A C T A P A L A E O N T O L O G I C A P O L O N I C A

Vol. 25 1980 No. 3—4

MARIA RÓŻKOWSKA *

ON UPPER DEVONIAN HABITATS OF RUGOSE CORALS

RÓŻKOWSKA, M.: On Upper Devonian habitats of rugose corals. Acta Palaeont. Polonica, 25, 3/4, 597—611, January 1981.

Frasnian deposits in Poland are mostly organogenic, forming biostromes and bioherms. The latter should be considered as reefs, because they are rigid, continuous structures, elevated above the sea floor. In the Holy Cross Mts they form a chain along the Dyminy anticline. Some communities of these bioherms are preserved *in situ*. The fauna in biostromes is mostly redeposited a short distance from the site of life. Depositional environments changed in the uppermost Frasnian becoming more terrigenous. The lower Famennian is characterized by intercalations of marly limestones and shales containing small horn-shaped corals, blind trilobites and small bivalves. Upper Famennian depositional environments were variable. External morphology of corals, shape of their calices, ornamentation of septa and arrangement of skeletal elements reflect their habitats.

K e y w o r d s: corals, Rugosa, habitats, depositional environments, Upper Devonian.

Received: January 1980.

* Prof. M. Różkowska died on June 20, 1979.

INTRODUCTION

The study summarizes the 25 years of the author's field and laboratory observations upon the rugose corals. Several data were adopted from other geologists and palaeontologists (Ozonkowa 1961; Osmólska 1962; Szulczewski 1971; Różkowska and Fedorowski 1972). In addition to the observations collected in the Holy Cross Mts, a single outcrop from the Cracow region was also discussed as being very rich in corals. The morphology of corals was discussed in terms of their adaptation to the environment. The adaptive characters are reflected in shape of corallites and calices, ornamentation of septa and arrangement of skeletal elements.

Figures were designed and drawn in the early sixties by Dr. J. Fedorowski on the basis of the author's information and suggestions. Fig. 1 was afterwards adopted to the Lecompte's (1967) bathymetric zones.

BATHYMETRIC ZONES AND THE REEF CONCEPT

According to the fauna and the type of sediment Lecompte (1967) distinguished 5 bathymetric zones. An arrangement of some of the fauna in four of them is shown on fig. 1.

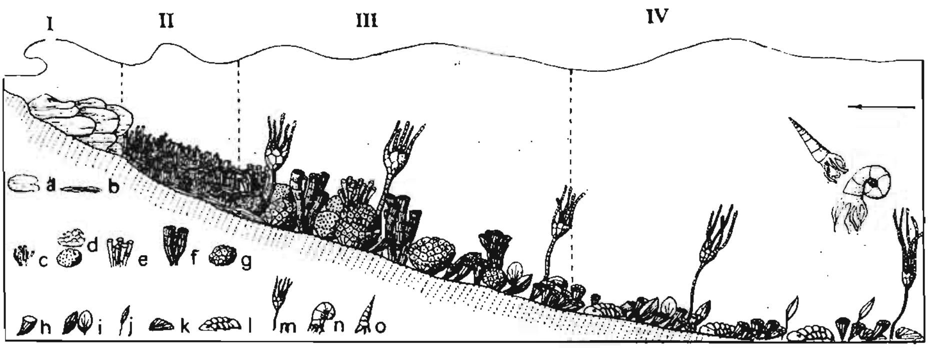

Fig. 1. The bathymetric zones and fauna of Frasnian seas in the Holy Cross Mts., adopted to Lecompte's (1967) zonation. *I* turbulent zone, *II* near turbulent zone, *III* subturbulent zone, *IV* quiet water zone; Stromatoporoidea: *a* massive, *b* plate-like, *c* branching; Tabulata: *d* massive, *e* branching; Rugosa: *f* branching, *g* massive, *h* solitary; brachiopods: *i* articulate, *j* inarticulate; *k* bivalves; *l* trilobites; *m* crinoids, *n* goniatitids; *o* nautiloids.

1. The turbulent zone, characterized by pure limestones with almost no clay minerals admixture. The fauna (and flora?) is dominated by large massive Stromatoporoidea and large colonies of Tabulata. Massive and branching rugose corals are less common. Krebs (1967) was of the opinion that lamellar Stromatoporoidea rather than the massive ones were best adopted to the turbulent water. The present author, however, follows the opinion of Belgian geologists.

2. The near-turbulent zone. Lamellar and branching Stromatoporoidea, Rugosa differentiated in shape and branching or plate-like Tabulata are embedded in slightly argillaceous limestones. In this zone the activity of waves is less strong than in the former one.

3. The subturbulent zone. Large solitary Rugosa dominate in marls and marly limestones. Branching Tabulata are rare and Stromatoporoidea do not occur. Weak traces of wave activity are detectable.

4. The quiet water zone. Small solitary corals, trilobites and bivalves occur in marly shales and shales. This zone is just below wave base.

5. The deep water zone. Rare tentaculitids and ostracodes occur is shales.

As shown by the listed bathymetric zones, rugose corals could live in comparatively deep water (zone 4). They were the most abundant and dominative group in the subturbulent zone, which was too deep for stromatoporoids. The turbulent zone, densely colonized by the latter, was much less favourable for corals. The dominant position of Stromatoporoidea in shallow water and their complete absence in deep and muddy water may confirm Kaźmierczak's (1976) opinion of their cyanophycean nature.

The reef problem has been the subject of many discussions. In accordance to Lowenstam's definition, accepted by Hill (1970), reef is a rigid structure, continuous in nature, resistant against wave activity and elevated above the sea bottom. This definition includes bioherms but excludes biostromes as reef structures. Lecompte (1967) reconstructed Palaeozoic reefs as structures initiated by rugose corals. The reef base produced by them was then colonized by Stromatoporoidea, which formed a continuous reef framework. Lecompte and other Belgian geologists (e.g. Tsien 1971; Coen-Aubert 1973) considered both bioherms and biostromes as reefs. Krebs (1967) distinguished two kinds of massive limestones (Massenkalk) in the Rheinische Schiefergebirge: 1. The bedded limestones: biostrome-like limestones deposited on shelves with no definite structures being formed by stromatoporoids and corals. 2. The massive limestones, considered by him as reefs because of a kind of framework formed in them by the above mentioned organisms. Fragmented remains of organisms were trapped within the structure and the small holes between them were filled with limy mud and calcite. Scrutton (1977) did not consider the coral-stromatoporoid structures of south Devon to be reefs. According to him, only structures analogous to the Recent ones should be considered as reefs.

According to Hubbard and Pocock (1972) rugose corals often were unattached and did not form ecological reef communities.

THE UPPER DEVONIAN CORAL-BEARING DEPOSITS IN THE HOLY CROSS MOUNTAINS

FRASNIAN

The Frasnian deposits in the south-western and south-eastern parts of the Holy Cross Mts were developed both as biostromes and bioherms. An appearance of a given form was conditioned by the tectonic regime of the sea bottom. Biostromes were formed on a shelf area while bioherms have been developed in basins as a reaction of organisms against the negative tendency of the sea bottom. A chain of biohermal hills (now in the area of Kielce), such as Szczukowskie Górki, Karczówka, Psie Górki, Kadzielnia and others appeared along the Dyminy ancticline margin as a result of that tendency.

1. Kadzielnia

Lower and Middle Frasnian. — Bioherms of this age, built up of light biomicrite and surrounded by darker interbiohermal limestones are the oldest deposits cropping out in the Kadzielnia quarry. Pajchlowa and Stasińska (1963) distinguished three communities in some of these bioherms. In the lower (I) and upper (III) communities there occur small branching stromatoporoids (*Stachyodes* sp. and *Amphipora* sp.) and small colonies of *Actinostroma devonense* Lecompte as well as solitary rugose corals, such as *Pterorrhiza czarnockii* (Różkowska) and *Temnophyllum isetense* (Soshkina). The horn-shaped Rugosa possessing densely packed skeletal elements and septa ornamented by button-like trabeculae were cemented to the sea bottom, as shown by their well developed talons and

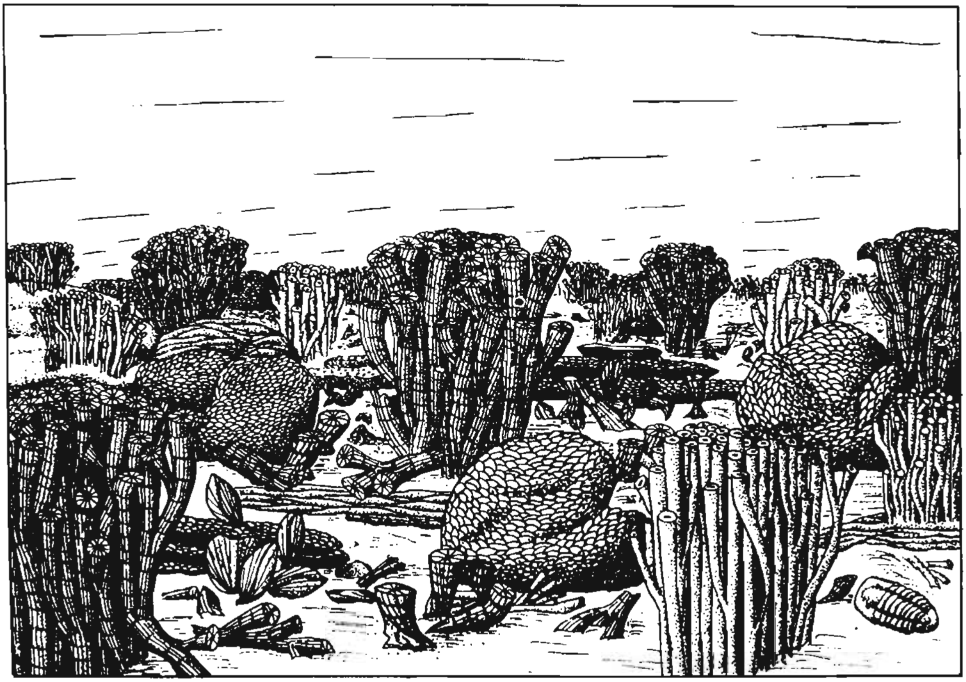

Fig. 2. The *in situ* community of the subturbulent zone of one of the Lower Frasnian bioherms in the Kadzielnia quarry. Explanation as in the fig. 1.

attaching processes. Abundant tentacles (corresponding with the large number of septa) were able to clean out the fine-grained limy mud from the calices. The concave tabularium of the branching coral, *Disphyllum monozonatum* Soshkina indicates activity of its muscles. Colonies of this species became elevated high above the sea bottom, making the food infiltration easier. The described communities were probably characteristic of the near-turbulent zone.

Large massive colonies of stromatoporoids are the most abundant component of the middle (II) community of Pajchlowa and Stasińska (1963). Kaźmierczak (1971) calculated that these colonies form 30% of the rock volume. *Stromatoporella mudlakensis* (Galloway), *Stictostroma socialis* (Nicholson), *Actinostroma devonense* Lecompte and other species with individual colonies reaching up to 1.5 m in diameter are common. Stromatoporoids were accompanied by massive (*Alveolites suborbicularis* Lamarck) and branching (*Thamnopora reticulata* (de Blainville)) colonies of Tabulata and by rare rugose corals. Abundant algae, mainly *Calcisphera*, and peloids were also reported. Such a community is here considered as characteristic of the zone of turbulent water (zone 1 of Lecompte 1967).

In the middle part of the Kadzielnia quarry (Różkowska 1953: point 9) the present author investigated a community preserved *in situ* (fig. 2). Branching colonies of Rugosa, such as *Thamnophyllum monozonatum* Soshkina and *Disphyllum kostetskae* (Soshkina), solitary rugosans of the genus *Pterorrhiza*, massive colonies of tabulates (*Alveolites suborbicularis* Lamarck, *A. parvus* Lecompte), branching stromotoporoids (*Stachyodes* sp. and *Amphipora* sp.), brachiopods and gastropods occur there in large number. Szulczewski (1971) described sediment of this outcrop as micritic limestone with algae and small bioclasts. Holes in the limestone were filled with calcite. The described part of the bioherm has been developed in quiet water of the euphotic zone, possibly below the turbulent zone. In the present author's opinion the bioherm of Kadzielnia should be considered as a Palaeozoic reef with a framework produced by stromatoporoids and corals.

Upper Frasnian. — In the upper *Ancyrognathus triangularis* and lower *Palmatolepis gigas* Zones (F2i-j according to the Belgian nomenclature) characteristic cracked, almost brecciated, limestones are widely distributed. These beds form small bioherms. The limestones are micritic with abundant and often fragmented flat colonies of *Phillipsastrea macrommata* Roemer, lamellar stromatoporoids and numerous algae.

Similar limestones called by Tsien (1967) "red facies with *Phillipsastrea*" terminate the Devonian reef facies in Belgium. According to Tsien (1971) *Phillipsastrea* characterizes deeper water, while Lecompte (1970) considered that the red limestones with *Phillipsastrea* had been deposited in quiet water in the form of bioherms. Scrutton (1977) considered the red biohermal limestones to be the youngest massive limestones in southeastern Devon. According to him these limestones and the shales that capped them characterize the beginning of an increase of the sea depth in Devon.

The present author is of the opinion that *Phillipsastrea* with its septotheca of a "partition" type (Fedorowski and Jull 1976) was less resistant against wave activity than the epithecate coral *Marisastrum*. Calices with wide margins and dense ornamented septa indicate ability of the polyps to clean themselves from the accumulation of calcareous mud. Red limestones with *Phillipsastrea*, similar to these of Kadzielnia, were developed also on Wietrznia and Psie Górki.

2. Wietrznia

Lower Frasnian. — The Wietrznia quarry, located south of the Kadzielnia quarry begins an eastewardly prolonged chain of the Upper Devonian biostromes. The biostromes of Wietrznia are built of thickly-bedded limestones variable in colour, divided by thin layers of bituminous shales. Limestones are almost pure, biogenic, coarse-grained. Only locally they may contains some argillaceous admixture. They were deposited on the shelf area, which was inhabited by rich autochtonous fauna and flora. In the upper part of the biostrome, in turbulent water, large (over 1 m in across), massive colonies of stromatoporoids dominated. Massive colonies of tabulates (*Alveolites suborbicularis* and *A. crassus*) as well as less abundant rugosans, crinoids, clusters of brachiopods (*Atrypa* sp., *Schizophoria* sp.) accompanied the stromatoporoids. Algae, such as *Solenopora, Girvanella* and *Zeapora* and their peloids were also abundant. The schematized reconstruction (fig. 3) shows a qualitative and quantitative composition of the fauna collected by the present author (Różkowska 1953: points 1 and 8). Thanatocoenotic accumulations produced by waves were omitted. The age of the biostrome discussed was determined by Szulczewski (1970) as possibly *Polygnathus asymmetricus* Zone (Lower Frasnian).

Middle Frasnian. — Conodonts are very rare in biostromes, which has made identification of their exact stratigraphic position difficult. The basal sediments of the biostrome belong to toIα (Szulczewski 1971). This makes it possible to predict that the deposits outcropping to the north are of the toIβ zone and the topmost ones already belong to the toIγ zone, i.e. to *Palmatolepis gigas* or F3 zone according to the Belgian division.

In point 13 (Różkowska 1953) light and dark biocalcarenite and breccia are locally interbedded with crinoidal limestones. Large bioclasts of *Marisastrum sedwicki, M. mirabillis, Pterorrhiza ultima, Tabulophyllum densum,* as well as larger or smaller fragments of tabulates, lamellar stromatoporoids, and abundant brachiopods occur in the breccia. These bioclasts are accompanied by algae (the cosmopolitan *Calcisphera* and peloids). The biogenic mass is cemented by coarse-grained calcite. This organic breccia was possibly deposited in the intertidal zone, in well aerated, highly dynamic water. The rugosan fauna possibly lived close to the place of their deposition in the near-turbulent zone. This is indicated by their densely packed skeletal elements and thick walls and by a lack of abrasion. Some solitary rugosans have their proximal ends preserved.

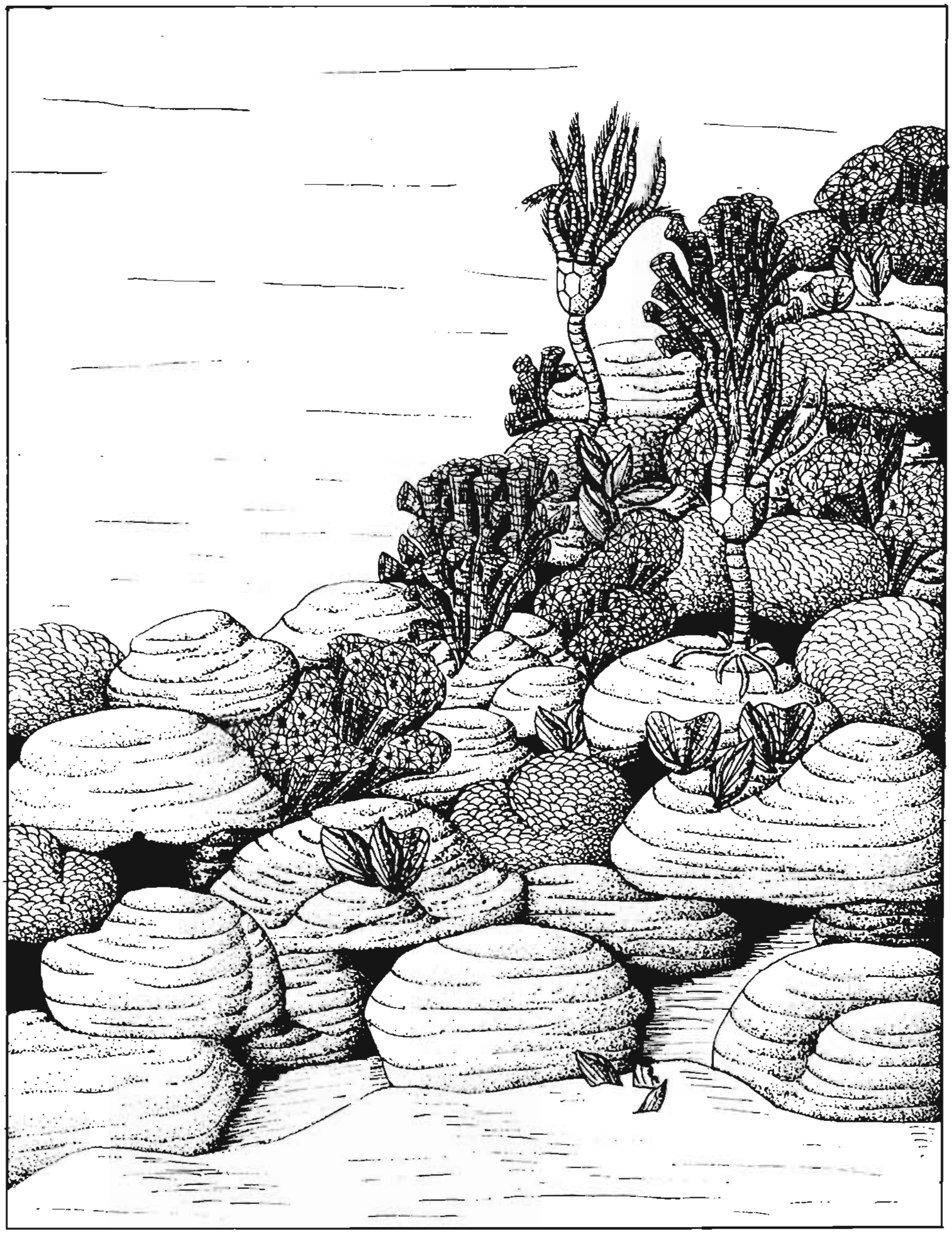

Fig. 3. Reconstruction of the redeposited community found in the Upper Frasnian deposits of the Wietrznia quarry. Explanation as in the fig. 1.

Upper Frasnian. — In Wietrznia quarry (point 15 of Różkowska 1953, *Ancyrognathus triangularis* Zone = toIγ) there occurs a small bioherm built of red, nodular, pelitic limestone and biomicrite with *Phillipsastrea ananas* and the fauna similar to that of the analogous stratigraphic level of the Kadzielnia quarry. Lecompte (1970) pointed out the presence of similar small bioherms with *Phillipsastrea* in Neuville and Philippeville. He considered these structures as characteristic of the subturbulent zone. The fauna of the bioherm of Wietrznia is very differentiated. Several species of *Phillipsastrea* and *Frechastraea,* massive and branching tabulates were identified. Calcareous algae, such as *Solenopora, Calcisphaera, Sphaerocodium* occur in large numbers contrasting well with the dark background of the rocks. The automorphic quartz crystals and concentrations of chalcedony are spread throughout the rocks. Polańska (*in* Różkowska 1953) considered silicification of the sediment as diagenetic. Small, flattened colonies of *Phillipsastrea* with delicate skeletons and with no dividing walls confirm Lecompte's (1970) opinion as to the quiet depositional environment of these limestones.

Red limestones with *Phillipsastrea* are covered (point 19 of Różkowska 1953) with the deeper sea deposits of the top part of F3 zone, developed as coarse-grained limestones with rare bioclasts and with concentrations of calcite and *Calcisphaera* in places. The community of Rugosa is similar to that found in point 15 of Różkowska (1953) but in addition to *Phillipsastrea* and *Frechastraea, Smithicyathus lacunosus* (Gürich), *Tabulophyllum* cf. *priscum* (Münster), a rare, astreoid colonial coral *Scruttonia bowerbanki* (M.-Edwards et Haime), large solitary *Kowalaephyllum poculum* Różkowska and weakly colonial *Iowaphyllum oliveri* Różkowska are present. *Kowalaephyllum,* a large, cylindrical coral with its wide, flat calice, numerous smooth septa and horizontal tabulae was (according to the criteria of Hubbard and Pocock 1972) a passive inhabitant of quiet environment. A community similar to that characterized above is also known to occur in Kowala and on the Karczówka hill. The presence of *Phillipsastrea* may indicate the neighbourhood of a bioherm, but the community itself occupied possibly the subturbulent zone. Osipova *et al.* (1971) described similar communities from fairly deep Devonian seas in the USSR.

3. Bolechowice

Upper Frasnian. — Slightly westward of the Bolechowice quarry, which in turn is located in the south-eastern part of the Gałęzice syncline, there occurs a biostrome built up with amphiporoid limestones at the bottom, and light, so-called "sugar-like", stromatoporoid limestones in the upper part. Stromatoporoids, mainly *Atelodictyon pseudocolumnare* (Riabinin) and *Ferestromatopora parksi* Stern, form spherical colonies preserved *in situ* in life position. Such colonies appear in the case of an increase of water salinity and activity in the turbulent zone (Tsien 1971). Holes between individual colonies were filled in with chemical limestone. Stromatoporoids were accompanied by rare branching colonies of *Smithicyathus lacunosus* (Gürich), branching tabulate coral *Syringopora* sp. and molluscs *Megalodon* sp. and *Loxonema* sp. The rock is crowded with small bioclasts of algae, foraminifera, stromatoporids and crinoids. Bioclasts and intraclasts were cemented by diagenetic calcite crystals (Polańska *in* Różkowska 1953).

4. Kowala

Upper Frasnian. — This outcrop, belonging also to the Gałęzice syncline, is located close to the Kielce-Busko railway. Abundant alga *Calcisphaera laevis*, brachiopods (mainly *Hypothyridina cuboides*) and corals (rugosans and tabulates) occur in medium- and thinly-bedded, fine-grained limestones intercalated with pelitic limestones. Corals are almost completely silicified due to the precipitation of silica derived from the dissolved spicules of sponges. Small colonies of *Phillipsastrea* and large solitary *Kowalaephyllum excelsum* Różkowska, *Fedorowskicyathus similis* Różkowska and *Iowaphyllum oliveri* Różkowska are most common. The community characterizes the subturbulent zone. Similar communities are known to occur in Wietrznia quarry (Różkowska 1953: point 19 and in the Upper Frasnian of Philippeville in Belgium.

5. Sobiekurów

Upper Frasnian. — This quarry is located south of Opatów in the south-eastern part of the Kielce-Łagów synclinorium. The Upper Frasnian age of the thickly-bedded, light- and dark-gray limestones quarried there was determined mainly on the basis of abundant *Phillipsastrea*. Large, massive colonies of *Phillipsastrea plantana* Różkowska embedded in biocalcarenite were found in the middle part of the geological section. Higher up, the biocalcarenite changes into cryptocrystalline autochthonous limestone, identified by Ozonkowa (1961) as a coralline biolite. It crops out at the top of the northern side of the quarry, forming a biostrome with the coral community resting *in situ*. Small, flat colonies of *Phillipsastrea dybowskii* Różkowska, resting mainly in growth position, are most common. *Alveolites suborbicularis* Lamarck and fragmented, branching colonies of tabulate corals are less abundant. The large admixture of clay minerals in the limestones explains the absence of stromatoporoids. Water was transparent enough for *Calcisphaera*, which is comparatively abundant there. The small dimensions of the coral colonies indicate that they tolerated these ecological conditions with difficulty. The impoverished coral fauna and a complete lack of goniatites differentiate the discussed fauna from that of the western part of the Holy Cross Mts. This is possibly because of the location of the area on the periphery of the Upper Frasnian sea.

FAMENNIAN

1. Kadzielnia

The Famennian deposits of Kadzielnia quarry were intensively studied by several authors. Wolska (1967) studied the conodonts and established stratigraphic divisions of the deposits between the *crepida* (= to IIα) and *quadrantinodosa* (= to IIIα) Zones. Różkowska (1969) described very rich and diversified corals. Szulczewski (1971) reconstructed the depositional

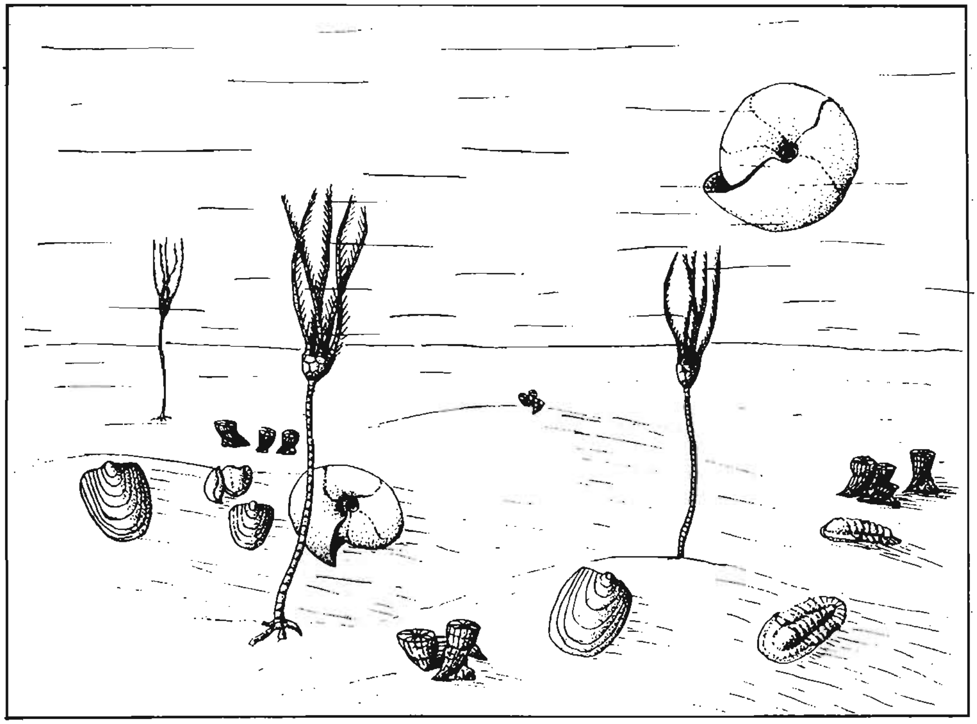

Fig. 4. The *in situ* community of the Lower Famennian in the Kadzielnia quarry. Explanation as in the fig. 1.

environments and described the petrography of these deposits. Ecological adaptations of the Rugosa are briefly discussed below.

The Upper Frasnian/Lower Famennian boundary was marked by a general change in depositional environments and faunal communities.

Deposition of light, almost pure, often bioclastic limestones, accumulated in clean, well aerated, transparent water of the Frasnian seas was replaced by the Lower Famennian accumulation of chiefly terrigenous sediments deposited in quiet, poorly aerated basins. Szulczewski (1971) found a contact of the Lower Famennian *crepida* Zone with three kinds of Frasnian limestones: coral-stromatoporoid massive limestone, detrital limestone and cephalopod limestone. The present author distinguished a contact with a fourth kind of Frasnian limestone, namely the red, *Phillipsastrea*-bearing limestone, occurring in the north-eastern side of the quarry.

The Famennian sedimentation began with gray micritic limestone, containing *Petraiella centralis* Różkowska, *Cheiloceras* sp., *Dinichthys ceterus* Kulczycki and crinoid columnals. The higher series consists of monotonous marly limestones intercalated with shales. The limestones are thinly-bedded, very fine-grained, almost pelitic with aggregations of dark-brown iron oxides and with small, recrystallized bioclasts (S. Cebulak, M.Sci., *in litt.*). The dark-gray, slightly calcareous or marly shales contain aggregations of iron oxides and sulphids. A poor fauna occurs chiefly in the lower part of the series (fig. 4). Small solitary rugose corals were accompanied by comparatively abundant vermitids, the blind trilobite *Cyrtosymbole pusilla* (Gürich), rare crinoids and by the inarticulate brachiopod *Orbiculoidea kadzielnensis Biernat*. The latter is considered as indicating a poorly aerated environment (Biernat 1970). The listed fauna colonized the muddy sea floor covered by algal meadows, the remains of which coloured the shales dark. The conditions described can most probably be compared to the zone IV (quiet water) of Lecompte (1967).

The exclusively solitary, small, subcylindrical, often rejuvenated rugose corals are monotonous taxonomically. Species of the genera *Amplexocarinia, Petraiella, Nalivkinella, Kielcephyllum* and *Kozlowskinia* are most common, while these of *Gorizdronia, Guerichiphyllum* and *Oligophylloides* (Heterocorallia) are fairly rare. Individual corallites are often preserved *in situ* in growth position, being embedded vertically in the sediment. Rare overturned specimens do not show any traces of transportation. A majority of specimens have attaching surfaces or processes developed. Sometimes they are flat and wide as in *Oligophylloides* which attached itself vertically to the sea bottom. More commonly attaching processes are located on the convex sides of the specimens. The process of rejuvenescence, observed e.g. in *Kielcephyllum confluens* Różkowska, *Guerichiphyllum parvum* Różkowska and *Petraiella centralis* Różkowska led always to the reduction of their diameter. Such a reduction was most possibly conditioned by a temporary deterioration in supply of nutrients and oxygen or by an increase of mud admixture in the water. Axial tubes, developed at least in the juvenile stages, are present in almost all rugosans of the community discussed. Their skeletal elements are thin, dissepiments rare and tabulae widely spaced (e.g. *Guerichiphyllum parvum* Różkowska).

In addition to corals of such morphology, there occur also corals morphologically complex and phylogenetically advanced, such as *Kielcephyllum densum* Różkowska. Such corals were much more abundant in the subturbulent zone, however.

2. Gałęzice village, Besówka hill

Upper Famennian. — The conodont zones, from lower *quadrantinodosa* to *costatus*, were distinguished there by Wolska (1967) in a very condensed geological section. Trilobite and coral faunas of these zones and their habitats were discussed by Osmólska (1962) and Różkowska (1969) respectively. Famennian deposits rest there on the Givetian (or Lower Frasnian) amphiporoid limestones. The Famennian began with biomicrites (Różkowska 1969: fig. 3, beds 10-6) covered by intercalated limestones, marls and shales (beds 5-1). In the lowermost biomicrites, enriched with quartz grains and chalcedony, the reworked and disorderly deposited fauna occurs. Cephalopods, ostracodes, trilobites, molluscs, rugosans and abundant algae *Solenopora* and *Calcisphaera* were identified by the authors. These beds were considered as deposited on submarine thresholds (e.g. Pajchlowa 1959).

The rugosan community is completely different from that of the Lower Famennian in the Kadzielnia quarry. Representatives of the families Metriophyllidae, Cyathaxoniidae and Laccophyllidae dominated and Heterocorallia were abundant. All specimens were redeposited, often damaged, but none show any trace of rolling. They possibly lived in the close vicinity of the place of deposition in an environment similar to the facies reconstructed by Fedorowski (1971) in the Upper Viséan of Gałęzice.

Among the most abundant rugose corals described by Różkowska, (1969) *Metriophyllum soshkinae, Syringaxon* aff. *cyathaxoniaeformis* and *Cyathaxonia cornu* posses thick skeletal elements, major septa meeting in corallite axes, deep calices, axial tubes or columellae and talons. Such corals were inhabitants of turbid water and were strongly attached to the substrate. Other species, such as *Neaxon regulus, Hillaxon vesiculosus* and *Czarnockia obliqua* have no talons, but possess thick skeletal elements, widely open calices, and strongly curved, almost sphaerical shape. They might have rested unattached on the sea bottom. Two species of Heterocorallia, namely *Heterophyllia famenniana* Różkowska and *Oligophylloides tenuicinctus* Różkowska might have been suspended among algae, while the thick-walled *Oligophylloides pachythecus* Różkowska with its wide talon and vermitid-like shape was probably attached to the sea bottom in a vertical position. Such a position was possible only in a well sheltered place, somewhere in a niche of the sea bottom.

THE UPPER FRASNIAN DEPOSITS OF THE SILESIA-CRACOW UPLAND

FRASNIAN

Dębnik

The Upper Frasnian deposits, possibly of the *Palmatolepis gigas* zone are known to occur in a small abandoned quarry Żarnówczany Dół near Dębnik village, north of Krzeszowice. A very rich coral fauna was found there in the interformational conglomerates composed of large, dark-gray intraclasts embedded in dark-brown marly biomicrite. Among the rugose corals *Phillipsastrea macrommata* Roemer, *P. friedbergi* Różkowska and *Frechastraea pentagona* (Goldfuss) are most common. Large massive colonies of *Alveolites taenioformis* Schlüter and *Alveolitella fecunda* (Salée) dominated among tabulates. This is also the type locality for *Debnikiella formosa* Różkowska. Massive colonies of stromatoporoids do not occur. The coral community discussed is similar to those found in the Kielce region of the Holy Cross Mts and especially to point 19 (Różkowska 1953) of the Wietrznia quarry. The original life area of the community was possibly located in the subturbulent but euphotic zone (judging by the presence of *Calcisphaera*). Strong wave activity might have removed fauna from its life position, transported and mixed the uprooted specimens with limestone pebbles to form the interformational conglomerate mentioned.

CONCLUSIONS

The morphology of corals characterizes facies. This is reflected in shape of corallites and calices and in their internal structure.

1. In clean turbulent water all corals possess skeletal elements thick and densely packed. Massive colonies are hemispherical; wide and shallow calices of their corallites contain numerous, distinctly ornamented septa. Frequently branching fasciculate colonies possess corallites united by connecting processes. Calices are shallow with flat bottoms. Strong, compact solitary corals are supplied with well developed attaching surfaces and/or processes.
2. Corals living on the calcareous-muddy bottom in the subturbulent zone all have thin skeletons. Massive colonies are small and flattened. Fasciculate colonies with long corallites branch rarely. Solitary corals, attached to the substrate, are large with wide calices and numerous tabulae and septa.
3. Small, slightly bent, subcylindrical corals attached to the substrate by talons, with rouded, current-ward directed calices, characterize the quiet and shallow water environments of algal meadows.

4. Rugosans found in the calcareous breccia were derived from a shallow neritic zone and possess morphology similar to that characterized in point 1.

5. Rugose corals collected in the Upper Famennian of Gałęzice are invariably solitary, shallow-water forms. They lived on the submarine thresholds attached to the substrate by talons or lay unattached on the sea bottom.

6. Frasnian limestones formed two kinds of structures in the Holy Cross Mountains: 1) the bedded limestones — biostromes, which did not elevate above the sea bottom and 2) vertically continuous, rigid and wave-resistant bioherms, considered by the present author as coral-stromatoporoid reefs. Both these forms were developed in tropical or subtropical seas between palaeolatitudes of 30°N to 30°S.

REFERENCES

BIERNAT, G. 1970. Lower Famennian brachiopods from the Holy Cross Mountains, Poland. — *Acta Palaeont. Polonica*, **15**, 1, 33—56.

COEN, M. et COEN-AUBERT, M. 1976. Conodontes et coraux de la partie supérieure du Frasnien dans la tranchée du chemin de fer de Neuville (Massif de Phillipsville, Belgique). — *Bull. Inst. R. Sci. Nat. Belgique*, **50**, 8, 1—7.

COEN-AUBERT, M. 1973. Facies, conodontes et stratigraphie du Frasnien de l'est de la Belgique, pour servir à une révision de l'étage. — *Ann. Soc. Géol. Belgique*, **95**, 2, 239—253.

FEDOROWSKI, J. 1971. Aulophyllidae (Tetracoralla) from the Upper Viséan of Sudetes and Holy Cross Mountains. — *Palaeont. Polonica*, **24**, 1—137.

— and JULL, R. K. 1976. Review of blastogeny in Palaeozoic corals and description of lateral increase in some Upper Ordovician rugose corals. — *Acta Palaeont. Polonica*, **21**, 1, 37—78.

HILL, D. 1970. The bearing of some Upper Palaeozoic reefs and coral faunas on the hypothesis of continental drifts. — *J. Proc. Roy. Soc. N. S. W.*, **103**, 3/4, 93—102.

HUBBARD, J. A. E. B. and POCOCK, Y. P. 1972. Sediment rejection by recent scleractinian corals: a key to palaeo-environmental reconstruction. — *Geol. Rundschau*, **61**, 2, 598—626.

KAŹMIERCZAK, J. 1976. Cyanophycean nature of stromatoporoids. — *Nature Lond.*, **264**, 5581, 49—51.

— 1971. Morphogenesis and systematics of the Devonian Stromatoporoidea from the Holy Cross Mountains in Poland. — *Palaeont. Polonica*, **26**, 1—150.

KREBS, W. 1967. Reef development in the Devonian of the eastern Rhenish Slate Mountains, Germany. Intern. Symp. Devonian System, **2**, 295—306, Calgary.

LECOMPTE, M. 1967. La Belgique et le Nord de la France. *Ibidem*, **1**, 15—52.

— 1970. Die Riffe im Devon der Ardennen und ihre Bildungsbedingungen. — *Geol. Palaeont.*, **4**, 25—71.

McLAREN, D. J. 1970. Time, life, boundaries. — *J. Paleont.*, **44**, 5, 801—815.

(OSIPOVA, A. I., HECKER, R. F. and BELSKAJA, T. N.) ОСИПОВА, А. И., ГЕККЕР, Р. Ф., БЕЛЬСКАЯ, Т. Н. 1971. Закономерности распространения и смены фауны в поздневизейских и ранненамюрских епиконтинентальных морях Русской платформы — *Тр. Палеонт. Инст. Акад. Н. СССР*, **130**.

OSMÓLSKA, H. 1962. Famennian and Lower Carboniferous Cyrtosymbolinae (Trilobita) from the Holy Cross Mountains, Poland. — *Acta Palaeont. Polonica*, **7**, 53—222.

OZONKOWA, H. 1961. Dewon w profilu Iwaniska-Piskrzyn (Góry Świętokrzyskie). — *Roczn. P. T. Geol.*, **31**, 1, 85—102.

PAJCHLOWA, M. 1959. Zagadnienia stratygrafii i rozwoju facji dewonu w Polsce. — *Przegl. geol.*, **2**, 71, 78.

— and STASIŃSKA, A. 1965. Formations récifales du Dévonien des Monts de Sainte-Croix (Pologne). — *Acta Palaeont. Polonica*, **10**, 2, 249—260.

RÓŻKOWSKA, M. 1953. Pachyphyllinae et *Phillipsastrea* du Frasnien de Pologne. — *Palaeont. Polonica*, **5**, 1—89.

— 1957. Considerations on Middle and Upper Devonian Thamnophyllidae Soshkina in Poland. — *Acta Palaeont. Polonica*, **2**, 2—3, 81—153.

— 1969. Famennian teracoralloid and heterocoralloid fauna from the Holy Cross Mountains (Poland). — *Ibidem*, **14**, 1, 5—187.

— and FEDOROWSKI, J. 1972. Genus *Disphyllum* de Fromentel (Rugosa) in the Devonian of Poland. — *Ibidem*, **17**, 3, 265—340.

SCRUTTON, C. T. 1977. Facies variations in the Devonian limestones of eastern South Devon. — *Geol. Mag.*, **114**, 3, 165—248.

SZULCZEWSKI, M. 1971. Upper Devonian conodonts, stratigraphy and facial development in the Holy Cross Mountains. — *Acta Geol. Polonica*, **21**, 1, 1—129.

— 1971. The Middle and Upper Devonian reef-complexes of Belgium. — *Petrol. Geol. Taiwan*, **8**, 119—172.

TSIEN, H. 1967. Distribution of rugose corals in the Middle and Upper Devonian (Frasnian) reef complex of Belgium. Intern. Symp. Devonian System, **2**, 273—293, Calgary.

WOLSKA, Z. 1967. Górno-dewońskie konodonty z południowo-zachodniego regionu Gór Świętokrzyskich — *Acta Palaeont. Polonica*, **12**, 4, 363—435.