diagnosis. — *Oligophylloides* possessing very thick and wavy protoheterotheca, in which ridges correspond to septa whereas furrows correspond to interseptal spaces.

Material. — Three fragmentarily preserved specimens embedded in limestone; six thin sections were made.

Description. — The holotype corallite is tube-shaped, of diameter 2.8 mm and 1 cm in length. Its external wall with well marked septal ridges and interseptal furrows. In transverse sections the lumen is very narrow, 0.2 mm diameter, about 1/10 of the corallite diameter, with 1–2 generations of septa visible. Other septa within the protoheterotheca are visible as zigzag path (Pl. 17: 1a, c and 2). They may divide, so the number of septal generations is much higher than this within the lumen (there was noted more then 30 septa in the diameter of 2.8 mm). Protoheterotheca is lamellar in nature and lamellae are wavy, thus the external wall also has a wavy shape. The lamellae in interseptal spaces are concave, whereas in septal sectors they form ridges, which are convex.

In longitudinal section no tabulae are visible in the lumen. The protoheterotheca is very thick, about 1/3 of the radius. Within the protoheterotheca trails, which may reflect the zigzag septal path, are observable.

The paratype specimen (Pl. 17: 2) is smaller (10 septa and 1 mm diameter) and more regular in shape. It differs from holotype also in its broader lumen (about 1/4 of the whole diameter).

Septa are built of a very fine granular tissue, the wall is lamellar.

Remarks. — Described specimens differ markedly from other representatives of *Oligophylloides* in the structure of protoheterotheca, which is distinctly wavy. Other characters, such as the morphology and arrangement of septa as well as the occurrence of zigzag septal paths, were previously noted in *O. pachythecus* and *O. parvulus*.

Occurrence. — Specimens were collected from the lens of organodetrital limestone embedded within the black shale just above the *Wocklumeria* Limestone at exposure 2 in the Wapnica Quarry in Dzikowiec, Sudetes, Poland. ?*S. praesulcata* Zone.

PALAEOECOLOGY AND PALAEOGEOGRAPHY OF THE FAMENNIAN CORALS

The peculiarities of the Famennian distribution of corals resulted mostly from the preceding Frasnian–Famennian biotic crisis, which removed a huge number of coral taxa from reefal communities. Famennian corals, in contrast to the widespread and numerous Frasnian and Viséan coral faunas, are known only from a

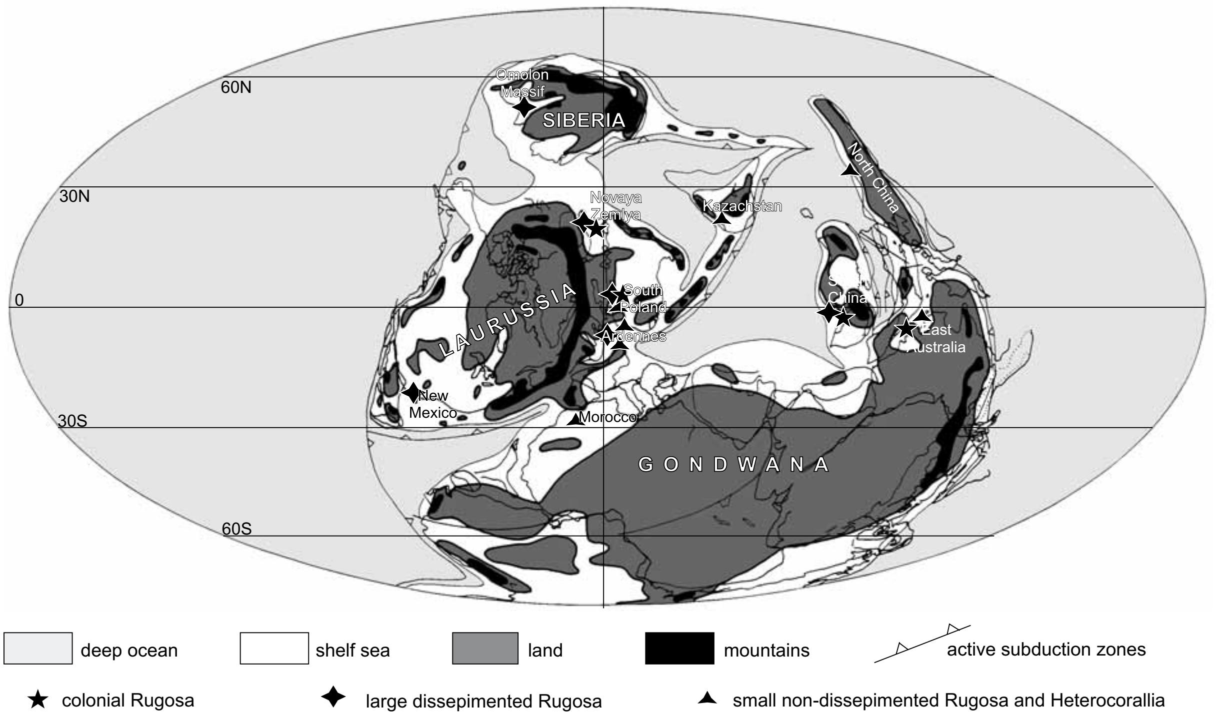

Fig. 16. Locations of the Famennian coral faunas shown on the Famennian (363 Ma) palaeogeography (map after Golonka *et al.* 1994).

few sites in the world (Text-fig. 16). The long-term persistence of poorly aerated conditions in the Famennian marine basins hampered diversification of shallow-water coral communities. Thus, most commonly, descriptions of Famennian taxa are restricted to small non-dissepimented genera and species.

Non-dissepimented rugosan corals occur in a broad range of environments including deep-water facies and typical shallow-water facies where they co-occur with solitary dissepimented and colonial corals. On the other hand, small non-dissepimented rugosans (*Cyathaxonia* fauna *sensu* Hill 1938) and heterocorals are commonly regarded as living in poorly aerated and deep-water facies. For example, Famennian heterocorals (*Oligophylloides* and *Mariaephyllia*) occur only in pelagic cephalopod limestones, rich in organic matter. These stem-like solitary or weakly colonial corals had septa developed solely in distal ends of long branches. It has been shown, that heterocoral soft tissue was not restricted to the distal, septal part of the corallum but covered the entire skeleton (see e.g., Wrzołek 1993b; Chwieduk 2001). One may thus wonder about the feeding strategy of these corals that had such extensive tissue cover but only small and widely separated septate parts of the skeleton assumed to be the only areas where polyps could extend their food-capturing tentacles. Chwieduk (2001: pp. 1217, 1218) suggested that polyps of *Oligophylloides* had no tentacles and fed by filtering suspended organic matter through a unique system of perforated gastrovascular cavity, similar to the Recent deep-water scleractinian *Leptoseris fragilis*. One may further speculate, considering the skeletal differences between *Leptoseris* vs. *Oligophylloides* (compare Schlichter 1992), that heterocorals could have had their own anatomical specializations to utilize suspended or dissolved organic matter, such as a complex system of surface ciliary tracts transporting captured organic particles to the polyp mouth. Regardless of what specialization allowed them to function in deep water, their association only with these facies makes it possible to use them as index fossils for deeper and poorly oxygenated conditions.

It is generally accepted that large dissepimented corals required rather warm and well-aerated environments. The Famennian large dissepimented and colonial rugosans are known only from subtropical or tropical seas. The only exception is the Omolon Massive, but the high palaeolatitude postulated for this area (Golonka *et. al.* 1994) is questionable. The best-known areas of coral occurrence reveal much endemism, which may have resulted from the long distances between these areas or oceanic currents separating each from the other.

Due to the long persisting unfavourable conditions, the recovery of coral faunas started late in the Famennian (*P. expansa* and *P. praesulcata* conodont zones) when environments became more aerated. This

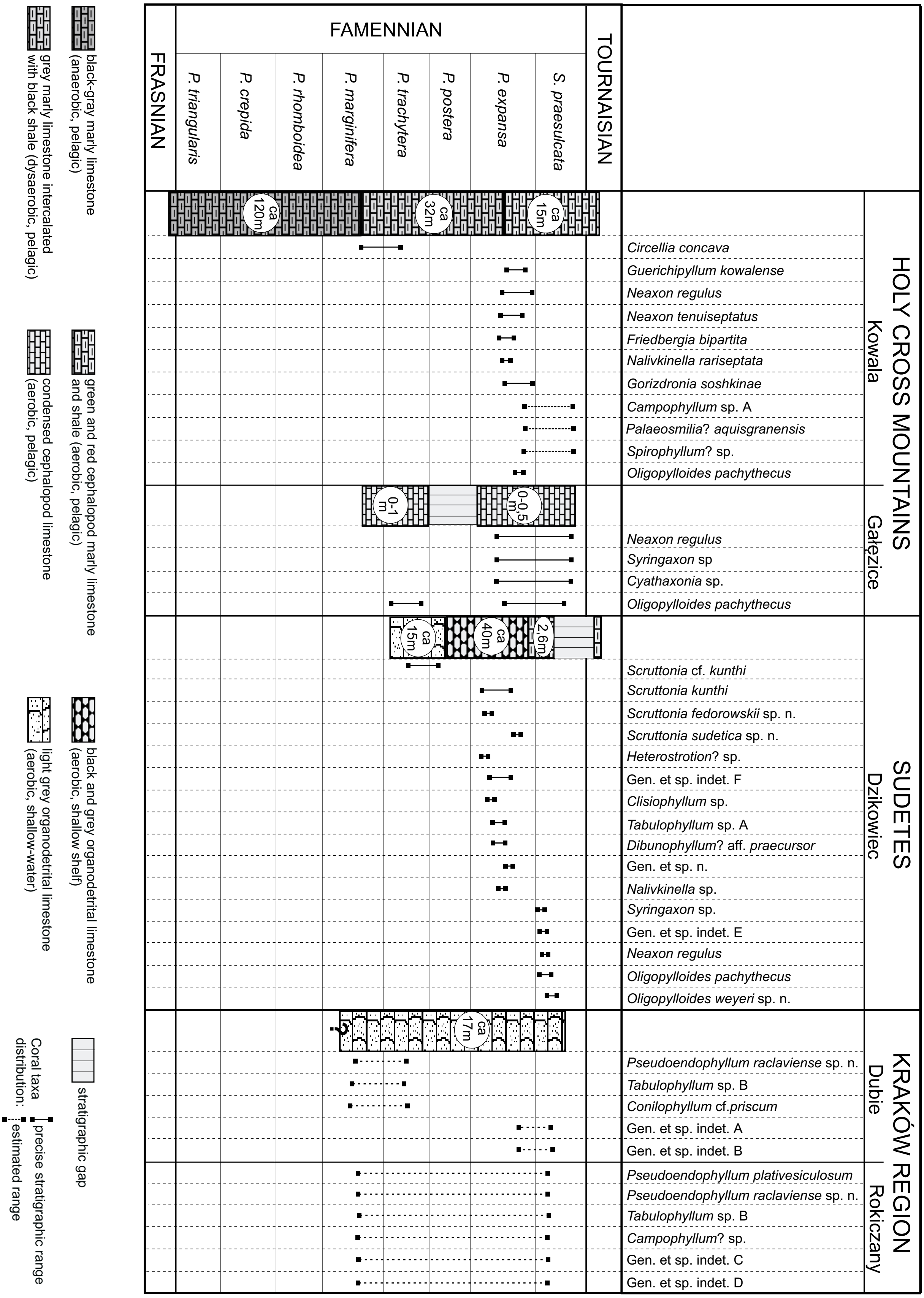

Fig. 17. Distribution of the coral taxa studied within correlated stratigraphy and facies of the investigated areas.

Strunian radiation took place almost all over the world within isolated basins, what is noted also within three areas of southern Poland studied. The process of recovery documented in the localities of southern Poland seems to follow the pattern reported from other sites of the world (Poty 1984, 1986, 1999; Scrutton 1988). The species composition, however, is hardly comparable probably because of ecological differences (Text-fig. 17). Some of them are typical for the Famennian, with only deep-water species; others may represent refugees in which shallow-water colonial corals survived. They possibly provided the basis for the Viséan restitution of the coral reefs.

The most complete Famennian succession is found in the Holy Cross Mountains. The first corals appeared in the *P. marginifera* to *P. trachytera* zones, being represented by a monospecific assemblage of *Circellia concava*. This species was able to settle on soft muddy and dysaerobic sediments in the relatively deeper-water area of Kowala. The heterocoral *Oligophylloides* dominates in the black cephalopod limenstone at Łagów. Much more diversified and numerous coeval coral faunas have been described from Kadzielnia (Różkowska 1969). When the environment became more aerated in the *P. expansa* and *S. praesulcata* zones, a diverse coral assemblage expanded. This was initially a laccophylloid fauna (*sensu* Różkowska 1969) with heterocorals, and then a canino-clisiophylloid fauna (*sensu* Hill 1938). In the Gałęzice area, where the Famennian is strongly stratigraphically condensed on a drowning pelagic platform, corals appeared late, being represented by the laccophylloid fauna and heterocorals.

In the Kraków region (Racławka Valley) corals are known only in the latest Famennian. Extremely shallow-water organodetrital limestone was deposited there. Two species of the colonial rugose *Pseudoendophyllum* and several solitary corals are represented in the "Stromatoporoid Rocks".

The Famennian corals from the Sudetes (Wapnica Quarry in Dzikowiec) represent two different facies: a shallow-shelf limestone (the Main Limestone) and somewhat younger pelagic cephalopod limestone (*Wocklumeria* Limestone). Within the Main Limestone three species of massive colonial *Scruttonia* occur followed by a few species of solitary dissepimented corals of the canino-clisiophylloid fauna. In the cephalopod limestone, corals are scarce and represented by eurytopic laccophylloid fauna and heterocorals typical to the Famennian cephalopod facies.

High diversity of the Famennian coral taxa described here is caused mainly by the variability in the facies development between the studied areas. However, when comparing them with other regions of the world they display surprising mutual affinities and differences, which often do not fit the Famennian palaeogeography.

Corals occurring in the Holy Cross Mountains (Kowala, Gałęzice) reveal affinities to the fauna from the Varican sea. Small non-dissepimented corals (nalivkinelloid and laccophylloid fauna *sensu* Różkowska 1969) are regarded now as the most diversified in the world. They were noted also from the widespread basinal facies of the Variscan Europe, Morocco, Kazakstan, and northern China. Apart from them, endemic taxa of the family Kielcephyllidae Różkowska, 1969 occur in Kadzielnia. Several specimens of large dissepimented solitary corals from Kowala reveal strong similarity to those of the Ardennes.

Solitary corals from the Kraków region (Racławka Valley) are very scarce and represent mostly species not described previously. Colonial forms, represented there by two species of *Pseudoendophyllum* reveal a surprising similarity to colonies described from the Famennian of Novaya Zemlya by Gorsky (1935, 1938). Similarities between species of *Pseudoendophyllum* from both regions may result from homeomorphy or a real phylogenetic affinity. The latter seems to be more likely because their contemporaneous nature can be confirmed by the presence of the conodont genus *Mashkovia* (Bełka 1998) and the labechiid stromatoporoids co-occurring with *Pseudoendophyllum* in both regions. Additionally, the presence of another conodont genus *Omolonognathus* described by Baliński (1995) from the Kraków region, previously known only from Omolon Massif, may also support this correlation. Such a surprising occurrence of similar taxa of corals, conodonts, and labechiids in these areas has not been reported in other regions of Europe (apart from the lost cerioid rugosan specimen of Wulff 1923). Thus, it seems that the Kraków region may have been isolated in the Famennian from the West European Province (*sensu* Fedorowski 1981) and was in contact with the eastern provinces (Text-fig. 16). This suggestion, however, requires additional evidence to be seriously considered.

Coral faunas from the Sudetes (Dzikowiec and Zdanów IG-1 borehole) contain both solitary and colonial taxa. Large dissepimented rugosans from the Main Limestone are very close to the columellate taxa from the Ardennes. Apart from them, some undetermined species are described here. Three species of the colonial amural genus *Scruttonia* from Dzikowiec and two genera and species of *Heterostrotion* and *Scruttonia* from Zdanów IG-1 borehole exemplify the richest assemblage of the Famennian colonial corals. The Famennian species of *Scruttonia* are known only from the Sudetes and may be regarded as descendants of Frasnian *Scruttonia*, which survived in refugee. The phaceloid species of *Heterostrotion* are not known to occur before the Frasnian–Famennian boundary, but they could be related to the Tournaisian and Viséan representatives of this genus. They were reported from South China (Poty and Xu 1996) and Vietnam (Khoa 1996), as well as from the Ardennes (see Poty and Xu 1997). This relation was already mentioned by Fedorowski (1991), who suggested that the Chinese species of *Heterostrotion* originated from the Emsian *Pseudopetraia devonica* described by Soshkina (1951) from the Urals, which migrated westward into Poland and then into the Ardennes. However, Weyer (1991) identified a species of *Pseudopetraia* from the Pragian of the Thuringia (*P. issa* Weyer, 1991). Thus, solitary taxa displaying similar heterocoralloid symmetry of septal apparatus are known in Europe from much older strata. The Famennian species of *Heterostrotion* from the Sudetes remain the oldest-known representative of the genus.

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FAMENNIAN RUGOSA AND HETEROCORALLIA FROM SOUTHERN POLAND

PLATE 1

Scruttonia kunthi Frech, 1885 28

Dzikowiec, exposure 1, Main Limestone Dfγ foraminiferal Zone corresponding to conodont *Palmatolepis expansa* Zone.

Fig. 1. Polished longitudinal section of colony UAM Tc-B\02\DI\07\a. Alternating high- and low-density growth bands are clearly visible. Below note a phaceloid colony of *Syringopora* sp.

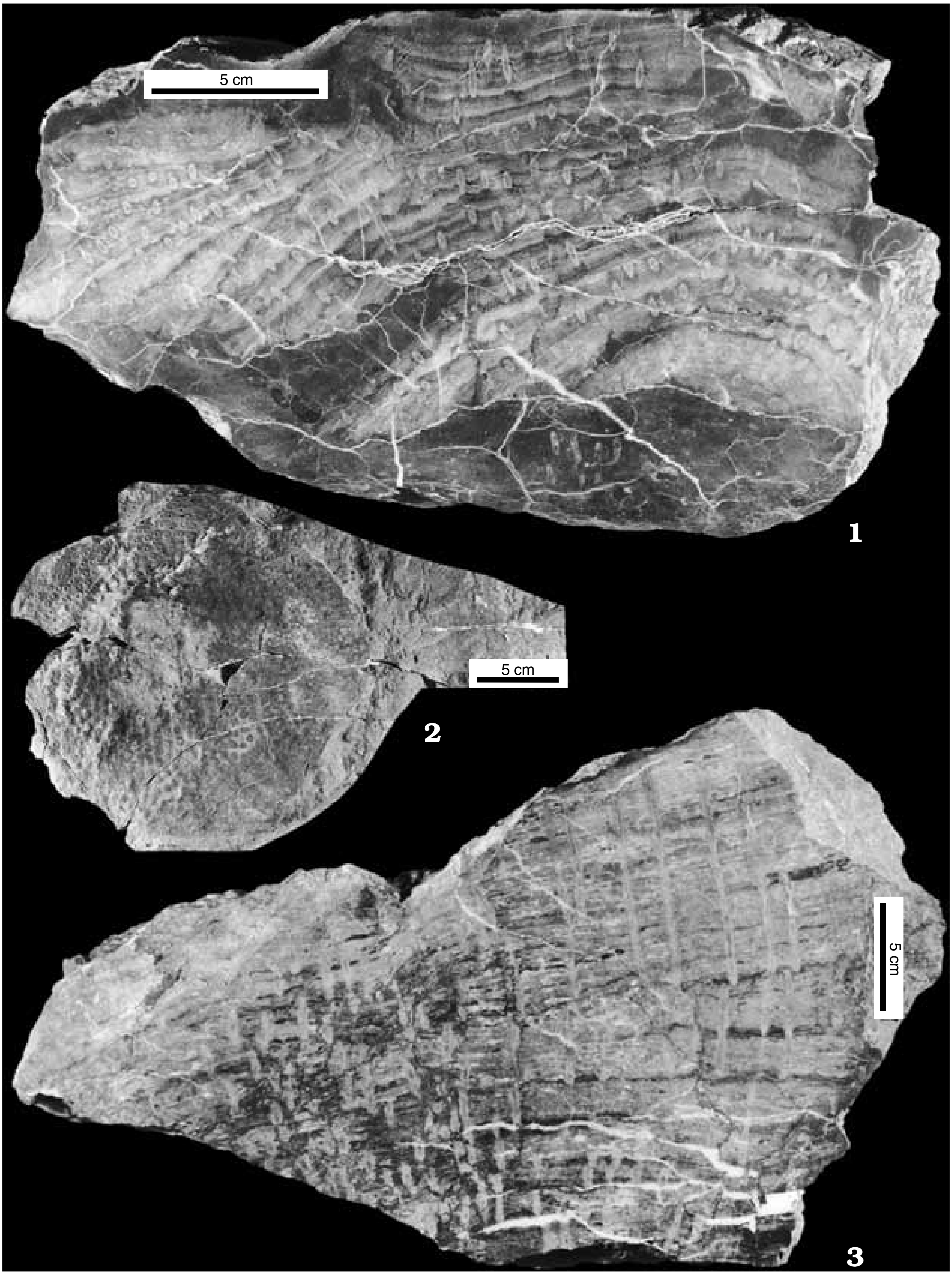
Dzikowiec, exposure 3, Main Limestone Dfδ foraminiferal Zone corresponding to conodont *P. expansa* Zone.

Fig. 2. Upper surface of colony UAM Tc-B\02\DIII\12b.

Scruttonia fedorowskii sp. n. 33

Dzikowiec, exposure 1, Main Limestone Dfδ, foraminiferal Zone corresponding to conodont *P. expansa* Zone.

Fig. 3. Polished longitudinal section of aphroid colony UAM Tc-B\02\DI\05.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5 cm
5 cm
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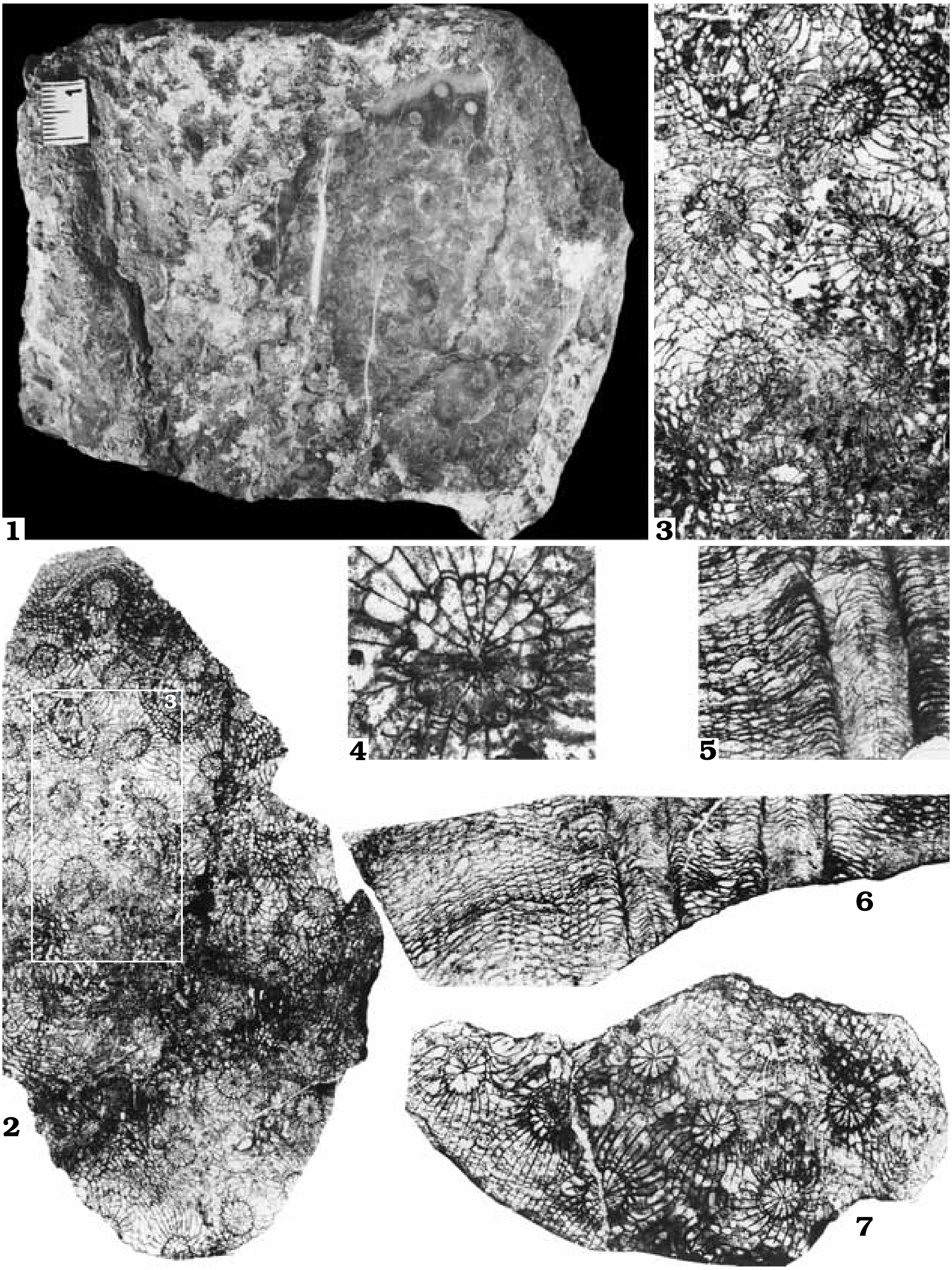
FAMENNIAN RUGOSA AND HETEROCORALLIA FROM SOUTHERN POLAND

PLATE 2

Scruttonia kunthi Frech, 1885 28

Dzikowiec, Main Limestone.

Fig. 1. Lectotype, fragment of a colony (MB, unnumbered). Originally labeled by F. Frech as “No 1”, × 1.
Fig. 2. Transverse thin section made from the lectotype by F. Frech (1885: pl. 7: 4); (MB, unnumbered), × 2.
Fig. 3. Part of the same (Fig. 2) thin section, × 4.
Fig. 4. Magnification of one corallite from the same thin section (Fig. 2), × 8.
Fig. 5. Syntype of A. Kunth (1870: pl. 1: 4d); MB. K.372-2. Part of the longitudinal thin section, × 4.
Fig. 6. New longitudinal thin section made from the lectotype (MB, unnumbered), × 4.
Fig. 7. Syntype of A. Kunth (1870: pl. 1: 4c); MB. K.372-1. Transverse thin section, × 4.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FAMENNIAN RUGOSA AND HETEROCORALLIA FROM SOUTHERN POLAND

PLATE 3

Scruttonia kunthi Frech, 1885 28

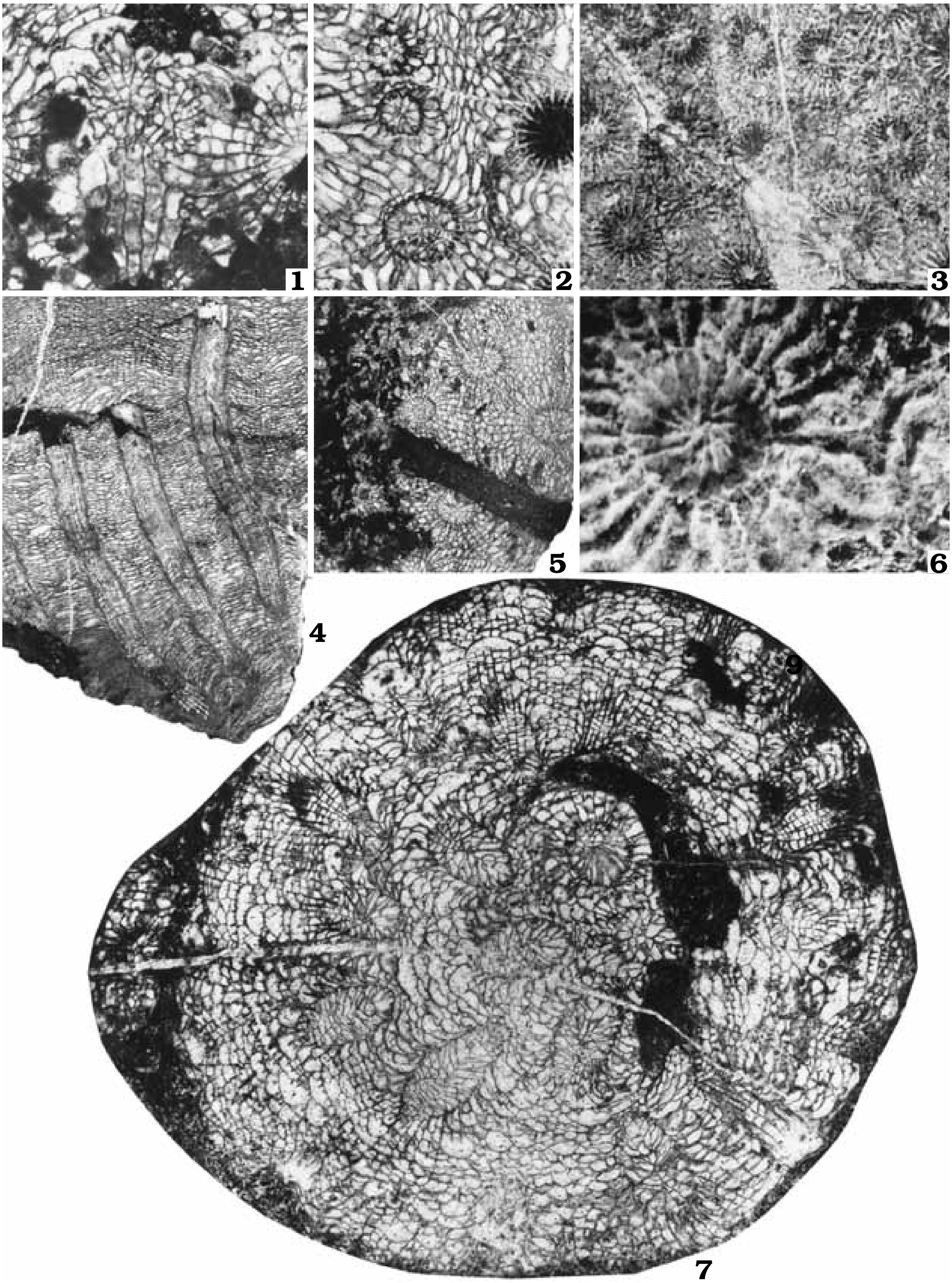
Dzikowiec, Main Limestone Dfδ, foraminiferal Zone corresponding to conodont *Palmatolepis expansa* Zone.

Fig. 1. Transverse thin section of a double budding within colony UAM Tc-B\02\DIII\3. Exposure 3, × 6.
Fig. 2. Transverse thin section of budding within colony UAM Tc-B\02\DI\7a. Exposure 1, × 4.
Fig. 4. Longitudinal thin section of colony UAM Tc-B\02\DIII\12b. Exposure 3. Internal high- and low-density banding and partly buried upper surface is visible, × 2.
Fig. 5. Transverse thin section of the colony UAM Tc-B\02\DIII\3. Exposure 3. Horizontal boring is visible, × 2.
Fig. 6. Calice of colony UAM Tc-B\02\DIII\3. Exposure 3, × 8.
Fig. 7. Transverse thin section of colony UAM Tc-B\02\DIII\12a. Exposure 3. Protocorallite is indicated as "p", two investigated lateral buddings are indicated as "b1", "b2", × 4.

Scruttonia cf. *kunthi* Frech, 1885 31

Dzikowiec, exposure 0, Basal Limestone.

Fig. 3. Transverse thin section of poorly preserved colony UAM Tc-B\02\D0\1, × 4.



B. BERKOWSKI: FAMENNIAN RUGOSA AND HETEROCORALLIA FROM SOUTHERN POLAND

FAMENNIAN RUGOSA AND HETEROCORALLIA FROM SOUTHERN POLAND

PLATE 4

Scruttonia sudetica sp. n. 31

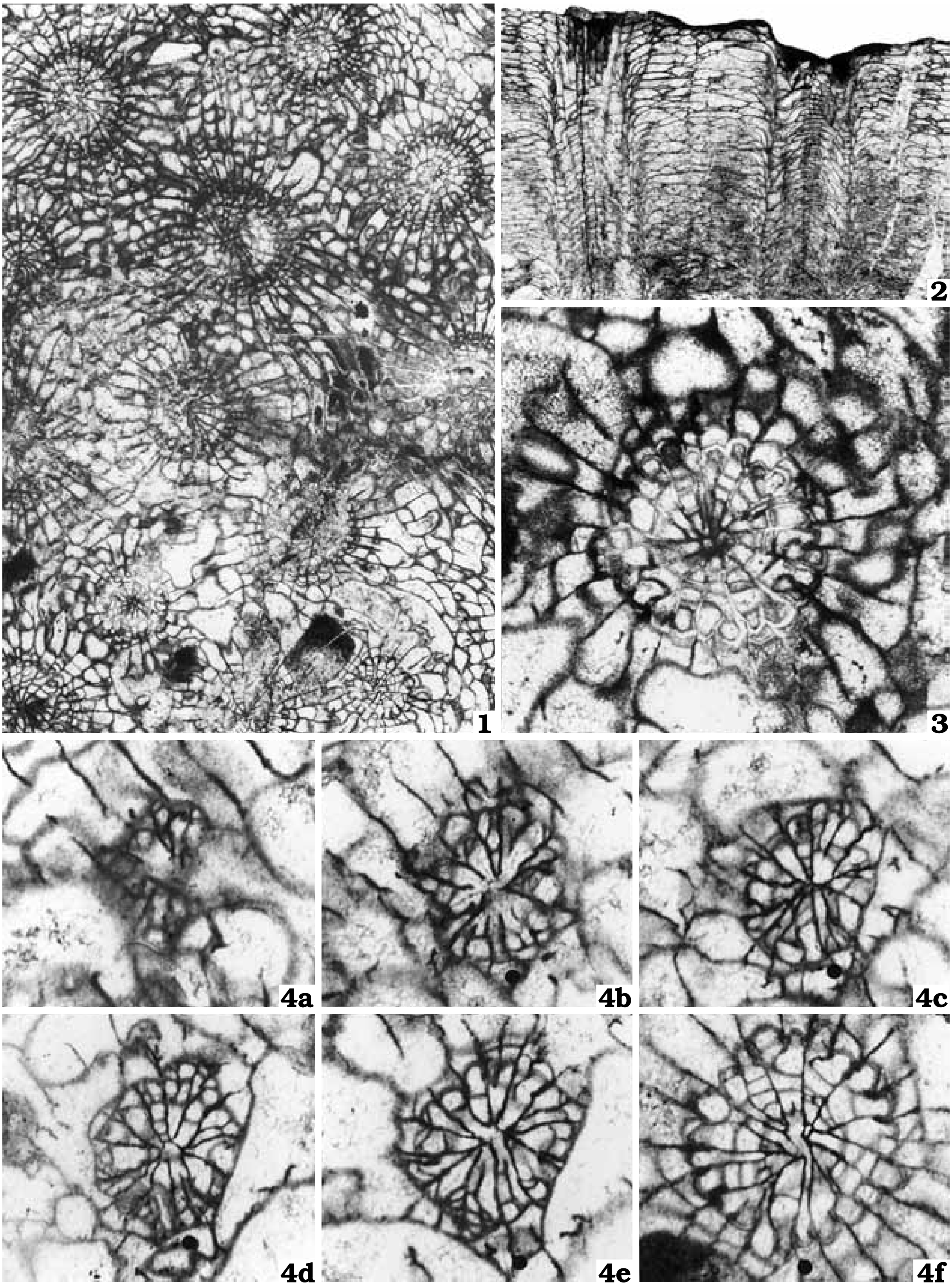
Dzikowiec, exposure 1, Main Limestone Dfδ, foraminiferal Zone corresponding to conodont *Palmatolepis expansa* Zone.

Fig. 1. Transverse thin section of colony UAM Tc-B\02\DI\12 (holotype), × 4.

Fig. 2. Longitudinal thin section of colony UAM Tc-B\02\DI\12 (holotype), × 4.

Fig. 3. Transverse thin section of corallite from colony UAM Tc-B\02\DI\12 (holotype). Cardinal, alar and counter septa are indicated as “c”, “a”,”K”, × 12.

Fig. 4a–f. Successive serial sectioning of internal bud within colony UAM Tc-B\02\DI\12 (holotype). Cardinal septum is indicated as black points, × 12.



B. BERKOWSKI: FAMENNIAN RUGOSA AND HETEROCORALLIA FROM SOUTHERN POLAND

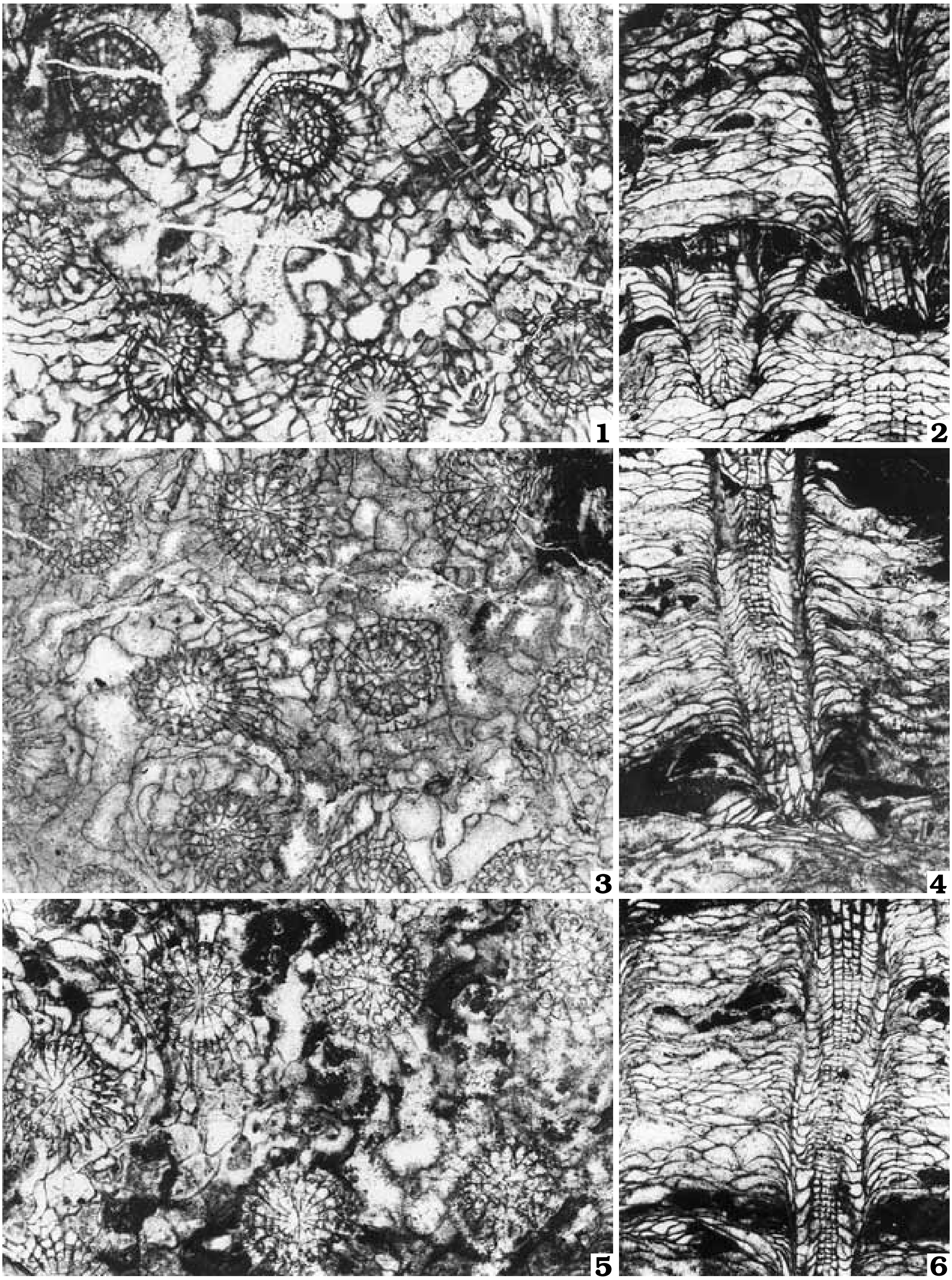
FAMENNIAN RUGOSA AND HETEROCORALLIA FROM SOUTHERN POLAND

PLATE 5

Scruttonia fedorowskii sp. n. 33

Dzikowiec, exposure 1, Main Limestone Dfδ, foraminiferal Zone corresponding to conodont *Palmatolepis expansa* Zone.

Fig. 1. Transverse thin section of colony UAM Tc-B\02\DI\5a (holotype), × 4.
Fig. 2. Longitudinal thin section of colony UAM Tc-B\02\DI\5a (holotype), × 4.
Fig. 3. Transverse thin section of colony UAM Tc-B\02\DI\5b, × 4.
Fig. 4. Longitudinal thin section of colony UAM Tc-B\02\DI\5b, × 4.
Fig. 5. Transverse thin section of colony UAM Tc-B\02\DI\5c, × 4.
Fig. 6. Longitudinal thin section of colony UAM Tc-B\02\DI\5c, × 4.



B. BERKOWSKI: FAMENNIAN RUGOSA AND HETEROCORALLIA FROM SOUTHERN POLAND

FAMENNIAN RUGOSA AND HETEROCORALLIA FROM SOUTHERN POLAND

PLATE 6

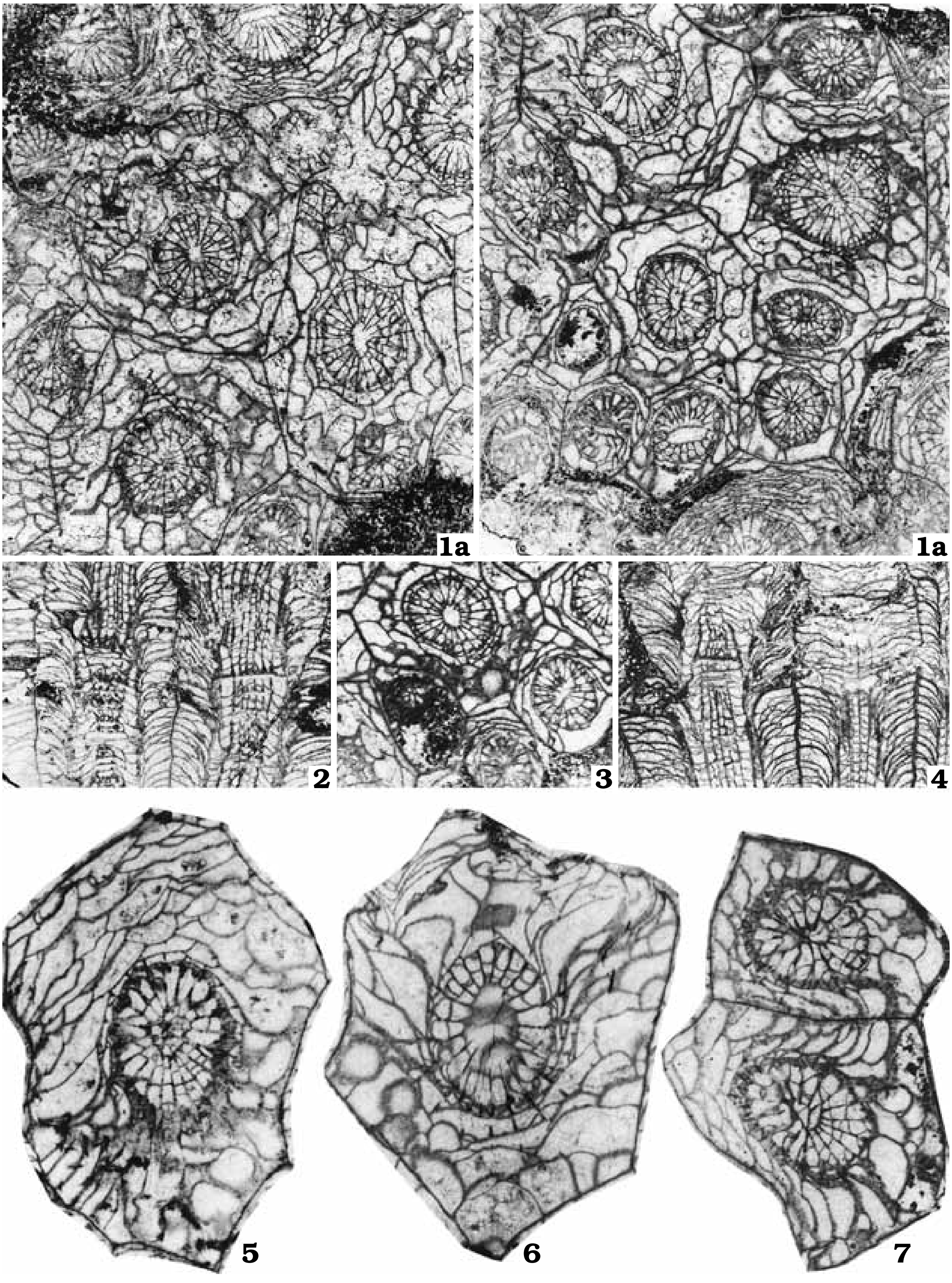
Pseudoendophyllum plativesiculosum (Gorsky, 1935). 25

Racławka Valley, Dubie Formation, Góra Żarska Member, Late Famennian.

Figs 1a, 1b, 3. Transverse thin sections of colony UAM Tc-B\03\10. Fig. 3 shows a phenomenon of rejuvenescence within the colony, × 4.

Figs 2, 4. Longitudinal thin sections of the colony UAM Tc-B\03\10, × 4.

Figs 5, 6. Transverse thin sections of corallites of colony UAM Tc-B\03\10. Figs 5a, b shows successive stages of corallite growth revealing amplexoid character of septa, × 12.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FAMENNIAN RUGOSA AND HETEROCORALLIA FROM SOUTHERN POLAND

PLATE 7

Pseudoendophyllum raclaviense sp. n. 26

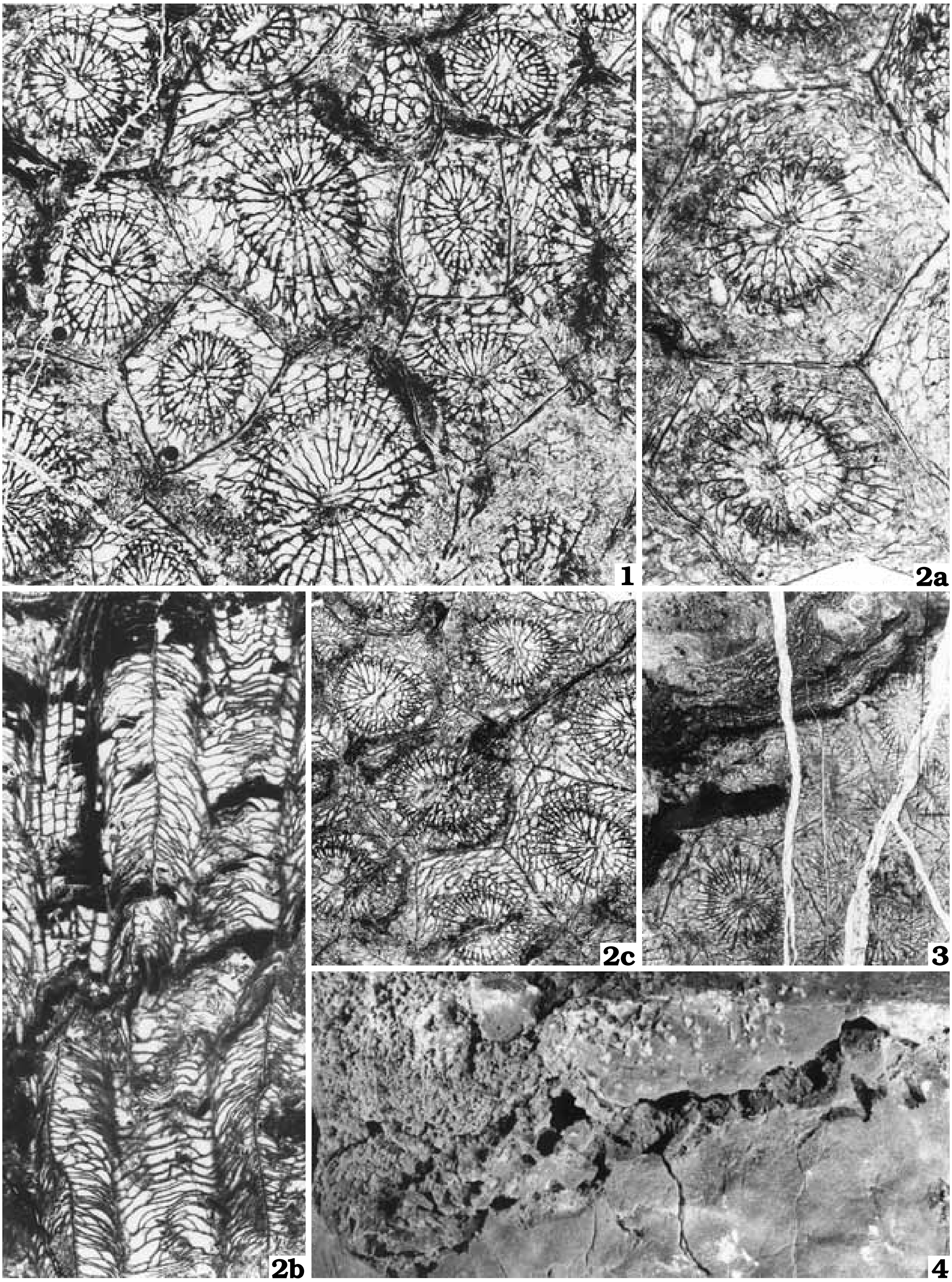
Stromatoporoid Rock, at Dubie village, Dubie Formation, Góra Żarska Member, Late Famennian.

Fig. 1. Transverse thin section of the colony UAM Tc-B\03\01 (paratype). Cardinal septa on two corallites indicated as black points, × 4.

Figs 2a–c. Holotype colony UAM Tc-B\03\09 in transverse (a, c, × 4 and × 2, respectively) and longitudinal (b; × 4) thin sections.

Fig. 3. Transverse thin section of colony UAM Tc-B\03\03 overgrown by stromatoporoids, × 2.

Fig. 4. Weathered surface of the colony UAM Tc-B\03\03 overgrown by stromatoporoids and syringoporoids "*Caunopora*" tubes, × 1.5.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FAMENNIAN RUGOSA AND HETEROCORALLIA FROM SOUTHERN POLAND

PLATE 8

Circellia concava Różkowska, 1969 22

Kowala Quarry, set K, conodont *Palmatolepis marginifera* or early *Palmatolepis trachytera* Zone.

Fig. 1. Specimen UAM Tc-B\01\34, scolecoid morphotype, × 2.
Fig. 2. Specimen UAM Tc-B\01\32, trochoid morphotype, × 2.

Neaxon tenuiseptatus Różkowska, 1969 20

Kowala Quarry, set L, conodont *Palmatolepis expansa* Zone.

Fig. 3. Specimen UAM Tc-B\01\51, attached to shell of goniatite *Sporadoceras*, × 2.

Palaeosmilia? *aquisgranensis* (Frech, 1885) 38

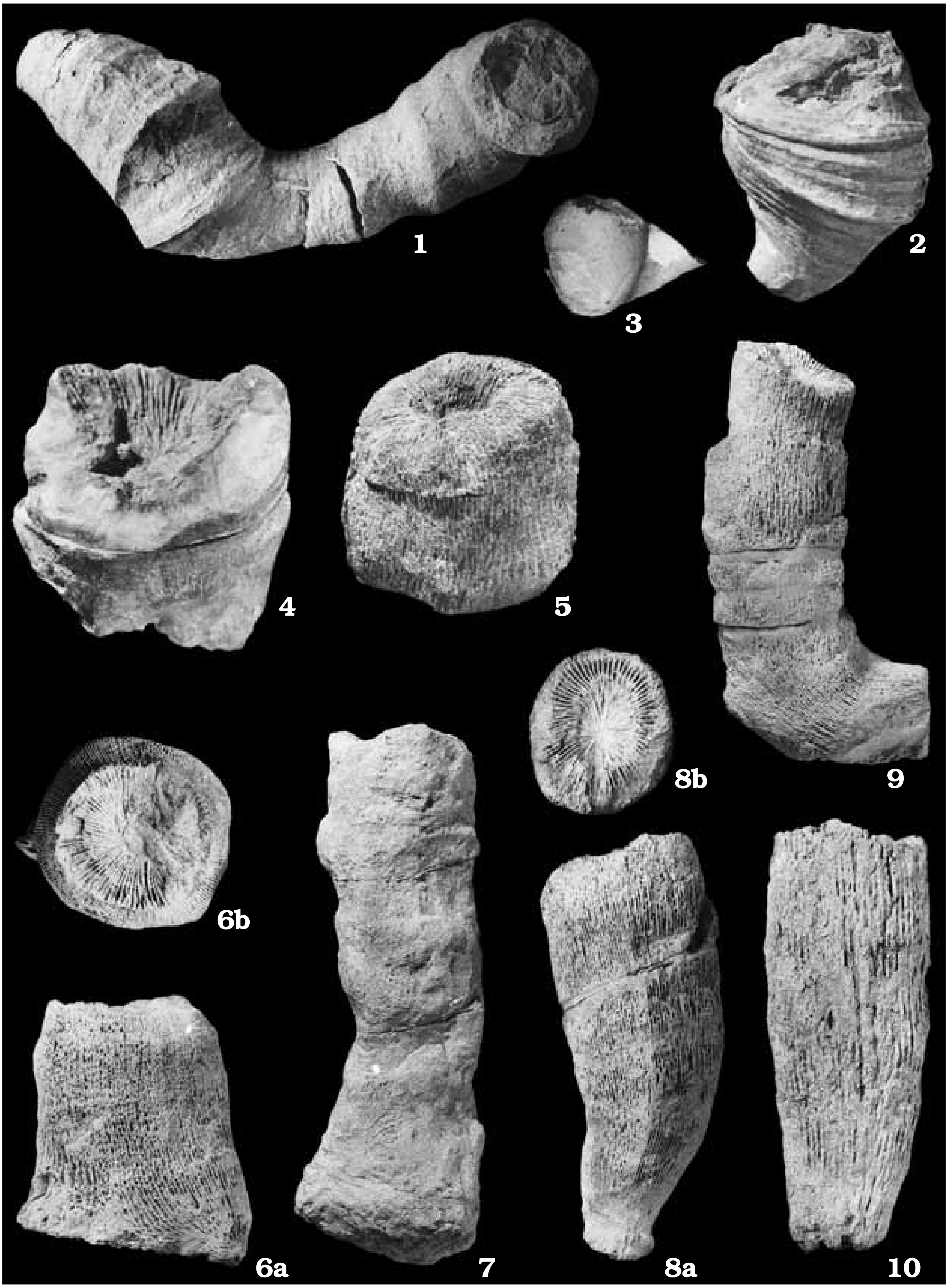
Kowala trenches, set L, conodont *Palmatolepis expansa* or *Siphonodella praesulcata* Zone.

Fig. 4. Specimen UAM Tc-B\01\10, × 1.
Fig. 5. Specimen UAM Tc-B\01\13, × 1.
Fig. 6. Specimen UAM Tc-B\01\03 in alar side (a) and calicular (b) views, × 1.
Fig. 7. Specimen UAM Tc-B\01\11, × 1.

Campophyllum sp. A 35

Kowala trenches, set L, conodont *Palmatolepis expansa* or *Siphonodella praesulcata* Zone.

Fig. 8. Specimen UAM Tc-B\01\04 in alar side (a) and calicular (b) views, × 1.
Fig. 9. Specimen UAM Tc-B\01\07, × 1.
Fig. 10. Specimen UAM Tc-B\01\06, × 1.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FAMENNIAN RUGOSA AND HETEROCORALLIA FROM SOUTHERN POLAND

PLATE 9

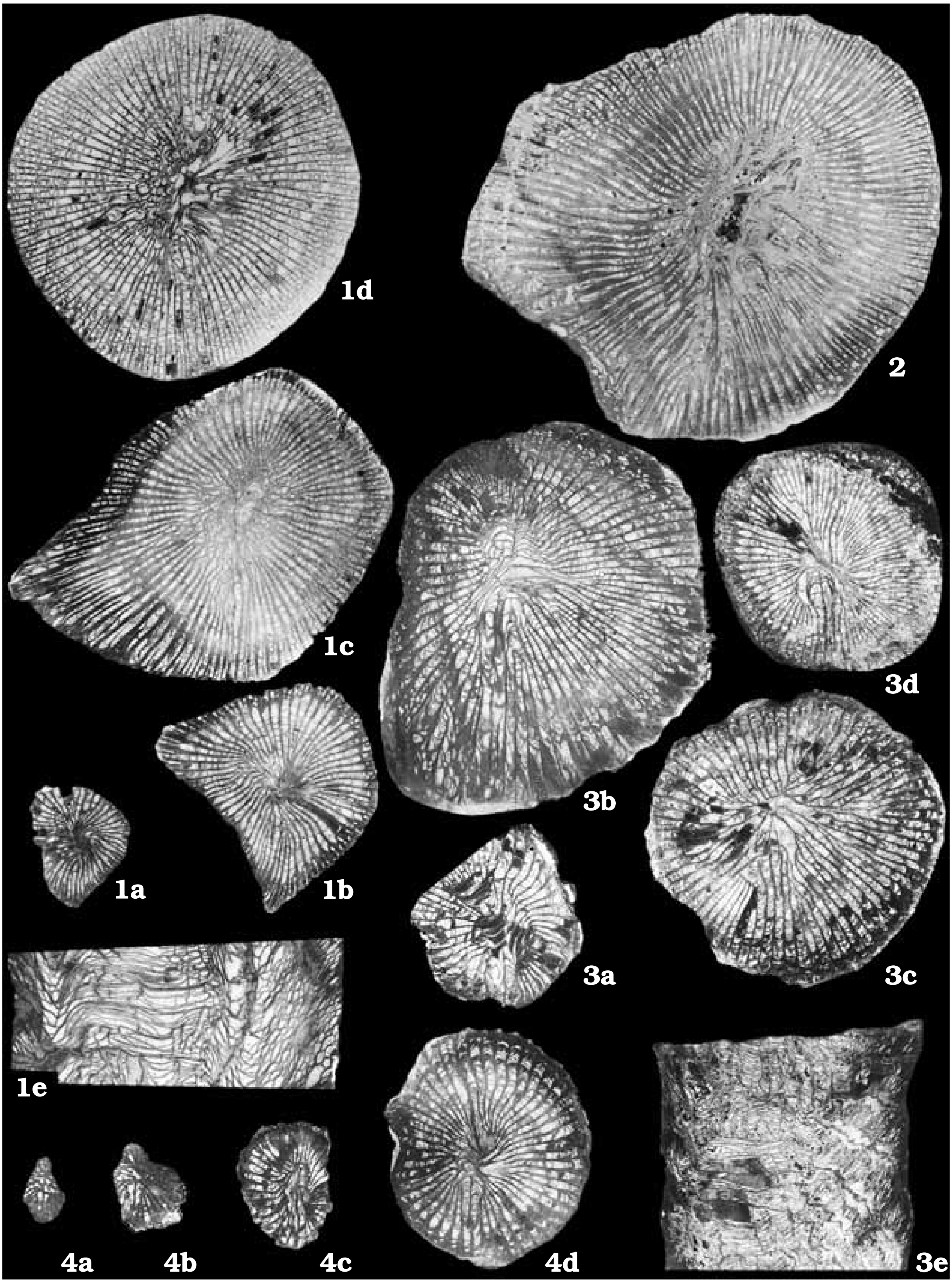
Kowala trenches, set L, conodont *Palmatolepis expansa* or *Siphonodella praesulcata* Zone.

Fig. 1. Specimen UAM Tc-B\01\03, serial transverse thin sections (a–d), and longitudinal section in counter-cardinal plane (e), × 2.

Fig. 2. Specimen UAM Tc-B\01\10, transverse thin section below calice, × 2

Fig. 3. Specimen UAM Tc-B\01\11, serial transverse thin sections (a–d), and longitudinal thin section in counter-cardinal plane (e), × 2

Fig. 4. Specimen UAM Tc-B\01\12, serial transverse thin sections (a–d), × 2


1d
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4d
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FAMENNIAN RUGOSA AND HETEROCORALLIA FROM SOUTHERN POLAND

PLATE 10

Palaeosmilia? *aquisgranensis* (Frech, 1885) 38

Kowala trenches, set L, conodont *Palmatolepis expansa* or *Siphonodella praesulcata* Zone.

Fig. 1. Specimen UAM Tc-B\01\13, transverse thin section (a), and longitudinal section in counter-cardinal plane (b), × 2.

Campophyllum sp. A 35

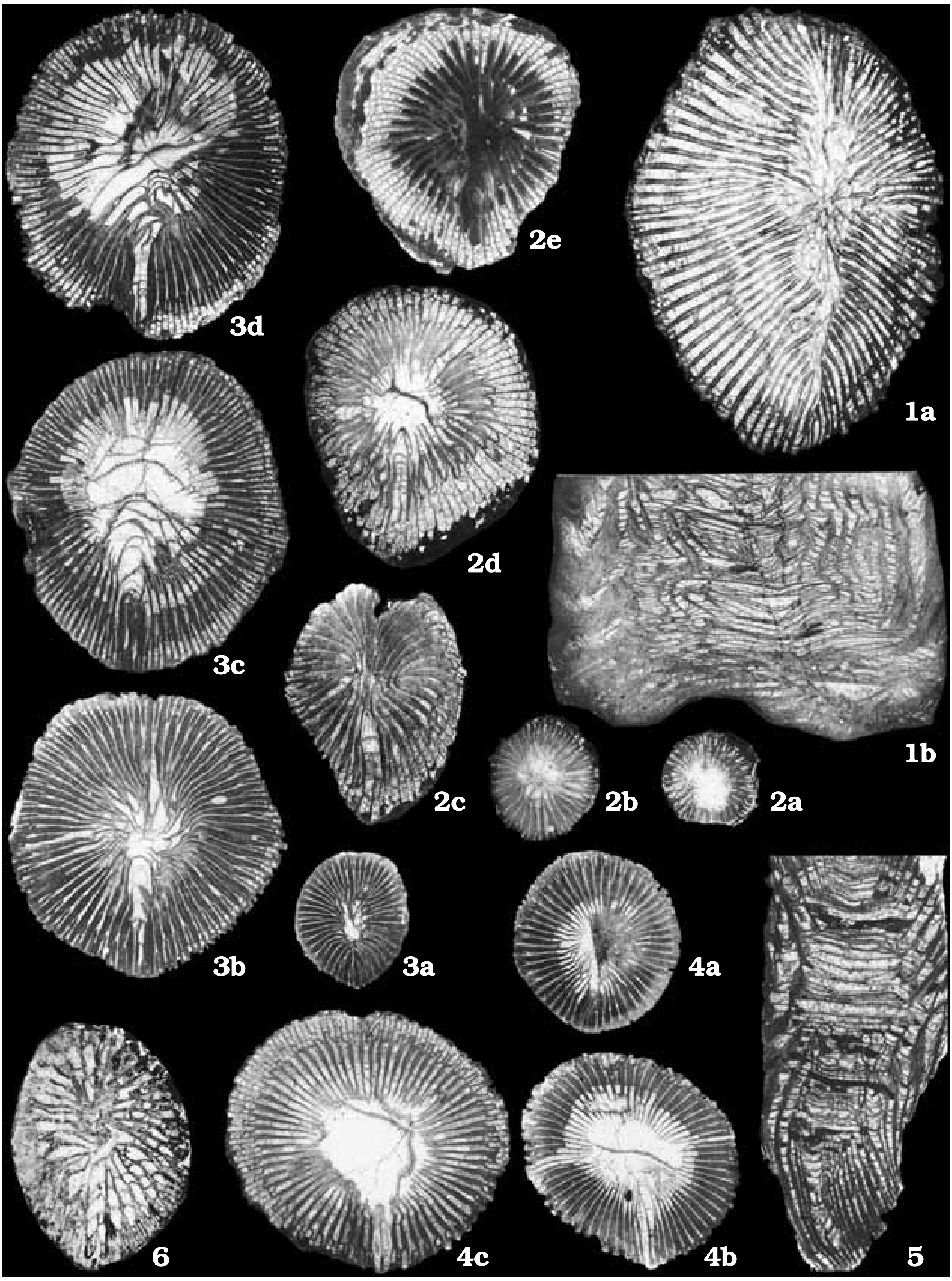
Kowala trenches, set L, conodont *Palmatolepis expansa* or *Siphonodella praesulcata* Zone.

Fig. 2. Specimen UAM Tc-B\01\01, serial transverse thin sections (a–e), × 2.
Fig. 3. Specimen UAM Tc-B\01\04, serial transverse thin sections (a–d), × 2.
Fig. 4. Specimen UAM Tc-B\01\06, serial transverse thin sections (a–c), × 2.
Fig. 5. Specimen UAM Tc-B\01\02, longitudinal thin section, × 2.

Campophyllum? sp. 36

Stromatoporoid Rock, Rokiczany Ravine, Dubie Formation, Góra Żarska Member, Late Famennian.

Fig. 6. Specimen UAM Tc-B\03\31, transverse thin section, × 2.


3d
2e
1a
2d
3c
1b
2c
2b
2a
3b
3a
4a
6
4c
4b
5

FAMENNIAN RUGOSA AND HETEROCORALLIA FROM SOUTHERN POLAND

PLATE 11

Clisiophyllum sp. 37

Dzikowiec, exposure 1, Main Limestone Dfδ, foraminiferal Zone corresponding to conodont *Palmatolepis expansa* Zone.

Fig. 1. Specimen UAM Tc-B\02\DI\4\1, serial transverse thin sections (a–e), × 4.

Dibunophyllum? aff. *praecursor* Frech, 1885. 37

Dzikowiec, exposure 1, the Main Limestone Dfδ, foraminiferal Zone corresponding to conodont *Palmatolepis expansa* Zone.

Fig. 2. Specimen UAM Tc-B\02\DI\6\4, transverse thin sections (a, b), × 4.

Spirophyllum? sp. 37

Kowala trenches, set L, conodont *Palmatolepis expansa* or *Siphonodella praesulcata* Zone.

Fig. 3. Specimen UAM Tc-B\01\15, transverse thin section, × 4.

Gen. et sp. n. 38

Dzikowiec, exposure 1, the Main Limestone Dfδ, foraminiferal Zone corresponding to conodont *Palmatolepis expansa* Zone.

Fig. 4. Specimen UAM Tc-B\02\DI\4\5, transverse thin sections (a, b), longitudinal thin section (c), × 4.

Heterostrotion? sp. 40

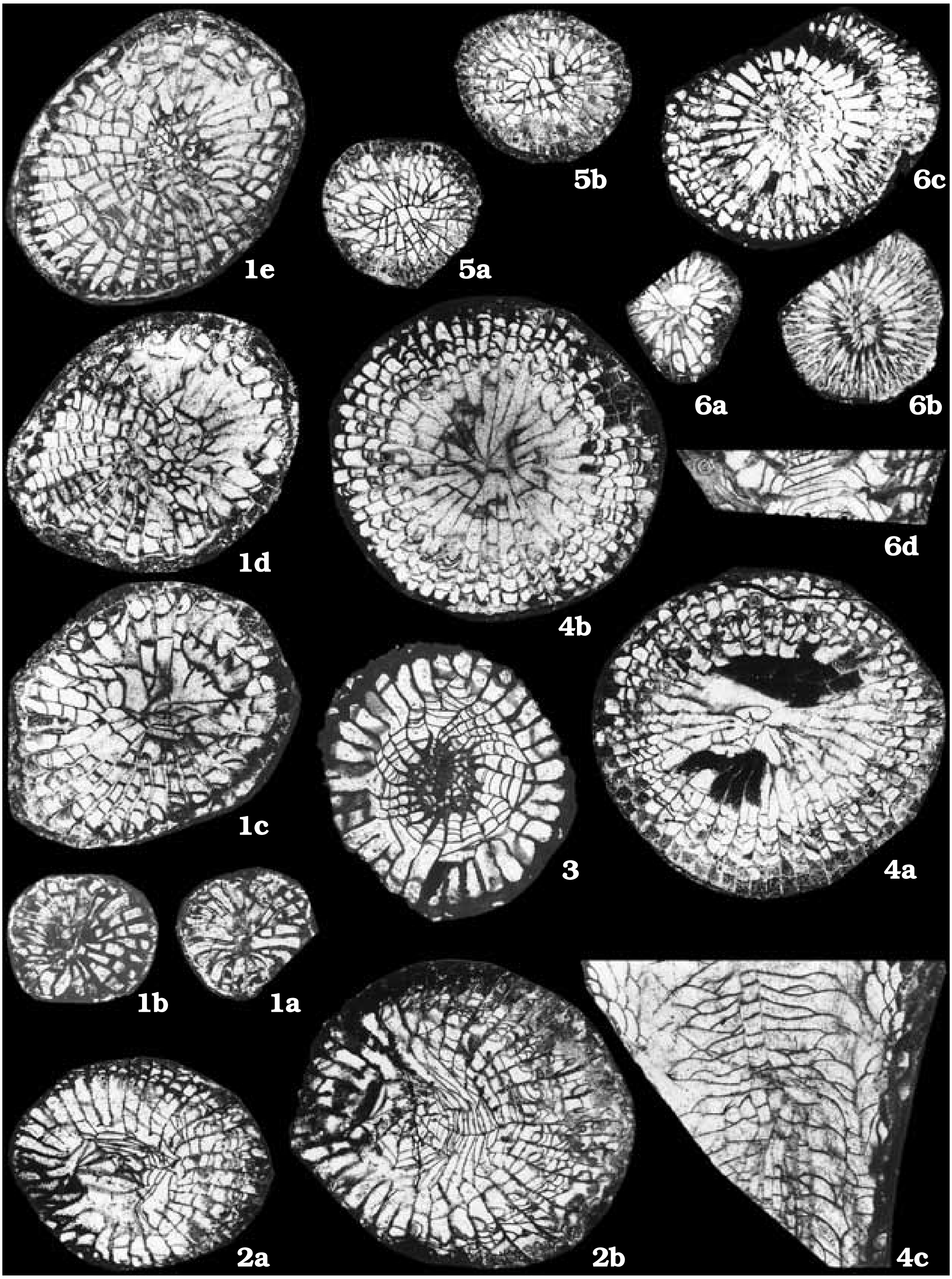
Dzikowiec, exposure 1, Main Limestone Dfδ, foraminiferal Zone corresponding to conodont *Palmatolepis expansa* Zone.

Fig. 5. Specimen UAM Tc-B\02\DI\2\1, transverse thin sections (a, b), × 4.

Gen. et sp. indet. C 41

Stromatoporoid Rock at Rokiczany Ravine, Dubie Formation, Góra Żarska Member, Late Famennian.

Fig. 6. Specimen UAM Tc-B\03\25, serial transverse thin sections (a–c), and longitudinal thin section (d), × 4.


1e
5a
5b
6c
6a
6b
1d
4b
6d
1c
3
4a
1b
1a
2a
2b
4c

FAMENNIAN RUGOSA AND HETEROCORALLIA FROM SOUTHERN POLAND

PLATE 12

Gen. et sp. indet. A 41

Stromatoporoid Rock at Dubie village, Dubie Formation, Góra Żarska Member, Late Famennian.

Fig. 1. Specimen UAM Tc-B\03\58, serial transverse thin sections (a–e), × 6.

Gen. et sp. indet. B 41

Stromatoporoid Rock at Dubie village, Dubie Formation, Góra Żarska Member, Late Famennian.

Fig. 2. Specimen UAM Tc-B\03\50, transverse thin sections (a, b), × 6.

Tabulophyllum sp. A 24

Dzikowiec, exposure 1, Main Limestone Dfδ, foraminiferal Zone corresponding to conodont *Palmatolepis expansa* Zone.

Fig. 3. Specimen UAM Tc-B\02\DI\7\7, serial transverse thin sections (a–c), and longitudinal thin section (d), × 4.

Tabulophyllum sp. B 24

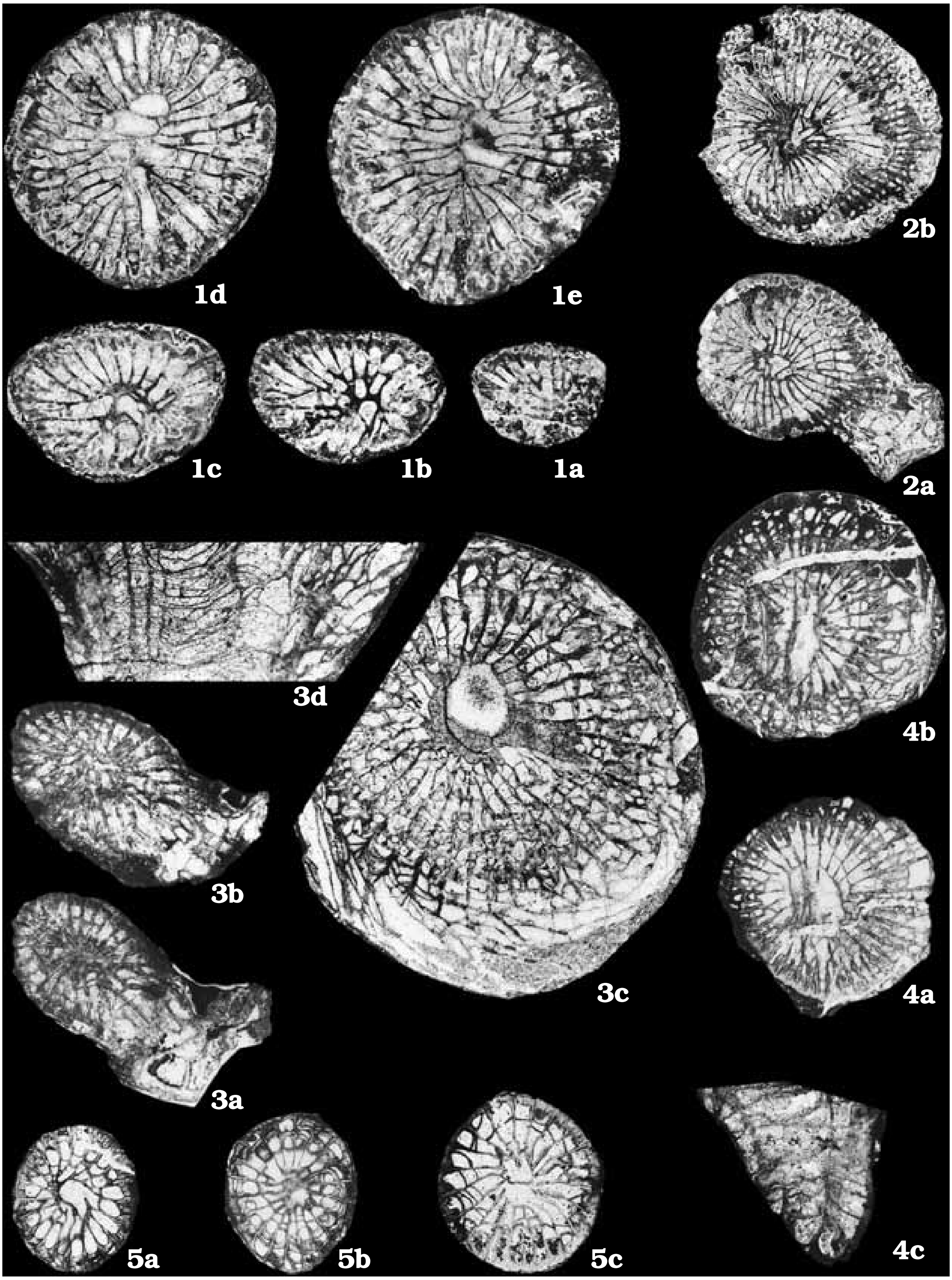
Stromatoporoid Rock at Dubie village, Dubie Formation, Góra Żarska Member, Late Famennian.

Fig. 4. Specimen UAM Tc-B\03\22, transverse (a, b) and longitudinal (c) thin sections, × 4.

Gen. et sp. indet. D 42

Stromatoporoid Rock at Dubie village, Dubie Formation, Góra Żarska Member, Late Famennian.

Fig. 5. Specimen UAM Tc-B\03\24, serial transverse thin sections (a–c), × 4.


1d
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1c
1b
1a
2a
3d
4b
3b
3c
4a
3a
5a
5b
5c
4c

FAMENNIAN RUGOSA AND HETEROCORALLIA FROM SOUTHERN POLAND

PLATE 13

Dzikowiec, exposure 2, *Wocklumeria* Limestone, ammonoid *Parawocklumeria paradoxa* Zone, conodnt *Palmatolepis expansa* Zone.

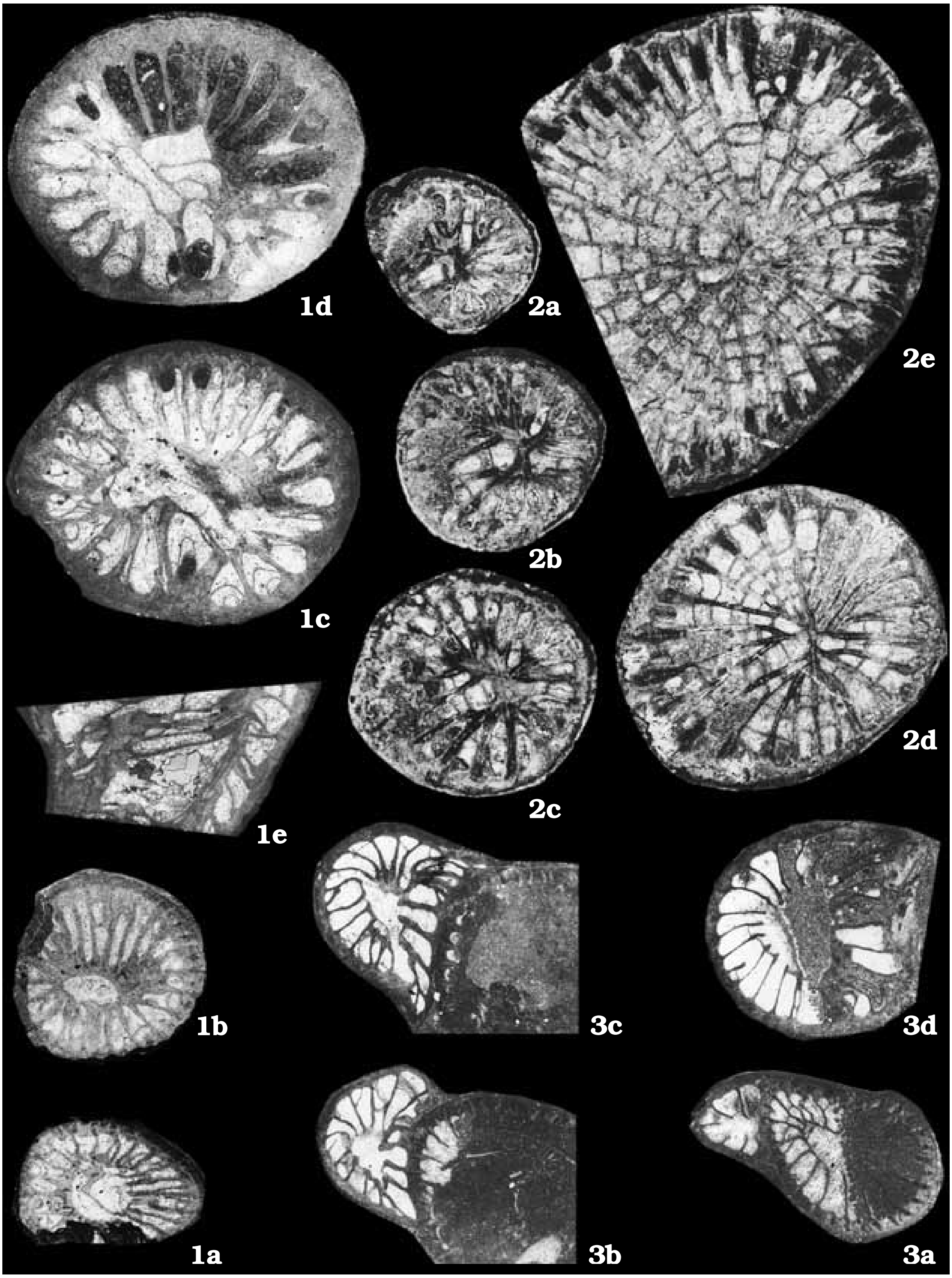
Fig. 1. Specimen UAM Tc-B\02\DII\63, serial transverse thin sections (a, b, d, e), and longitudinal thin section (c), × 4.

Dzikowiec, exposure 1, Main Limestone Dfδ, foraminiferal Zone corresponding to conodont *Palmatolepis expansa* Zone.

Fig. 2. Specimen UAM Tc-B\02\DI\4\2, serial transverse thin sections (a–e), × 4.

Kowala Quarry, set L, conodont *Palmatolepis expansa* Zone.

Fig. 3. Specimen UAM Tc-B\01\17, serial transverse thin sections (a–d), × 4.



1d
2a
2e
1c
2b
2d
1e
2c
1b
3c
3d
1a
3b
3a

FAMENNIAN RUGOSA AND HETEROCORALLIA FROM SOUTHERN POLAND

PLATE 14

Circellia concava (Różkowska, 1969) 22

Kowala Quarry, set K, conodont *Palmatolepis marginifera* or early *Palmatolepis trachytera* Zone.

Fig. 1. Specimen UAM Tc-B\01\34, scolecoid morphotype, serial transverse thin sections (a–c), × 4.
Fig. 2. Specimen UAM Tc-B\01\33, trochoid morphotype, serial transverse thin sections (a–c), × 2.
Fig. 3. Specimen UAM Tc-B\01\34, trochoid morphotype, longitudinal thin section, × 2.

Conilophyllum cf. *priscum* (Münster, 1848) 40

Stromatoporoid Rock at Dubie village, Dubie Formation, Góra Żarska Member, Late Famennian.

Fig. 4. Specimen UAM Tc-B\03\52, serial transverse thin sections (a–c), × 2.

Guerichiphyllum kowalense Różkowska, 1969 21

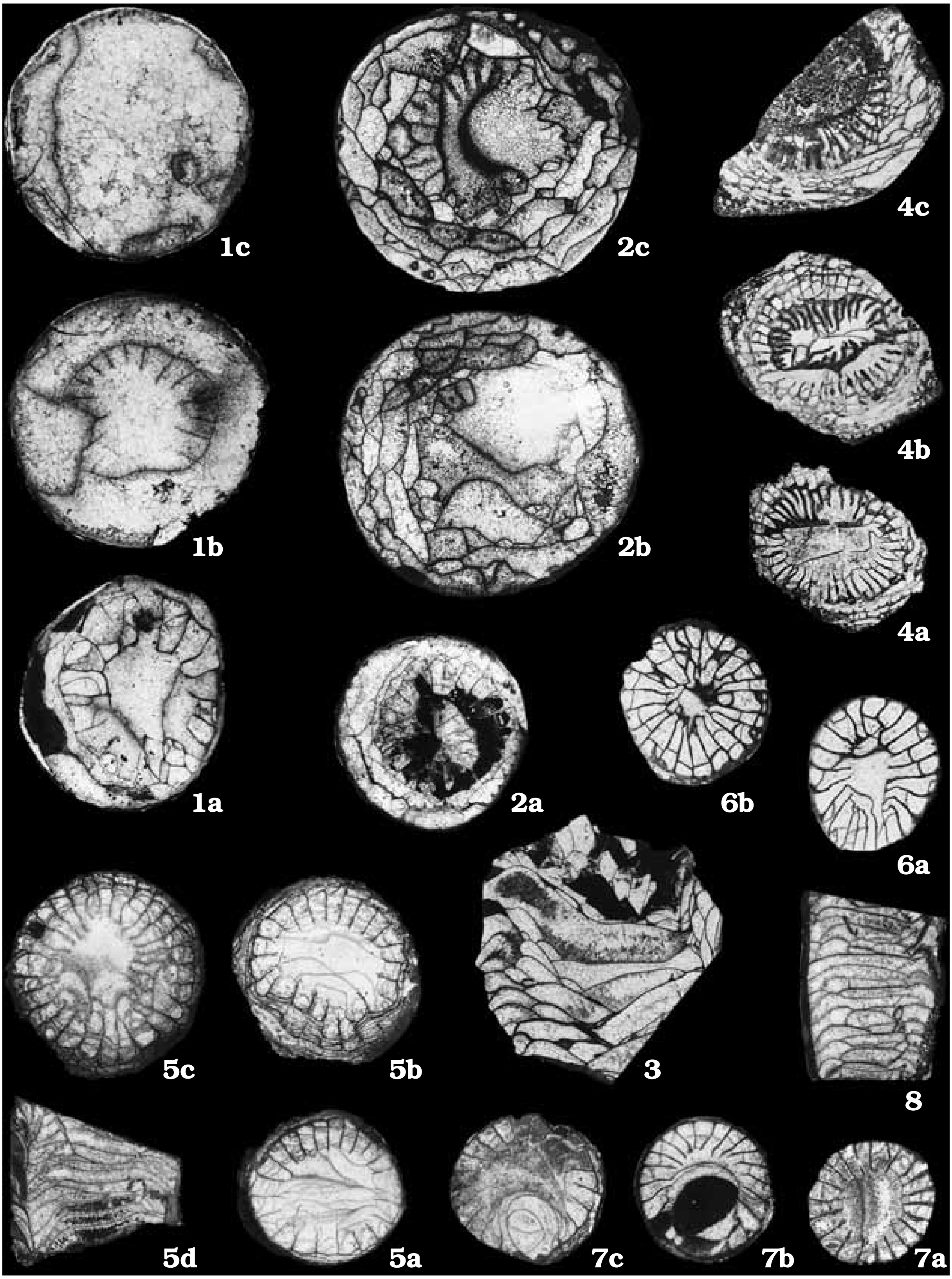
Kowala Quarry, set L, conodont *Palmatolepis expansa* Zone.

Fig. 5. Specimen UAM Tc-B\01\43, serial transverse thin sections (a–c), and longitudinal thin section (d), × 2.

Gorizdronia soshkinae Różkowska, 1974 23

Kowala Quarry, set L, conodont *Palmatolepis expansa* Zone.

Fig. 6. Specimen UAM Tc-B\01\27, transverse thin sections (a, b), × 2.
Fig. 7. Specimen UAM Tc-B\01\42, serial transverse thin sections (a–c), × 2.
Fig. 8. Specimen UAM Tc-B\01\40, longitudinal thin section, × 2.


1c
2c
4c
1b
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4a
1a
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6b
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5c
5b
3
8
5d
5a
7c
7b
7a

FAMENNIAN RUGOSA AND HETEROCORALLIA FROM SOUTHERN POLAND

PLATE 15

Neaxon tenuiseptatus Różkowska, 1969 20

Kowala Quarry, set L, conodont *Palmatolepis expansa* Zone.

Fig. 1. Specimen UAM Tc-B\01\16, serial transverse thin sections of the youngest stages (a–c), × 16; serial transverse sections of mature stages (d, e), × 8; longitudinal section (f), × 8.

Neaxon regulus (Richter, 1848) 20

Fig. 2. Specimen UAM Tc-B\02\DII\62, transverse thin sections (a, b). Dzikowiec, exposure 2, *Wocklumeria* Limestone, ammonoid *Parawocklumeria paradoxa* Zone, conodont *Palmatolepis expansa* Zone, × 6.

Fig. 3. Specimen UAM Tc-B\01\19, transverse thin sections (a, b). Kowala Quarry, set L, conodont *Palmatolepis expansa* Zone, × 8.

Nalivkinella rariseptata Różkowska, 1969 23

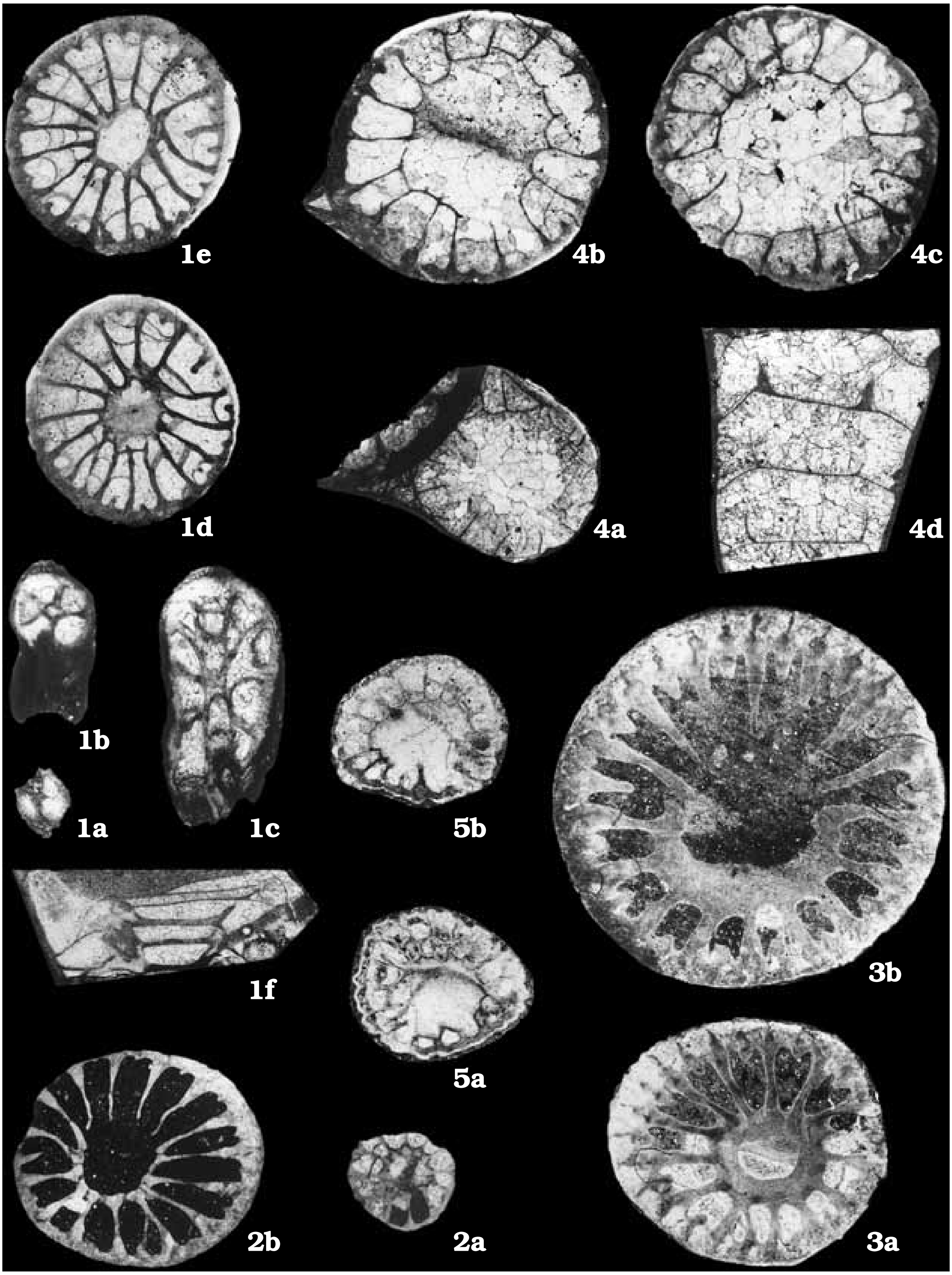
Kowala Quarry, set L, conodont *Palmatolepis expansa* Zone.

Fig. 4. Specimen UAM Tc-B\01\18, serial transverse thin sections (a–c), and longitudinal section (d), × 8.

Nalivkinella sp. 24

Dzikowiec, exposure 3, the Main Limestone Dfδ, foraminiferal Zone corresponding to conodont *Palmatolepis expansa* Zone.

Fig. 5. Specimen UAM Tc-B\02\DIII\6\3, transverse thin sections (a, b), × 4.


1e
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4c
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4d
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1c
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3b
1f
5a
2b
2a
3a

FAMENNIAN RUGOSA AND HETEROCORALLIA FROM SOUTHERN POLAND

PLATE 16

Cyathaxonia sp. 19

Gałęzice, Jaźwiny, conodont *Palmatolepis expansa* Zone.

Fig. 1. Specimen UAM Tc-B\01\66, serial transverse thin sections (a–c), × 8.

Syringaxon sp. 19

Fig. 2. Specimen UAM Tc-B\01\50, transverse thin section. Gałęzice, Todowa Hill, conodont *Palmatolepis expansa* Zone, × 12.

Fig. 3. Specimen UAM Tc-B\02\DII\61, transverse thin sections (a, b). Dzikowiec, exposure 2, *Wocklumeria* Limestone, ammonoid *Parawocklumeria paradoxa* Zone, conodnt *Palmatolepis expansa* Zone, × 16.

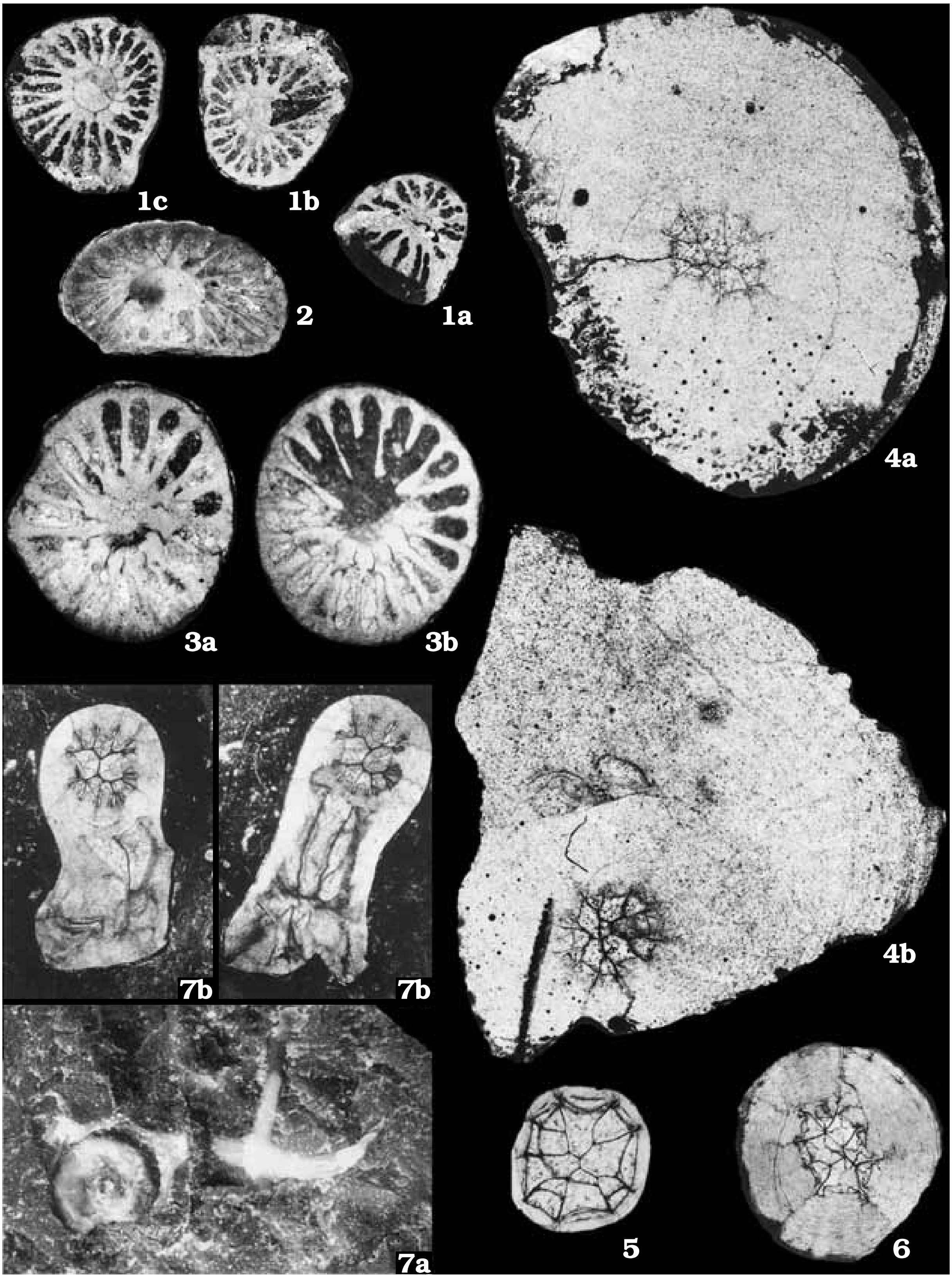
Oligophylloides pachythecus Różkowska, 1969 43

Fig. 4. Specimen UAM Tc-B\01\70, transverse thin sections (a, b). Gałęzice, Jaźwiny, conodont *Palmatolepis expansa* or *Siphonodella praesulcata* Zone, × 16.

Fig. 5. Specimen UAM Tc-B\01\72, transverse thin section. Gałęzice, Todowa Hill, conodont *Palmatolepis marginifera* Zone, × 12.

Fig. 6. Specimen UAM Tc-B\01\31, transverse thin section. Kowala Quarry, set L, conodont *Palmatolepis expansa* Zone, × 12.

Fig. 7. Specimen UAM Tc-B\02\DII\40, branching specimen, which overgrew a crinoid (a), × 4; successive blastogenetic stages (b, c), × 16. Dzikowiec, exposure 2, conodont *Palmatolepis expansa* Zone.


1c
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7b
7b
7a
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6

FAMENNIAN RUGOSA AND HETEROCORALLIA FROM SOUTHERN POLAND

PLATE 17

Oligophylloides weyeri sp. n. 44

Dzikowiec, exposure 2, conodont *Siphonodella praesulcata* Zone.

Fig. 1. Specimen UAM Tc-B\02\DII\101\3\1 (holotype), transverse (a, c) and longitudinal (b) thin sections, × 16. Note divisions of septa within protoheterotheca on magnified views (d, e) of transverse sections figured on 1a, c, × 50.

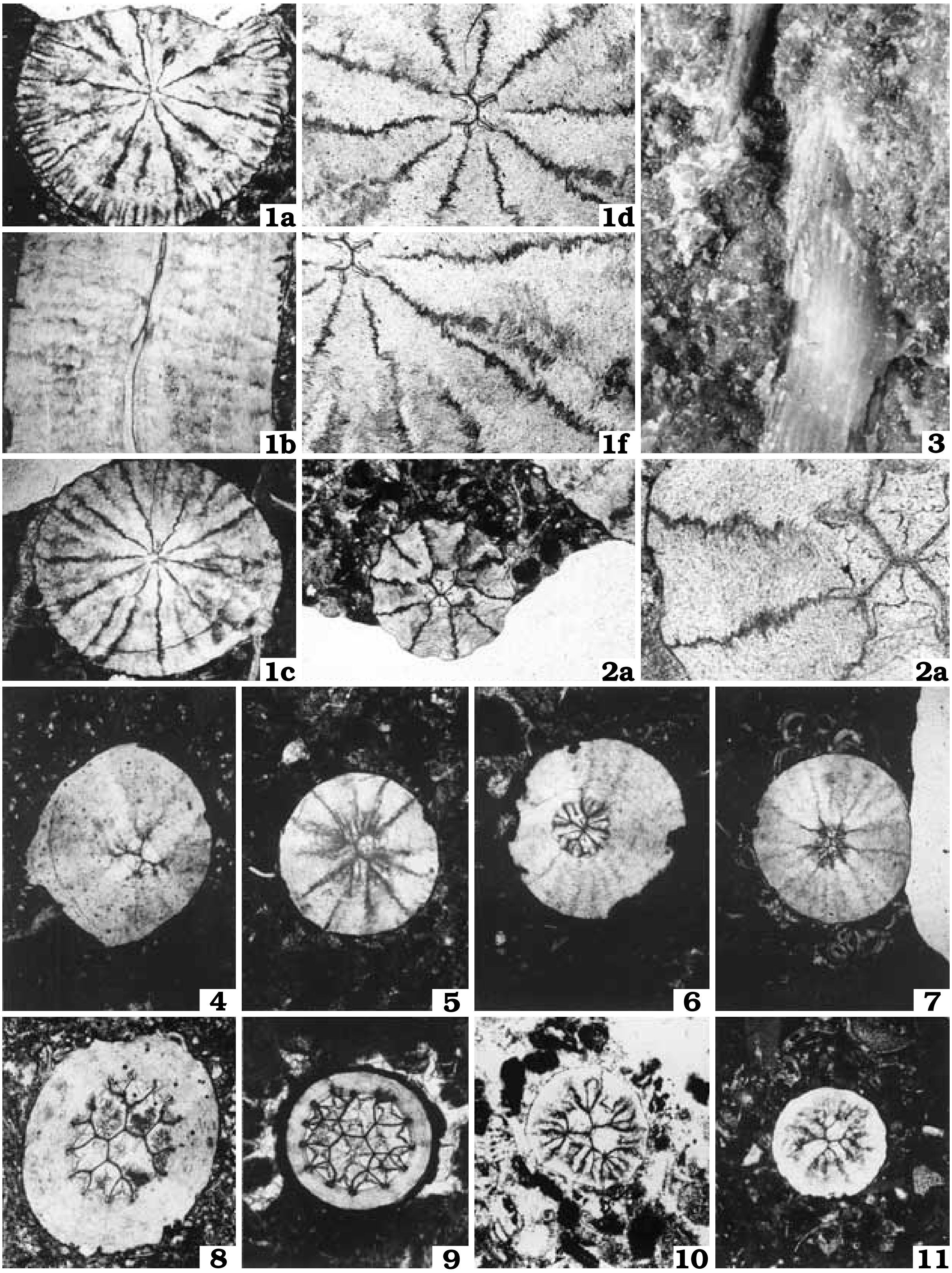
Fig. 2. Specimen UAM Tc-B\02\DII\101\3\2 (paratype), transverse thin sections (a, b), × 16 and × 50, respectively.

Fig. 3. Specimens UAM Tc-B\02\DII\101\3\1 (holotype) and UAM Tc-B\02\DII\101\3\2 (paratype) embedded in limestone. External surface of specimens reveals wavy character of external wall, × 8.

Oligophylloides pachythecus Różkowska, 1969 43

Dzikowiec, conodont *Palmatolepis expansa* or *Siphonodella praesulcata* Zone.

Fig. 4. Specimen UAM Tc-B\02\DII\55, Dzikowiec, exposure 2. Transverse thin section, × 16
Fig. 5. Specimen UAM Tc-B\02\DII\57, Dzikowiec, exposure 2. Transverse thin section, × 16.
Fig. 6. Specimen UAM Tc-B\02\DII\58, Dzikowiec, exposure 2. Transverse thin section, × 16.
Fig. 7. Specimen UAM Tc-B\02\DII\65, Dzikowiec, exposure 2. Transverse thin section, × 16.
Fig. 8. Specimen UAM Tc-B\02\DII\70, Dzikowiec, exposure 3. Transverse thin section, × 16.
Fig. 9. Specimen UAM Tc-B\02\DII\68, Dzikowiec, exposure 3. Transverse thin section, × 16.
Fig. 10. Specimen UAM Tc-B\02\DII\101\4, Dzikowiec, exposure 2. Transverse thin section, × 32.
Fig. 11. Specimen UAM Tc-B\02\DII\59, Dzikowiec, exposure 2. Transverse thin section, × 16.


1a
1d
1b
1f
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1c
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11

INDEX OF GENERIC AND SPECIFIC NAMES

Explanation to index: * — text-fig., bold — description