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Upper Devonian conodonts, stratigraphy and facial development in the Holy Cross Mts

ABSTRACT: The problems of stratigraphy, facial differentiation and the history of sedimentation of the Upper Devonian in the western part of the Holy Cross Mts (Central Poland) are the subject of the paper. The stratigraphical subdivision have been based on the conodonts. All platform conodonts and a few other, stratigraphically important species have been monographed. Of the 80 species described (together with subspecies) which are assigned to 11 genera, the following five species or subspecies are new: *Ancyrodella sinecarina* sp. n., *Palmatolepis circularis* sp. n., *Palmatolepis minuta wolskae* subsp. n., *Polygnathus sinuosus* sp. n. and *Pelekysgnathus?* sp.n. The conodont zonation, adopted for the correlation of profiles, enabled the solution of several problems of regional stratigraphy. The history of the Frasnian and Famennian sedimentation has been restored on the basis of their facial (including microfacial) analysis.

INTRODUCTION

It has already been in the last century that the Holy Cross Mts were one of the most grateful areas of geological studies on the Upper Devonian deposits. An impressive advance in the Upper Devonian stratigraphy all over the world, in particular that based on conodonts, along with the development of the sedimentology of calcareous deposits, opened new prospects of extending the knowledge of the stratigraphy, sedimentary conditions and facial development of the Holy Cross region. Since 1966 the author's efforts have been devoted to these problems, although some of the observations have even been made earlier. The studies included the western part of the Holy Cross Mts (cf. Fig. 1), abounding in convenient outcrops and presenting a full range of facial differentiation of the Upper Devonian deposits. Preliminary results on submarine gravitational processes (slumps, turbidites, etc.) in the sedimentation of the Upper Devonian limestones have been presented in a previous publication (Szulczewski 1968). The present paper is devoted to a more extensive subject-matter and its aim is to draw a picture of the facial differentiation, dynamic interdependence of particular facies and evolution of the facies in time. The analysis of these problems is based on stratigraphy which follows from the occurrence of conodonts. For this purpose, about 200 samples have been taken from which about 4,800 conodont specimens have been obtained and recognized as stratigraphically important and useful for a detailed zonation in the region.

Some problems concerning the sedimentation and diagenesis of the Upper Devonian deposits in the Holy Cross Mts, still require a separate elaboration. Such problems as the origin of synsedimentary fissures developed in massive limestones and filled with laminated limestones or a problem of the sedimentary boudinage will be discussed in forthcoming papers.

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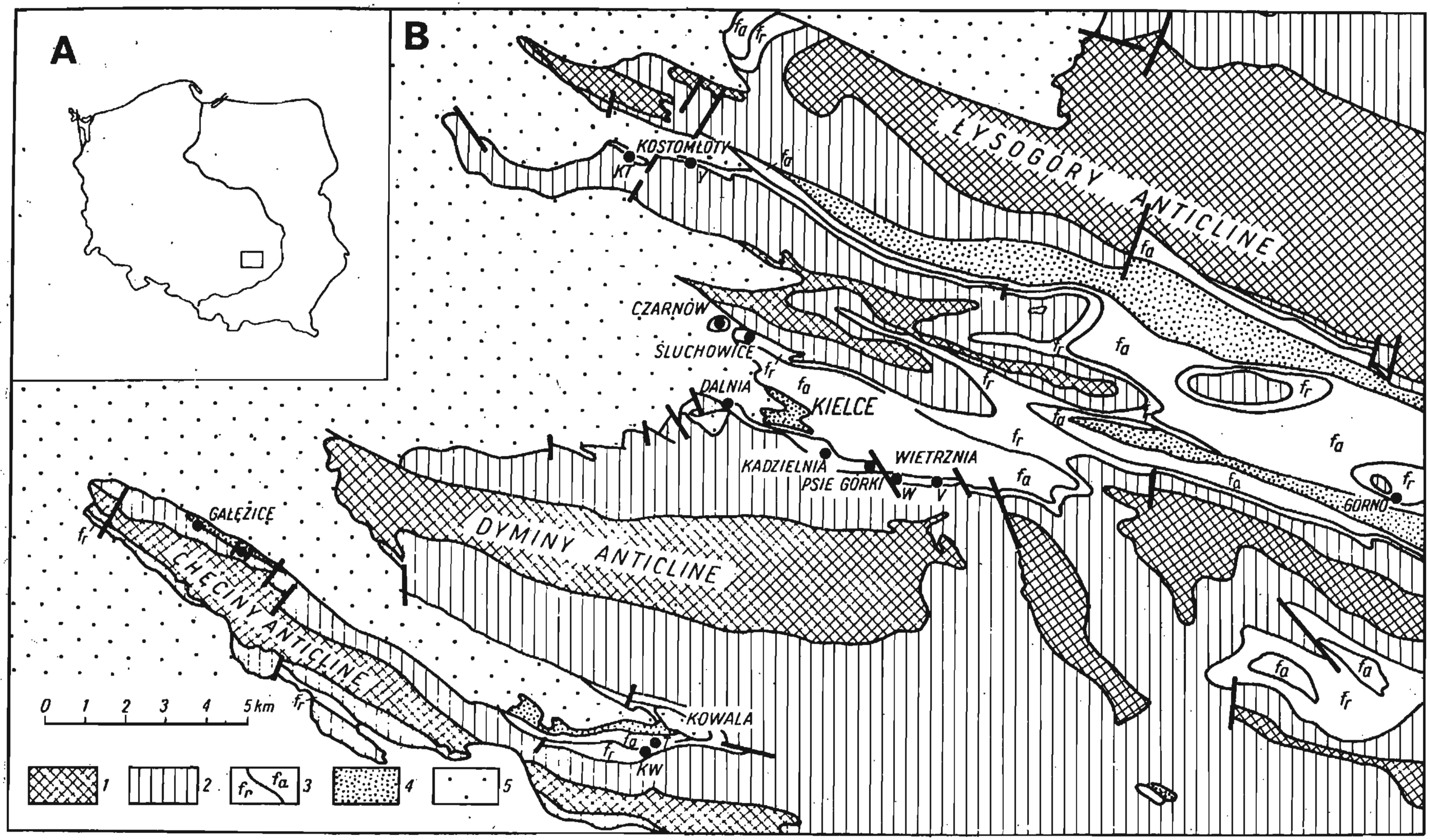
GENERAL SITUATION OF THE DEPOSITS

The present paper concerns the Upper Devonian of the western part of the Holy Cross Mts (Fig. 1) from their western end to the Daleszyce-Górno line. This area abounds in outcrops situated near each other. The Upper Devonian is part of the Variscan folded units whose axes run, on the whole, from WNW to ESE. This results in a steaked trace of the Devonian outcrops, connected with the strike of tectonic structures. The Famennian, susceptible to weathering, usually appears in synclinal zones, in which it still happens to be overlaid by Culmian deposits, discordantly resting the Zechstein, or the Bunter sandstone. On the other hand, the Frasnian occurs usually in the limbs of folds, and chains of hills develop mostly along Frasnian outcrops. In the north, these are Kostomłoty hills which run along the southern limb of the Miedziana Góra syncline. A successive southward belt of the Frasnian outcrops appears in the NE limb



General map of Poland (*A*) and geological sketch map (*B*) of the western part of the Holy Cross Mts (after Czarnocki 1938; simplified) showing location of profiles and collecting localities for conodonts (abbreviations: *KT* western part of the Kostomłoty hills, *Y* eastern part of the Kostomłoty hills, *W* Wietrzania I quarry, *V* Wietrznia II quarry, *KW* railroad cut at Kowala, *T* Kowala quarry — the same symbols are used in the tables of distribution and frequency of conodonts)
1 Cambrian, Ordovician and Silurian, 2 Lower and Middle Devonian, 3 Frasnian (*fr*) and Famennian (*fa*), 4 Lower Carboniferous, 5 post-Variscan cover (Zechstein — Upper Cretaceous)

of the Kielce syncline (Czarnów, Śluchowice) and the next in its SW limb in which it forms the Kadzielnia range (Dalnia, Karczówka, Kadzielnia, Psie Górki, Wietrznia and Zagórze). These both chains of the Frasnian are separated from each other by the Famennian of the Kielce syncline. The next Upper Devonian outcrops occurring to the south are considerably distant in this direction, as they appear as far as the SE end of the Gałęzice-Bolechowice syncline (Kowala, Bolechowice, Gałęzice). The last chain of the Upper Devonian runs in the SW limb of the Chęciny syncline along the hills which close from the SW the Palaeozoic core of the Holy Cross Mts (Góra Zamkowa, Miedzianka). A belt-like trace of most outcrops of the Upper Devonian makes difficult the reconstruction of the facial pattern. If in some regions (Kostomłoty and Kadzielnia hills) outcrops closely adjoin each other along the strike and enable a detailed reconstruction of the facial pattern, in the direction perpendicular to the axes of folds, in zones sometimes many kilometers wide, the Upper Devonian deposits are, in anticlinal parts, either eroded (*e.g.* Dyminy anticline), or hidden in synclines under the Lower Carboniferous. The extent of the outcropping of the Frasnian and Famennian is not identical. Frasnian limestones are exploited in numerous, frequently large quarries. The marly Famennian is usually exposed over the top of the Frasnian exploited. Hence, the lowermost Famennian is the most approachable for observations.

INTRODUCTION TO STRATIGRAPHY

Historical review

The presence of the Devonian in the Holy Cross Mts was found by Murchison (1845, vide Czermiński 1960). In the environs of Kielce, the Upper Devonian was distinguished by Roemer (1866) who divided it into two units: Kadzielnia limestone, and limestones and marls with goniatites which, in his opinion, corresponded to the German *Cypridina shales*. The works of Zeuschner (1868), Pusch (1881), Michalski (1883) and Siemiradzki (1887, 1888) extended the knowledge of the Upper Devonian, but an evidently considerable progress was due to Gürich (1896) who contributed both on its fossils and its stratigraphy. Gürich (1896) thoroughly studied the fossils of the Kadzielnia limestone and, in addition, distinguished two other units of the „*Unteres Oberdevon*" (that is, Frasnian) which are: transitional beds from Wietrznia underlying the Kadzielnia limestone and cephalopod beds with *Manticoceras intumescens* overlying them. Besides, he made several valuable observations concerning two higher Upper Devonian units he separated and which correspond to the present Famennian, but his observations were rather fragmentary.

They were extended and made considerably more accurate by Sobolev (1911, 1912a, b) who had new outcrops at his disposal. In particular he laid foundations for the cephalopod stratigraphy of the Cheiloceras and Clymenia beds. He was also the first to distinguish the Famennian Stage in the Holy Cross Mts. The uppermost Famennian was first discovered here by Czarnocki (1928) who found all cephalopod zones from the Cheiloceras Zone to the Wocklumeria Zone, then distinguished in Germany. He also presented on the map (Czarnocki 1938) the occurrence of the Frasnian and Famennian. Now, the general ideas of the stratigraphy and facial distribution of the Upper Devonian in the western part of the Holy Cross Mts are accepted in such a form as given by Czarnocki (*i.a.* 1928, 1948, 1950). Czarnocki (1927) observed also that the Holy Cross Palaeozoic was differentiated into two separate palaeogeographic and tectonic regions, that is, the Łysogóry (northern) and Kielce (southern) regions. The Upper Devonian of the Holy Cross Mts is developed only as calcareous and marly-calcareous deposits lacking any clastic deposits of the terrigenic origin; nevertheless, the facial differentiation is also marked (Czarnocki 1928, 1948, 1950). According to Czarnocki, the Frasnian of the Łysogóry region is of the geosynclinal nature, whereas reef deposits and detrital limestones occur in the Kielce facies. Reef deposits are developed in particular at the western end of the Holy Cross region in the margin of the Dyminy anticline. To the east, they are replaced by detrital shelf deposits. The Frasnian on the Kadzielnia hill was divided by Czarnocki (1948) into the following three stratigraphic units: the Lower Frasnian of the reef origin, the Middle Frasnian (brachiopod-coraliferous with *Rhynchonella coronula*) and the Upper Frasnian (brachiopod-cephalopodiferous with *Manticoceras, Beloceras* and *Rhynchonella cuboides*). Czarnocki's tripartite division was adopted by Różkowska (1953) who, on the basis of the rugose corals, used it for establishing the stratigraphy of other outcrops in the western part of the Holy Cross Mts. Three stratigraphic units of the Kielce Frasnian were expected to have their counterparts in the Pokrzywianka, Nieczulice and Kostomłoty Beds, distinguished by Czarnocki (1950) in the Łysogóry area. Pajchlowa (1957) found, however, that of these beds only the Kostomłoty Beds were unquestionably Frasnian. In her opinion, the Pokrzywianka Beds represent the Givetian and the stratigraphic position of the Nieczulice Beds is uncertain.

The facial differentiation of the northern and southern regions was also maintained in the Famennian, but the boundary of the facies was considerably moving southwards (Czarnocki 1928, 1950). In the very strongly limited Kielce facies, a sedimentation of limestones persisted in the Famennian. The presence of a remarkable stratigraphic condensation and gaps, tuffites, abundant cephalopods and other fauna is characteristic of this facies. On the other hand, a simultaneous marly-calcareous sedimentation took place in the Łysogóry area. The sedimentation was continuous and yielded thick deposits, and only few fossils are recorded in this facies.

Apart from general statements presented above, no detailed facial analysis of the Upper Devonian has so far been made. Selected problems of a general lithology (Czermiński 1960), reef sedimentation (Pajchlowa & Stasińska 1965, 1968) and subaqueous gravity depositional processes (Radwański & Roniewicz 1962, Szulczewski 1968) were the only subjects of new papers.

The Upper Devonian of the western part of the Holy Cross Mts is very rich in fossils. Many papers are devoted to selected groups of fossils such as: corals (Stasińska 1953, 1958; Różkowska 1953, 1957, 1968, 1969), brachiopods (Biernat 1969, 1970, 1971), trilobites (Osmólska 1958, 1962), cephalopods (Dybczyński 1913, Makowski 1962) [1] and fishes (Gorizdro-Kulczycka 1950). Most of these papers contain also stratigraphic information but, however, they adopt to the Frasnian the stratigraphic division given by Czarnocki and, so far have not developed any basis for its revision.

Discussion of previous results

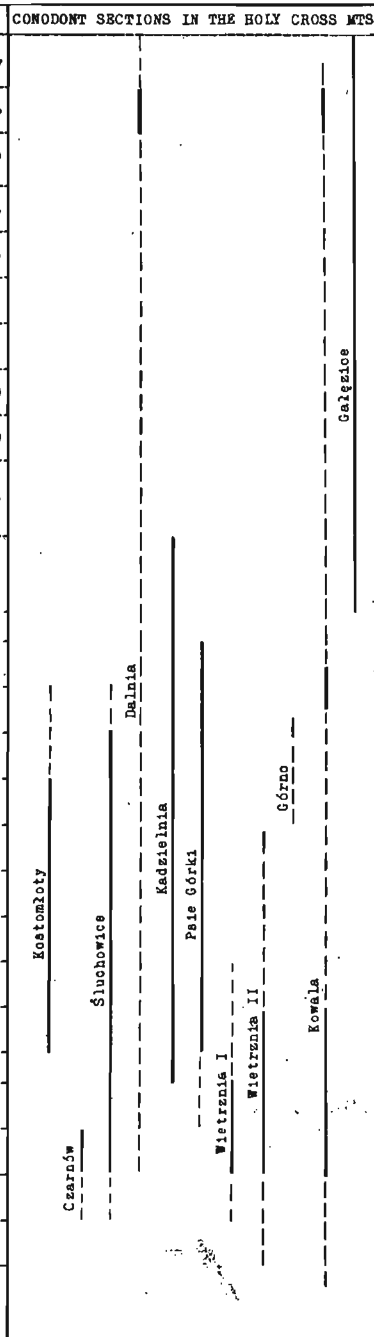
The stratigraphic schema of the Upper Devonian so far applied to the Holy Cross Mts was relatively simple. The Upper Devonian of this region was in principle divided into two stages, that is, the Frasnian and the Famennian, much the same as a division which was introduced in the Ardennes. The two stages clearly differed from each both bio- and lithofacially. A boundary between these stages could be easily separated in mapping, as a marly-calcareous sedimentation started in a decided majority of outcrops at the beginning of the Famennian. A more accurate division of both stages was made on the basis of various criteria, which resulted primarily from different assemblages of fossils occurring in the Frasnian and in the Famennian, this in turn being caused by general facial differences. In the Frasnian, decidedly prevailing fossils are such benthic organisms as, corals, stromatoporoids and brachiopods which were primarily a basis for age determinations. In the area under study, the Frasnian ammonoids were found only in two localities: on the Kadzielnia hill (Czarnocki 1948) and on the Miedzianka hill (Czarnocki & Samsonowicz 1911), but neither has so far been illustrated. In the eastern part of the Holy Cross Mts, Frasnian goniatites are also among the rarities. In all localities known thus far, Frasnian goniatites occurred only in definite layers and there is no single profile in which the succession of their species could be traced (cf. Gürich 1896, Czarnocki & Samsonowicz 1911,

[1] Unfortunately, Czarnocki's rich collection of cephalopods was partly destroyed during the last war. An elaboration of the rest of the collection will appear in a posthumous edition, now being prepared for print by Professor H. Makowski.

Table 1

Upper Devonian conodont zonation and stratigraphical range of the profiles in the western part of the Holy Cross Mts

Stages	Ammonoid Stufen		Conodont zones		
Famennian	Wocklumeria to VI	to VI	Spathognathodus bischoffi	Upper	27
	?	? to V/VI		Middle	26
	Clymenia to V	to V		Lower	25
			Polygnathus styriacus	Upper	24
				Middle	23
				Lower	22
	Platyclymenia to III-IV	to IV	Scaphignathus velifera	Upper	21
		to IIIβ		Middle	20
				Lower	19
		to IIIα	Palmatolepis quadrantinodosa	Upper	18
	Cheiloceras to II	to IIβ		Lower	17
			Palmatolepis rhomboidea		16
		to IIα	Palmatolepis crepida	Upper	15
				Middle	14
				Lower	13
	?	to I/II	Palmatolepis triangularis	Upper	12
		to Iδ?		Middle	11
Frasnian	Manticoceras to I	to Iδ		Lower	10
			Palmatolepis gigas	Upper with P. linguiformis	9
				Upper	8
		to Iγ		Lower	7
			Ancyrognathus triangularis		6
		to Iβ	Polygnathus asymmetricus	Upper	5
		to Iα		Middle	4
				Lower	3
?			Schmidtognathus hermanni – Polygnathus cristatus		2
Givetian	Maenioceras		Polygnathus varcus		1



The conodont zones and the conodont/ammonoid interzonation presented after Ziegler (1962b, 1965b); numbers of conodont zones the same as used by Glenister & Klapper (1966, Text-fig. 2) for a reference in particular distribution tables (Tables 2—9 in the present paper); stratigraphy based on conodonts at Gałęzice and in the uppermost part of the Kowala profile given after Wolska (1967)

Czarnocki 1948, Kościelniakowska 1967, Makowski 1971). All the goniatites found are indicative of the upper part of the Manticoceras Stage. Goniatites from the Pharsiceras lunulicosta Zone (*to Ia*) are unknown in the Holy Cross Mts. Under such circumstances, Czarnocki's (1948) division of the Frasnian accepted so far and also adopted later in other authors' works, was based on a fundamental lithological differentiation of the Frasnian and on changes in the assemblages of fossils it contained and which were assigned to various taxa. Thus distinguished taxa were protostratic units (*sensu* Henningsmoen 1961) in character, both litho- and biostratigraphically. Boundaries between the members distinguished are the typical quality boundaries with all the shortcomings resulting from this fact.

The stratigraphic division of the Famennian (Sobolev 1911, 1912a, b; Czarnocki 1928, 1948) is incomparably more satisfactory than that of the Frasnian, as it employs chronostratic units and, in addition, as based on cephalopods, a group of index fossils in the Upper Devonian, it is orthostratigraphic in character.

The conodont zonation, recognized in the western part of the Holy Cross Mts, and previously even in the Famennian (Wolska 1967), has been accepted as a basis for a new stratigraphic division of the Upper Devonian of this region. Basing the stratigraphy on conodonts, gives in turn the possibility of basing the stratigraphy of both the Frasnian and Famennian on one and the same group of fossils and of adopting a uniform stratigraphic schema for the entire Upper Devonian. None other group of organisms, in particular cephalopods, could perform this function in the Holy Cross Mts. The stratigraphic division, based on conodont zonation, replaces in the Frasnian Czarnocki's (1948) so far accepted protostratic units with biochronostratigraphic units. Moreover, instead of a local division it introduces a universal division on a world scale. For historical reasons, the division of the Upper Devonian, based on cephalopods, is orthostratigraphic in character, but a transposition of the parastratigraphic division, based on conodonts, to the division, based on cephalopods, is relatively easy and accurate (Table 1). Its accuracy is a principal advantage of the stratigraphy based on conodonts. It is considerably more precise than the division based on cephalopods and even incompably so than the division of the Frasnian of the region under study adopted thus far. In the Famennian of the Holy Cross Mts, it supplements the stratigraphy based on cephalopods from which it is usually more precise and easier to establish, this resulting from a greater frequency of occurrence of conodonts.

Thus, basing the stratigraphy of the Frasnian in the Holy Cross Mts on conodonts as an index group and acknowledging their stratigraphic role in the Famennian to be at least equivalent to that of ammonoids seem to be fully justified. At the same time, the stratigraphic division based on conodonts provides the possibility of a future exact determination and verification of a stratigraphic significance of other groups of fossils, such as, corals, brachiopods or even stromatoporoids, on which of necessity the stratigraphy has to be based in facies devoid of conodonts.

THE CONODONTS

Previous investigations

The first papers devoted to Upper Devonian conodonts from the Holy Cross Mts (Kościelniakowska 1967, Freyer & Żakowa 1967, Helms & Wolska 1967, Wolska 1967), and to their stratigraphic role have appeared only recently. The oldest conodonts, so far found in the Upper Devonian of the Holy Cross Mts, come according to Kościelniakowska (1967) from the zone *to Iβ/γ* (in writer's opinion, probably from the Lower Palmatolepis gigas Zone). Their presence was found by Kościelniakowska (1967) at Kostomłoty, which is situated in the area under study. That was an only locality in the western part of the Holy Cross Mts from which conodonts were described by Kościelniakowska. The rest of the fauna came from the eastern part of the area. This author did not distinguish conodont zones and contented herself with finding that zone *to Iβ/γ* occurred at Kostomłoty. Both the methodology of her elaboration and stratigraphic conclusions were subject to reservations (Szulczewski 1968, p. 305). In the present paper, the conodonts from Kostomłoty have been described anew and provided a basis for a different stratigraphic interpretation.

Conodonts from the Famennian and Lower Carboniferous of the Bolechowice borehole were presented by Freyer & Żakowa (1967). This fauna comes from all horizons of the Famennian ranging from the Palmatolepis crepida to the Spathognathodus costatus zones and from the Tournaisian.

Wolska (1967) was the author of the richest elaboration of the Upper Devonian conodonts from the Holy Cross Mts. She described a material very rich quantitatively and abounding in species, coming from numerous outcrops. Three of them, Kadzielnia, Kowala and Gałęzice are situated in the area dealt with in the present paper. Conodonts, described by Wolska, come from all horizons, ranging from the Palmatolepis triangularis zones to the Spathognathodus costatus zones, but the oldest assemblage from the western part of the Holy Cross Mts comes only from the Famennian Palmatolepis crepida Zone (*to IIa*) on the Kadzielnia hill. In Wolska's work, the taxonomic aspect of conodonts predominates over the stratigraphic one. She proved that in the Holy Cross Mts, one could easily distinguish conodont zones suggested by Ziegler (1962b), but she did not attempt to distinguish conodonts subzones and consequently decreased the precision of her stratigraphic determinations. Wolska's material came only from selected profiles abounding in conodonts.

Characteristics of the collected material

The material described in the present paper, does not come from all horizons of the Upper Devonian. It was collected beginning from the Lower or Middle Polygnathus asymmetricus zones (*to Iα*) up to the Polygnathus rhomboidea Zone (*to IIβ*). Higher conodont zones are now also located in the area under study, but they outcrop — except for the Palmatolepis quadrantinodosa Zone — only at Jabłonna and Gałęzice, where from conodonts were exhaustively described by Wolska (1967). Conodonts of the uppermost Devonian were found on the Dalnia hill, but the deposits containing them occur, in a specific situation, together with those of the Lower Carboniferous, also abounding in conodonts. These conodonts, as well as an abundant fauna of accompanying corals and trilobites, will be described in a separate publication (Osmólska, Różkowska, Stasińska & Szulczewski, *in preparation*). It is only the description of conodonts from the Famennian of Kadzielnia which has been repeated (after Wolska 1967) in the present paper. This was primarily caused by the necessity of an exact localization of the sampling places in a section of profile very important geologically. The material, sampled from Kadzielnia once again, turned out to be interesting and containing species so far unknown from this locality, as well as new ones (*Palmatolepis circularis, P. minuta wolskae, Polygnathus sinuosus*). Many species described in the paper have so far been unknown from the Holy Cross Mts and even from Poland. These are primarily species whose occurrence is limited to the Manticoceras Stage. Conodonts from this stage have only fragmentarily been known before in Poland. In the Holy Cross Mts, conodonts from zones older than the Lower Palmatolepis gigas Zone (*to Iγ*) have so far been unknown at all.

The Famennian species whose intraspecific variability was extensively illustrated by Wolska (1967), have usually been presented in the present paper only as single specimens. More extensive remarks are given only in case of necessity, usually referring to Wolska's descriptions, based on an abundant material. The writer has resolved to present these species since they are a basis for and documents of further considerations in the paper and, besides they were usually found in the outcrops from which they have not been known before. On the other hand, primarily the species from the Manticoceras Stage, belonging to the genera *Ancyrodella, Ancyrognathus, Icriodus, Nothognathella, Palmatolepis* and *Polygnathus,* have been described and illustrated more extensively. The abundant and strongly varying material has allowed the writer to illustrate a wide range of variability within many species and transitions between them.

One of the species described (*Ancyrognathus princeps* Miller & Youngquist) has not so far been known from Europe, some others, *e.g. Ancyrodella ioides* Ziegler, *Avignathus orthoptera* Ziegler, *Palmatolepis minuta loba* Helms, *Playfordia primitiva* (Bischoff & Ziegler), are rather of a rare occurrence over the world.

In most cases, the writer gave up diagnoses of species, since the majority of species are well known. Diagnoses have been given only in the cases in which they required correction or in which a species is little known. Usually, the writer contented himself with remarks on the characteristics of the material in hand and taxonomic significance of a species, as well as with new observations concerning the intraspecific variability and transitions between species.

The material under study contains almost all species of conodonts from the Manticoceras Stage, known so far and playing an important stratigraphic role. The writer has presented all platform conodonts in hand and those of the remaining ones whose stratigraphic significance has been established.

The abundance of conodont species, found by Wolska (1967) in the Famennian and now, by the writer, in the Frasnian, allows one to acknowledge the Holy Cross Mts as one of the areas particularly favourable to the studies on these microfossils. In contradistinction to some condensed profiles of the Famennian, described by Wolska (1967), the Frasnian is, however, usually marked by a considerable thickness (80 to 100 m) and, consequently, the frequency of conodonts is mostly ten or more times smaller than in the Famennian.

Paleontological description

The collected material comprises about 4,800 specimens of conodonts belonging to 11 genera and 80 species (9 of them represented by 16 subspecies); the four species and one subspecies are new.

The conodonts, usually well preserved, are almost always dark-coloured. Frequently, they have a preserved basal plate. Attention is also attracted by their large dimensions which, in some of the specimens, exceed 4 mm and are comparable with the material from the Rhine Slate Mts.

All the genera and species are presented below in alphabetical succession; the numbers of samples correspond to those in the profiles (cf. Fig. 7) and in the occurrence tables which also contain (Tables 2—9) numbers of the specimens. The photomicrographs (Pls 1—20) have been taken by L. Łuszczewska, M. Sc.

Genus *ANCYRODELLA* Ulrich & Bassler, 1926

Type species *Ancyrodella nodosa* Ulrich & Bassler, 1926

Ancyrodella buckeyensis Stauffer, 1938

(Pl. 2, Fig. 1)

1938. *Ancyrodella buckeyensis* n.sp.; Stauffer, p. 418, Pl. 52, Figs 17, 18, 23, 24.
1945. *Ancyrodella buckeyensis* Stauffer; Youngquist, p. 356, Pl. 54, Fig. 11.
1948. *Ancyrodella nodosa* Ulrich & Bassler; Youngquist & Miller, p. 441 [pars], Pl. 68, Fig. 14 [only].
1956. *Ancyrodella nodosa* Ulrich & Bassler; Bischoff, p. 119 [pars], Pl. 8, Fig. 12 [only].
1956. *Ancyrodella* sp.; Müller (1956a), Pl. 145, Fig. 13 [non Figs 12, 14 = *A. nodosa*].
1957. *Ancyrodella buckeyensis* Stauffer; Müller & Müller, p. 1091, Pl. 136, Fig. 5 [non Fig. 2 = *A. lobata*].
1958. *Ancyrodella buckeyensis* Stauffer; Ziegler, p. 40, Pl. 11, Fig. 7.
[non] 1959. *Ancyrodella buckeyensis* Stauffer; Krebs, Pl. 1, Fig. 6 [= *A. gigas*].
[non] 1965. *Ancyrodella buckeyensis* Stauffer; Ethington, p. 570, Pl. 68 Fig. 3 [= *A. nodosa* transitional to *A. buckeyensis*].
1969. *Ancyrodella buckeyensis* Stauffer; Chorowska, Pl. 1, Figs 2, 3.

Diagnosis. — A species of *Ancyrodella* with a short, triangular platform. Both posterior margins of the platform, or only one of them, are convex to straight. One of the posterior margins may have a sigmoid course. The platform is ornamented with nodes and ridges which run perpendicularly to the posterior margins of the platform. Secondary carinae and keels are fully developed.

Remarks. — According to Ziegler (1962a), *Ancyrodella buckeyensis* occupies an evolutionary position between *A. gigas* and *A. nodosa*. *A. buckeyensis* differs from *A. gigas* in the ornamentation of the platform with nodes and ridges, while the latter's platform bears only nodes. From *A. nodosa* it differs in outline of the platform: in *A. nodosa*, both posterior margins of the platform are sigmoid and, consequently, the posterior lobe of the platform is conspicuously marked, whereas in *A. buckeyensis*, at least one of the posterior margins is straight or convex.

Occurrence. — *A. buckeyensis*, according to Ziegler (1958, Table 2; 1962b, p. 23), ranges from the Middle Polygnathus asymmetricus Zone (*to Ia*) to the lower part of the Upper Palmatolepis gigas Zone (*to Iδ*). The specimens under study come from Kostomłoty (Y. 5).

Ancyrodella curvata (Branson & Mehl, 1934)

(Pl. 3, Fig. 5; Pl. 4, Figs 4—5)

1934. *Ancyrognathus curvata* n.sp.; Branson & Mehl, p. 241, Pl. 19, Figs 6, 11.
1957. *Ancyrodella curvata* (Branson & Mehl); Lys & Serre (1957a), pp. 795—796, Pl. 7, Fig. 1.
1957. *Ancyrodella curvata* (Branson & Mehl); Lys & Serre (1957b), p. 1039, Pl. 1, Fig. 1.
1960. *Ancyrodella curvata* (Branson & Mehl); Freyer, p. 32, Pl. 1, Fig. 6.
1966. *Ancyrodella curvata* (Branson & Mehl); Anderson, p. 403 [pars], Pl. 48, Figs 6, 9, 11, 13 [non Figs 2, 4 = *A. lobata*].
1966. *Ancyrodella curvata* (Branson & Mehl); Koverdynský & Zikmundová, Pl. 1, Fig. 6.
1966. *Ancyrodella curvata* (Branson & Mehl); Glenister & Klapper, p. 798, Pl. 86, Figs 13—15 [give synonymy].
[non] 1968. *Ancyrodella curvata* (Branson & Mehl); Mound, pp. 469—470, Pl. 65, Figs 5, 6, 13—16 [= *A. lobata*].

Remarks. — *Ancyrodella curvata* is very closely related to *A. lobata* and the distinction between them is necessarily arbitrary. *A. curvata* differs from *A. lobata* in a usually more pronounced additional lobe of the platform and a completely developed additional secondary keel. Carina on the additional lobe is usually completely developed, but in some specimens it is imitated only by a row of more conspicuous nodes not fused with each other. The separation of the additional lobe may be identical in some specimens of *A. lobata* and *A. curvata*.

Immature specimens considered by Mound (1968, Pl. 65, Figs 5, 6, 13—16) as *A. curvata* distinctly differ from immature specimens of *A. curvata* illustrated by Ethington & Furnish (1962, Pl. 172, Figs 12—20) and belong rather to *A. lobata*.

Occurrence. — *A. curvata*, according to Ziegler (1962b, Table 2), ranges from the base of the Upper Polygnathus asymmetricus Zone (*to Iβ*) to the top of the Lower Palmatolepis triangularis Zone (*to Iδ*). The specimens under study come from Kostomłoty (*KT. 25, 33; Y. 5, 11, 14, 18, 20, 27*), Śluchowice (*S. 13, 14, 36, 37, 38*), Kadzielnia (*XA. 8*), Psie Górki (*P. 8c, 9, 9a, 10, 10a*), Wietrznia I (*W. 56, 69*), Wietrznia III (*V. 17, 34*), Górno (*G. 5, 7*), Kowala (*KW. 29, 30, 32*).

Ancyrodella gigas Youngquist, 1947
(Pl. 2, Fig. 3; Pl. 4, Fig. 1)

1947. *Ancyrodella gigas* n.sp.; Youngquist, pp. 96—97, Pl. 25, Fig. 23.
1965. *Ancyrodella gigas* Miller & Youngquist [sic]; Ziegler, Pl. 1, Fig. 1.
1965. *Anyrodella* [sic] *gigas* Youngquist; Krebs & Ziegler, Pl. 2, Fig. 7.
1968. *Ancyrodella gigas* Youngquist; Mound, p. 470, Pl. 65, Figs 17, 18 [gives synonymy].
[non] 1969. *Ancyrodella gigas* Youngquist; Chorowska, Pl. 1, Figs 4, 5 [= *A. rotundiloba rotundiloba*].

Remarks. — *Ancyrodella gigas* resembles *A. buckeyensis* from which it differs in a usually more elongate platform sculptured by nodes, while the latter's platform is ornamented with nodes and ridges. Some of the specimens of *A. gigas* have nodes arranged in more or less distinct rows and thus are similar to *A. rugosa*.

Occurrence. — *A. gigas*, according to Ziegler (1958, p. 12; 1962b, pp. 19, 23), ranges from the base of the Middle Polygnathus asymmetricus Zone (*to Ia*) to the Upper Palmatolepis gigas Zone (*to Iδ*). The specimens under study come from Kostomłoty (*KS. 6, Y. 5*), Czarnów (*C. 14, 20*), Śluchowice (*S. 7, 13, 14, 20, 23*), Psie Górki (*P. 5*), Wietrznia I (*W. 71, 86*), Wietrznia III (*V. 16, 17, 34, 41*), Górno (*G. 1, 7*), Kowala (*KW. 12, 20*).

Ancyrodella ioides Ziegler, 1958
(Pl. 5, Fig. 1)

1958. *Ancyrodella ioides* n.sp.; Ziegler, p. 42, Pl. 11, Figs 2—4.

Diagnosis. — A species of *Ancyrodella* with a considerably or completely reduced platform. Two branches, bent anteriorly and forming an obtuse angle, detach themselves laterally from a long free blade. These bladelike extensions may

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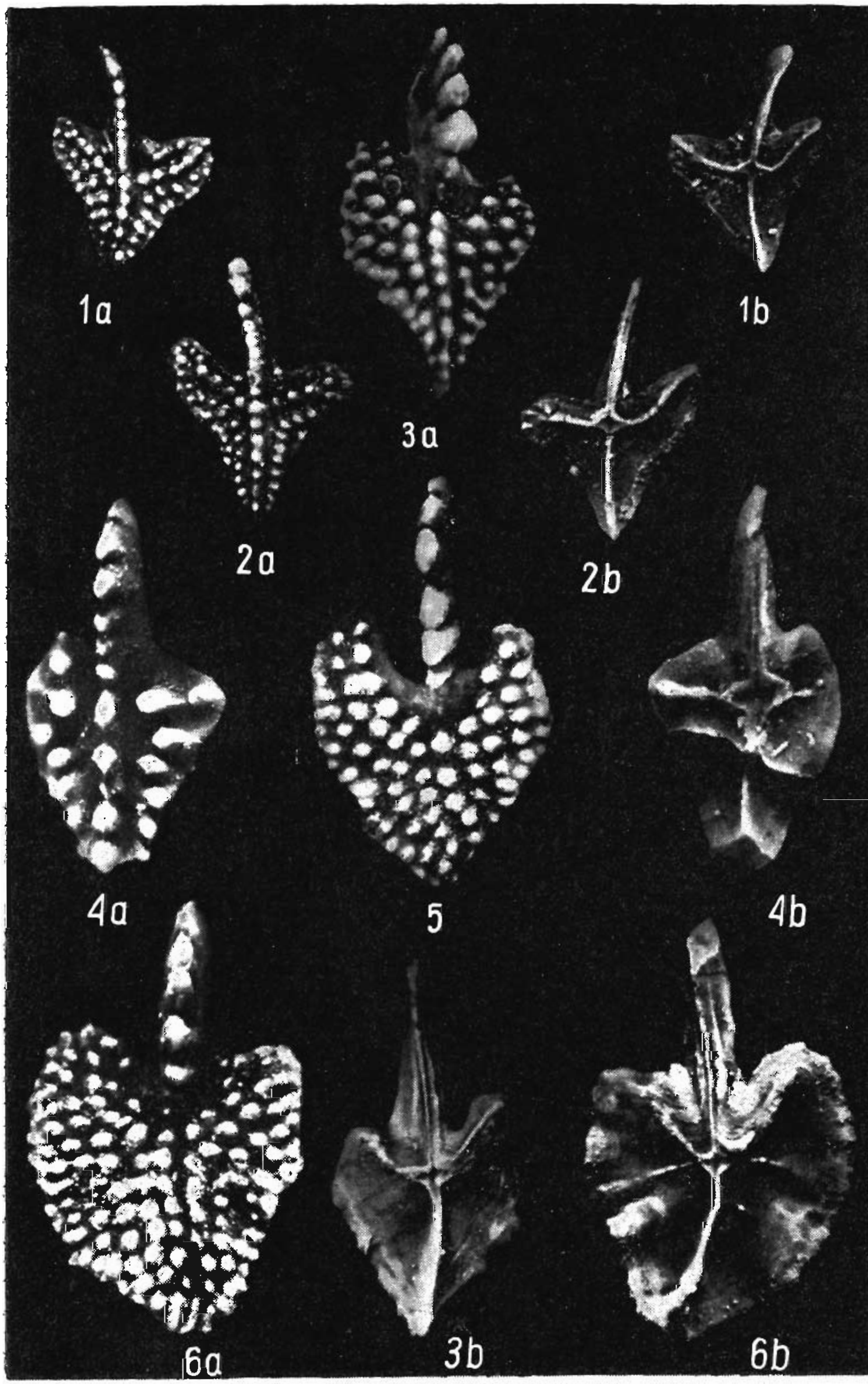
PL. 1

1, 2 — *Ancyrodella rotundiloba alata* Glenister & Klapper; *1a-b* upper and lower views of hypotype (IGP/S. 16) from Śluchowice (S. 6), *2a-b* upper and lower views of hypotype (IGP/S. 17) from Śluchowice (S. 6).
3, 4 — *Ancyrodella rotundiloba rotundiloba* (Bryant); *3a-b* upper and lower views of hypotype (IGP/S. 13) from Wietrznia I (W. 40), *4a-b* upper and lower views of broken hypotype (IGP/S. 14) from Wietrznia III (V. 8).
5, 6 — *Ancyrodella sinecarina* sp.n.; *5* upper view of broken paratype (IGP/S. 19) from Czarnów (C. 9), *6a-b* upper and lower views of holotype (IGP/S. 20) from Śluchowice (S. 3).

All photographs are × 36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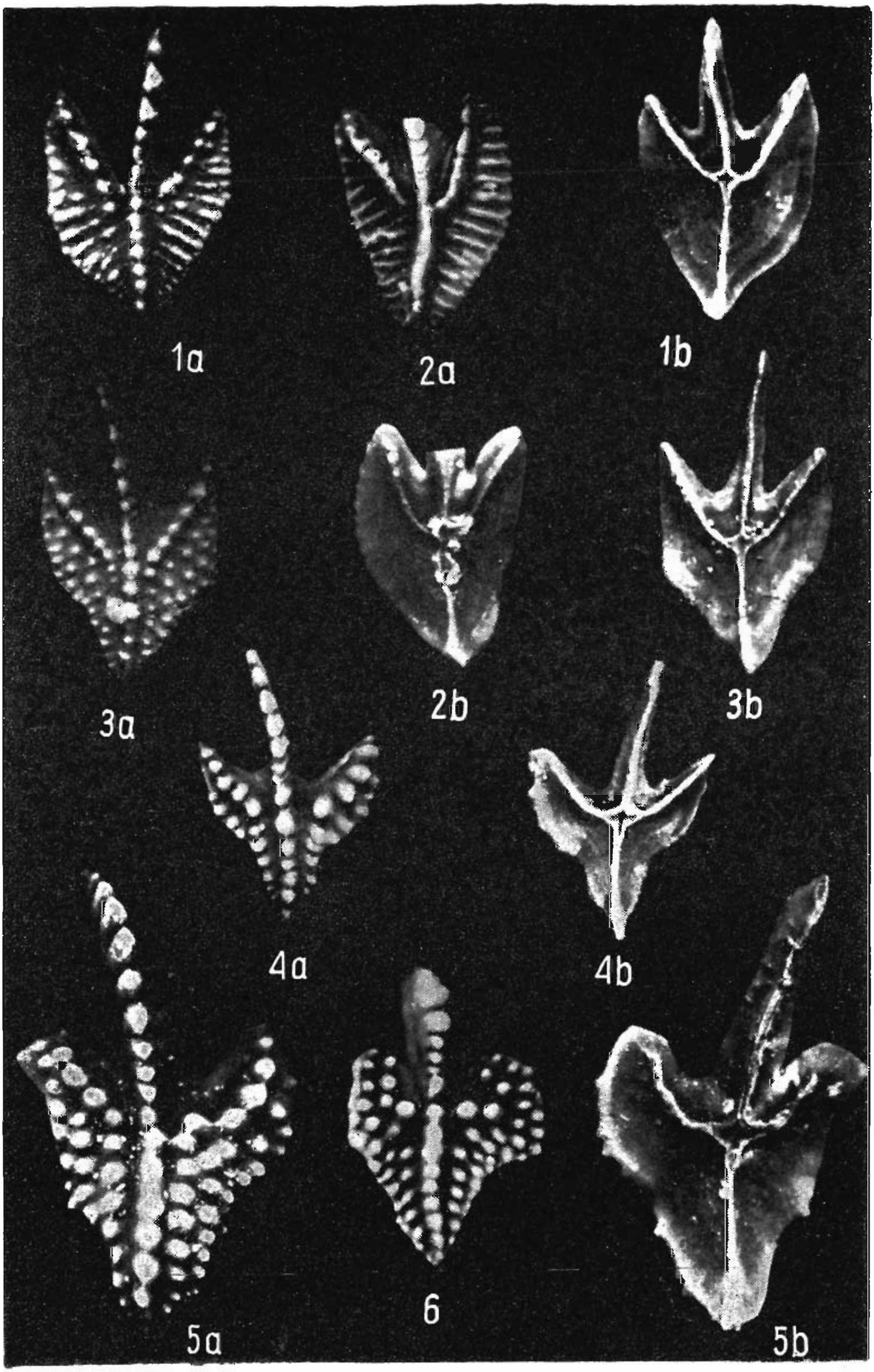
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be accompanied posteriorly by a narrow platform ornamented with few nodes. A large basal cavity, from which a keel and secondary keels deviate towards both lateral extensions, occurs on the lower surface in the place of connection of lateral branches with the free blade. A carina running posteriorly from this place is usually long, sometimes having a narrow platform developed in its anterior part.

Remarks. — Ziegler (1962a) proved that *Ancyrodella ioides* derives from *A. nodosa.* It differs from the latter in an atrophy or a considerable reduction of the platform. The specimens under study still have a vestigial platform.

Occurrence. — According to Ziegler (1958, Tables 2, 4; 1962b, pp. 20, 22), the occurrence of *A. ioides* is restricted to the upper part of the Ancyrognathus triangularis Zone (*to Iγ*) and Lower Palmatolepis gigas Zone (*to Iγ*). The specimens under study come from Kostomłoty (*KT.* 7), Śluchowice (*S. 22, 34*), Kadzielnia (*XB. 5*), Psie Górki (*P. 6, 7*), Wietrznia II (*V. 41*), Górno (G. 2).

Ancyrodella lobata Branson & Mehl, 1934 (Pl. 3, Figs 1—4; Pl. 4, Figs 2—3)

1934. *Ancyrodella lobata* n.sp.; Branson & Mehl, pp. 239—240, Pl. 19, Fig. 14; Pl. 21, Figs 22, 23.
1947. *Ancyrodella lobata* Branson & Mehl; Miller & Youngquist, pp. 502—503, Pl. 74, Figs 10—12.
1949. *Ancyrodella lobata* Branson & Mehl; Beckmann, p. 155, Pl. 1, Fig. 2; Pl. 4, Fig. 13.
1957. *Ancyrodella buckeyensis* Stauffer; Müller & Müller, p. 1091 [pars], Pl. 136, Fig. 2 [non Fig. 5 = *A. buckeyensis*].
1966. *Ancyrodella curvata* (Branson & Mehl); Anderson, p. 403 [pars], Pl. 48, Figs 2, 4 [only].
1968. *Ancyrodella lobata* Branson & Mehl; Mound, pp. 470—471, Pl. 65, Figs 7—12 [gives synonymy].
1968. *Ancyrodella curvata* (Branson & Mehl); Mound, pp. 469—470, Pl. 65, Figs 5, 6, 13—16.

Diagnosis. — A species of *Ancyrodella* having a bilaterally asymmetric platform with a lobelike protrusion on one of the anterior lobes. This protrusion is sculptured by irregularly arranged nodes and has not a fully developed carina; a corresponding keel on the lower surface may be complete, incipient, or absent.

Remarks. — *Ancyrodella lobata* displays a considerable variability in development of the platform, prominence of the lobelike protrusion, development of the additional keel and mode of ornamentation of the protrusion. The upper surface of the latter is usually sculptured by irregularly situated nodes. In some specimens, more prominent nodes are, however, arranged along the axis of the lobelike

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PL. 2

1a-b — *Ancyrodella buckeyensis* Stauffer; upper and lower views of hypotype (IGP/S. 1) from Kostomłoty (Y. 5).

2a-b — *Ancyrodella* sp. *B*; upper and lower views of specimen (IGP/S. 22) with broken free blade from Wietrznia III (V. 17a).

3a-b — *Ancyrodella gigas* Youngquist; upper and lower views of hypotype (IGP/S. 6) from Śluchowice (S. 20).

4a-b — *Ancyrodella nodosa* Ulrich & Bassler; upper and lower views of hypotype (IGP/S. 11) from Górno (G. 5).

5a-b — *Ancyrodella rugosa* Branson & Mehl; upper and lower views of hypotype (IGP/S. 18) from Śluchowice (S. 15).

6 — *Ancyrodella rotundiloba rotundiloba* (Bryant); Upper view of hypotype (IGP/S. 15) from Wietrznia I (W. 34).

All photographs are × 36

protrusion, forming an incipient carina. The keel on the lower surface of the lobelike protrusion may be incompletely developed. In such a case, it comes from the basal cavity but does not reach the outer margin of the platform or is marked only at its margin but does not reach the basal cavity. The secondary keel sometimes does not come from the basal cavity but ramifies from the secondary keel which runs along the anterior lobe. The specimens are also met with which have not an additional keel or have only a swell imitating it.

Occurrence. — *A. lobata*, according to Ziegler (1958, p. 12; 1962b, pp. 19, 23), ranges from the Middle Polygnathus asymmetricus Zone (*to Ia*) to the Upper Palmatolepis gigas Zone (*to Iδ*). The specimens under study come from Kostomłoty (*KS. 6, Y. 5*), Czarnów (*C. 17, 19, 20*), Śluchowice (*S. 13, 17, 20, 21, 22, 23, 24, 30*), Dalnia (*D. 8*), Kadzielnia (*XA. 9; XB. 2, 4; X. 1, 2*), Psie Górki (*P. 3, 4, 5, 7, 8c*), Wietrznia I (*W. 56, 60, 71, 73, 86, 88*), Wietrznia III (*V. 17, 17a, 34*), Górno (*G. 4, 5, 7*), Kowala (*KW. 17, 19*).

Ancyrodella nodosa Ulrich & Bassler, 1926
(Pl. 2, Fig. 4; Pl. 5, Figs 2—5)

1926. *Ancyrodella nodosa* n.sp.; Ulrich & Bassler, p. 48, Pl. 1, Figs 10—13.
1966. *Ancyrodella nodosa* Ulrich & Bassler; Spasov, Pl. 1, Fig. 13.
1966. *Ancyrodella nodosa* Ulrich & Bassler; Glenister & Klapper, pp. 798—799, Pl. 86, Figs 5—12 [give synonymy].
1968. *Ancyrodella nodosa* Ulrich & Bassler; Huddle, pp. 6—7, Pl. 13, Figs 7—10 [non Fig. 1 = *A. nodosa* transitional to *A. lobata*, non Figs 2, 3 = *Ancyrodella* sp., non Fig. 4].

Remarks. — Ziegler (1962a) demonstrated an evolutionary position of *Ancyrodella nodosa* between *A. buckeyensis* and *A. ioides*. However, *A. nodosa* is probably polyphyletic and may derive also from *A. gigas*. The demarcation between the latter two species is arbitrary and based on the trace of the posterior margins of platform, much the same as the demarcation between *A. buckeyensis* and *A. nodosa*. There are also forms which are transitional from *A. nodosa* to *A. lobata*. They have a considerably reduced platform and a contracted posterior lobe, but anterior lobes are asymmetric and one of them has a slight protrusion devoid of the secondary keel on the lower surface. Similar forms were described by Ulrich & Bassler (1926, Pl. 7, Fig. 7), Müller & Müller (1957, Pl. 136, Fig. 4) and Huddle (1968, Pl. 13, Fig. 1) as *A. hamata*.

Occurrence. — *A. nodosa*, according to Ziegler (1958, p. 12), ranges from the Ancyrognathus triangularis Zone (*to Iγ*) to the Upper Palmatolepis gigas Zone

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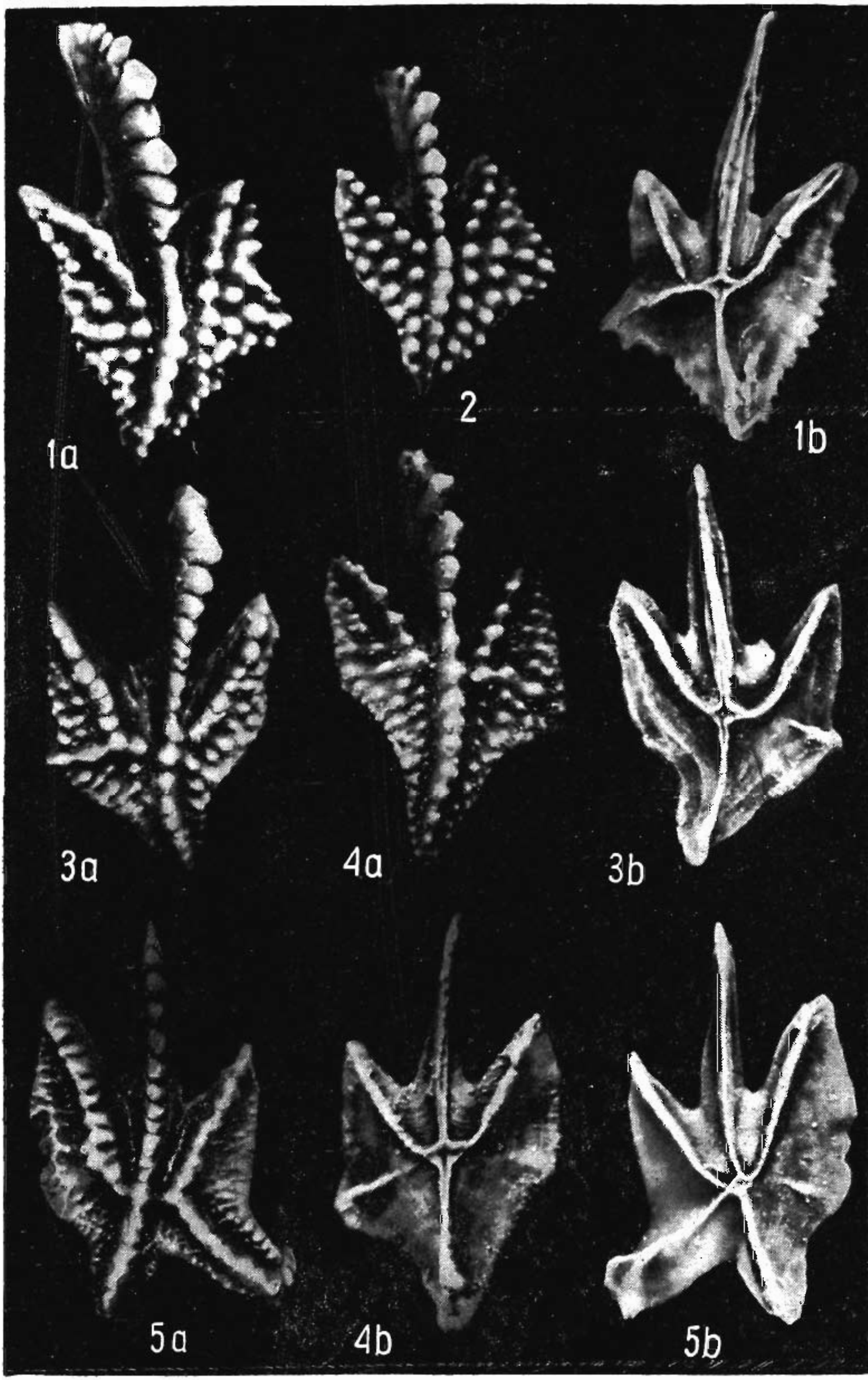
PL. 3

1-4 — *Ancyrodella lobata* Branson & Mehl; *1a-b* upper and lower views of hypotype (IGP/S. 26) from Czarnów (C. 19), *2* upper view of hypotype (IGP/S. 23) from Wietrznia III (V. 17), *3a-b* upper and lower views of hypotype (IGP/S. 28) from Górno (G. 5) bearing incipient additional carina on the lobe-like protrusion, *4a-b* upper and lower views of hypotype (IGP/S. 27) from Wietrznia III (V. 17).

5 — *Ancyrodella curvata* (Branson & Mehl); upper and lower views of hypotype (IGP/S. 3) from Psie Górki (P. 9a).

All photographs are × 36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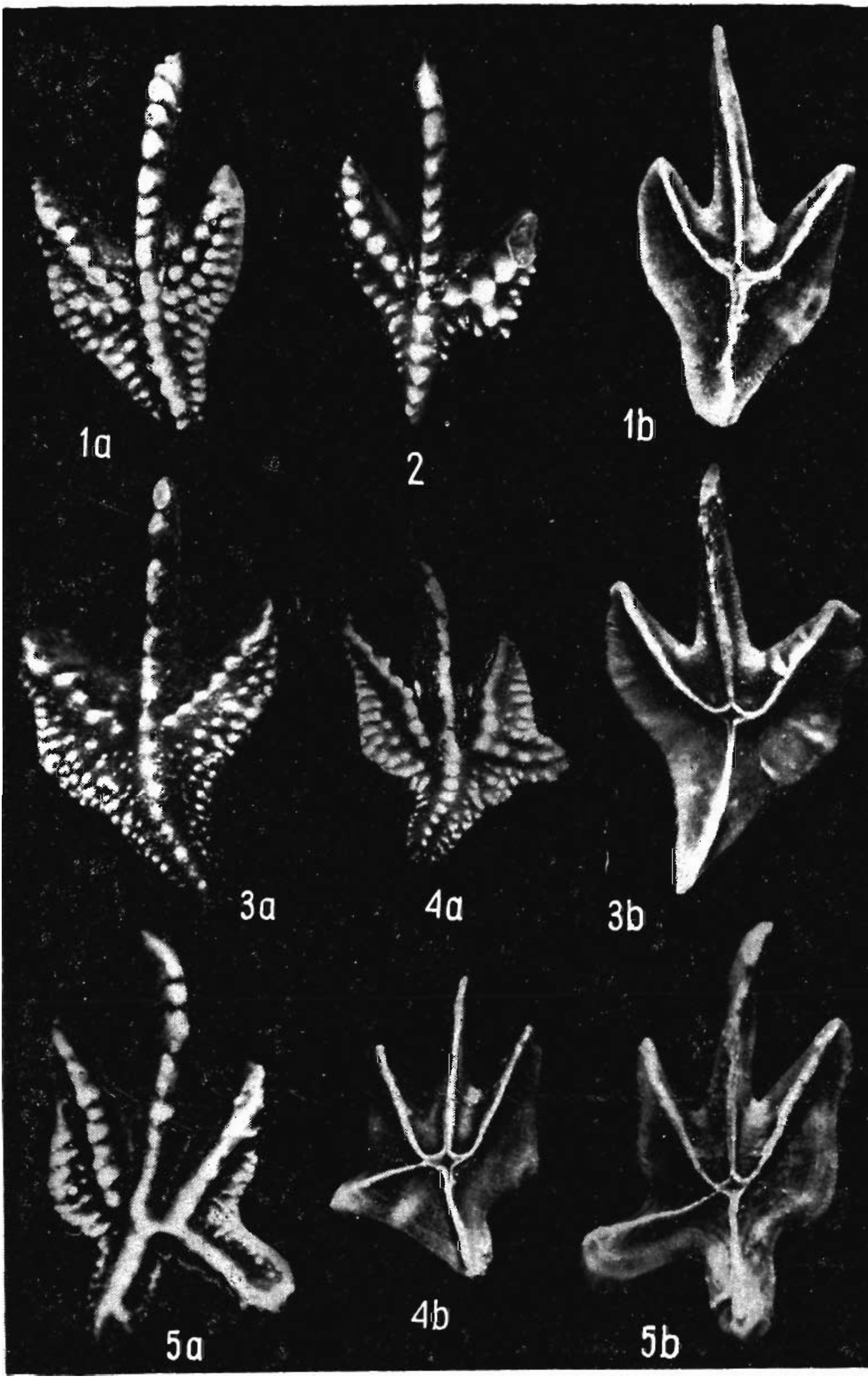
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(to *Iδ*). The specimens under study come from Kostomłoty (*KT. 19; KS. 6; Y. 5*), Śluchowice (*S. 17, 20, 21, 22, 23, 24, 36*), Kadzielnia (*XA. 2; XB. 4, 5*), Psie Górki (*P. 5, 6, 7, 8c*), Wietrznia II (*V. 34*), Górno (*G. 1, 2, 3, 5, 7*).

Ancyrodella rotundiloba rotundiloba (Bryant, 1921) (Pl. 1, Figs 3—4; Pl. 2, Fig. 6)

1921. *Polygnathus rotundilobus* n.sp.; Bryant, pp. 26—27, Pl. 12, Figs 1—6.
1959. *Ancyrodella rotundiloba* (Bryant); Krebs, Pl. 1, Fig. 15.
1966. *Ancyrodella rotundiloba rotundiloba* (Bryant); Glenister & Klapper, p. 799, Pl. 85, Figs 9—13 [give synonymy].
1967. *Ancyrodella rotundiloba* (Bryant); Müller & Clark, p. 908 [pars], Pl. 116, Figs 1—5.
1967. *Ancyrodella rotundiloba* subsp. *A*; Uyeno, p. 5, Pl. 1, Figs 1, 3, 6.
1969. *Ancyrodella gigas* Youngquist; Chorowska, Pl. 1, Figs 4, 5.

Remarks. — In the material under study, in addition to typical forms, there also occur specimens similar to the forms described by Uyeno (1967) as *Ancyrodella rotundiloba* subsp. *A*. In the outline of the platform and mode of orientation, these forms correspond to one of the varieties of *A. rotundiloba* indicated by Müller & Clark (1967) and probably fall in the variability of *A. rotundiloba rotundiloba.*

Occurrence. — *A. rotundiloba rotundiloba* was stated by Glenister & Klapper (1966, Tables 5, 9) in the Lower and Middle Polygnathus asymmetricus zone (*to Iα*). The specimens under study come from Czarnów (*C. 14, 20*), Śluchowice (*S. 3, 7*), Wietrznia I (*W. 7, 34, 40, 52*), Wietrznia II (*V. 8, 14, 16*), Kowala (*KW. 8, 10, 12*).

Ancyrodella rotundiloba alata Glenister & Klapper, 1966 (Pl. 1, Figs 1—2)

1965. *Ancyrodella rotundiloba* n.subsp.; Krebs & Ziegler, p. 736, Pl. 1, Figs 6—9.
1966. *Ancyrodella rotundiloba alata* n.subsp.; Glenister & Klapper, pp. 799—800, Pl. 85, Figs 1—8; Pl. 86, Figs 1—4.
1968. *Ancyrodella rotundiloba alata* Glenister & Klapper; Pollock, p. 424, Pl. 61, Figs 2, 3 [gives synonymy].

Remarks. — The specimens under study correspond to the typical forms in an alate platform outline, fine ornamentation and characteristic development of secondary keels, one of which is longer and extended obliquely-anteriorly and the other, shorter one, runs laterally or slightly posteriorly.

Occurrence. — *A. rotundiloba alata* was found by Glenister & Klapper (1966, Tables 7, 9) in the Lower Polygnathus asymmetricus Zone (*to Iα*), but Uyeno (1967,

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PL. 4

1a-b — *Ancyrodella gigas* Youngquist; upper and lower views of hypotype (IGP/S. 5) from Górno (G. 7).
2, 3 — *Ancyrodella lobata* Branson & Mehl; *2* upper view of hypotype (IGP/S. 24) from Kadzielnia (XB. 4) with reduced platform, *3a-b* upper and lower views of hypotype (IGP/S. 25) from Psie Górki (P. 4).
4, 5 — *Ancyrodella curvata* (Branson & Mehl); *4a-b* upper and lower views of hypotype (IGP/S. 2) from Śluchowice (S. 36), *5a-b* upper and lower views of hypotype (IGP/S. 4) from Śluchowice (S. 37) with extremely extended additional lobe.

All photographs are × 36

Table 1) found it in the Middle Polygnathus asymmetricus Zone (*to Ia*). This confirms Pollock's suggestion (1968, p. 424) that the range of *A. rotundiloba alata* does not differ from that of the nominal subspecies. The specimens under study come from Śluchowice (*S. 3, 4, 6*), Wietrznia I (*W. 34, 52*), Wietrznia III (*V. 16*).

Ancyrodella rugosa Branson & Mehl, 1934
(Pl. 2, Fig. 5)

1934. *Ancyrodella rugosa* n.sp.; Branson & Mehl, p. 239, Pl. 19, Figs 15, 17.
1949. *Ancyrodella rugosa* Branson & Mehl; Beckmann, Pl. 1, Fig. 1; Pl. 4, Fig. 2.
1957. *Ancyrodella rugosa* Branson & Mehl; Bischoff & Ziegler, p. 42, Pl. 16, Fig. 13.
1958. *Ancyrodella rugosa* Branson & Mehl; Ziegler, p. 45.
1959. *Ancyrodella rugosa* Branson & Mehl; Krebs, Pl. 1, Fig. 14.
1964. *Ancyrodella rugosa* Branson & Mehl; Spasov, pp. 271—272, Pl. 2, Fig. 6.
1968. *Ancyrodella rugosa* Branson & Mehl; Pollock, p. 428, Pl. 61, Fig. 1.

Diagnosis. — A species of *Ancyrodella* with an extensive platform sculptured by nodes, which usually display a tendency to be arranged in rows parallel to axis of the platform. Anterior lobes have slightly rounded tips. Secondary carinae developed; secondary keels, corresponding to them, are identically developed and run towards the tips of lobes or terminate on the boundary of the crimp.

Remarks. — *Ancyrodella rugosa* is still insufficiently studied and illustrated. In the holotype, secondary keels on the lower surface do not reach the tips of anterior lobes, whereas they do in the specimens described by Beckmann (1949, Pl. 1, Fig. 1b), Bischoff & Ziegler (1957, p. 42) and Ziegler (1958, p. 45). The specimen under study represents both cases mentioned above. A characteristic arrangement of nodes in rows is not always observed on the studied specimen (cf. also Krebs 1959, Pl. 1, Fig. 14). In typical specimens, the platform is wide, but sometimes its posterior lobe may be considerably contracted.

A. rugosa takes an evolutionary position between *A. rotundiloba* and *A. gigas* (Ziegler 1962b). *A. rugosa* resembles *A. rotundiloba* in its rounded anterior lobes of the platform, but differs in conspicuously and uniformly developed secondary keels and the presence of well developed secondary carinae. From *A. gigas,* it differs in the rounding of anterior lobes and, sometimes, in an incomplete development of secondary keels which may not reach the tips of anterior lobes.

Occurrence. — Ziegler (1958, Table 2) recorded the range of *A. rugosa* as limited to the Lower and Middle Polygnathus asymmetricus zones (*to Ia*). The specimen under study come from Śluchowice (*S. 15*).

Ancyrodella sinecarina sp.n.
(Pl. 1, Figs 5—6)

Holotype: Specimen numbered *IGP/S. 20,* figured in Pl. 1, Fig. 6.
Type horizon: Lower or Middle Polygnathus asymmetricus Zone (*to Ia*).
Type locality: Sluchowice quarry.
Derivation of name: in Latin — lacking of carina.

Diagnosis. — A species of *Ancyrodella* with an extensive, cordate platform. Free blade short, consisting of 5 to 6 denticles. Upper surface of the platform covered with many closely and irregularly spaced nodes. Carina and secondary carinae not developed. Lower surface of the platform undulate, with the main keel and secondary keels, proceeding from a small basal cavity. Both secondary keels are directed anteriorly and reach the crimp. Incipient additional keels may appear on the two swells of the lower surface.

Remarks. — *Ancyrodella sinecarina* sp.n. differs from the remaining species of *Ancyrodella* in the lack of carina. *A. sinecarina* stands closely to *A. rotundiloba rotundiloba* and *A. rugosa*. It differs from the latter in an irregular arrangement of nodes on the upper surface of the platform, and from *A. rotundiloba rotundiloba* in a more complete development of secondary keels.

Occurrence. — Czarnów (*C. 9*), Śluchowice (*S. 3*), Wietrznia III (*V. 16*).

Ancyrodella sp. *A*
(Pl. 5, Fig. 6)

Diagnosis. — A species of *Ancyrodella* with an alate outline of the platform whose anterior lobes are stretched laterally. Their ends are rounded. On the lower surface each of the lobes bears a secondary keel which disappears before reaching the tip of the lobe. Both secondary keels are directed obliquely-posteriorly. The upper surface is ornamented with large, irregularly arranged nodes. A carina runs across the middle of platform. Free blade long, equalling the length of the platform or even longer.

Remarks. — In the outline of the platform, *Ancyrodella* sp. *A* resembles *A. rotundiloba alata*, but differs from it in uniformly developed keels which run posteriorly and disappear near the ends of anterior lobes. Secondary keels are located near anterior margins of the lobes, while in *A. rotundiloba alata* they are shifted more posteriorly. *Ancyrodella* sp. *A* differs from *A. rugosa* in a shorter platform and its alate outline.

Occurrence. — Wietrznia I (*W. 52*).

Ancyrodella sp. *B*
(Pl. 2, Fig. 2)

Description. — An asymmetric, triangular platform has two tapering anterior lobes and an elongated posterior lobe. Both posterior margins of the platform are convex. The platform is divided into two uneven parts by a slightly bent carina which does not reach the end of the posterior lobe. It is formed by fused nodes. Secondary carinae are located near the inner margins of the anterior lobes. The upper surface is ornamented by distinct, regular ridges perpendicular to the posterior margins and not reaching the carina. The lower surface is smooth and bears a main and two secondary keels. Keels are located exactly under corresponding carinae and proceed from the polygonal basal cavity. The angle between the secondary keels is acute.

Remarks. — *Ancyrodella* sp. *B* is most similar to *A. plena* Stauffer whose upper surface is also covered with ridges. The platform of *Ancyrodella* sp. *B* is, however, more elongated than that of *A. plena*. In addition, *Ancyrodella* sp. *B* differs from *A. plena* in the presence of secondary carinae and more anteriorly directed anterior lobes. *Ancyrodella* sp. *B* is distinguished from *A. buckeyensis* in more elongated platform outline. In addition, the platform of the latter taxon is ornamented by nodes and less regular ridges.

Occurrence. — Wietrznia III (*V. 17a*).

Genus *ANCYROGNATHUS* Branson & Mehl, 1934
Type species *Ancyrognathus asymmetrica* Branson & Mehl, 1934
Ancyrognathus asymmetrica (Ulrich & Bassler, 1926)
(Pl. 6, Figs 6—7)

1926. *Palmatolepis asymmetrica* n.sp.; Ulrich & Bassler, p. 50, Pl. 7, Fig. 18.
1957. *Ancyrognathus* sp.; Lys & Serre (1957b), p. 1040, Pl. 1, Fig. 2.
1960. *Ancyrognathus euglypheus* Stauffer; Freyer, p. 33 [pars], Pl. 1, Fig. 7 [non Fig. 8 = *A. triangularis*].
1966. *Ancyrognathus asymmetrica* (Ulrich & Bassler); Glenister & Klapper, p. 801, Pl. 87, Figs 1—5 [give synonymy].
1967. *Ancyrognathus asymmetrica* (Ulrich & Bassler); Wolska, pp. 373—374, Pl. 1, Fig. 6.
1968. *Ancyrognathus asymmetrica* (Ulrich & Bassler); Huddle, p. 7, Pl. 13, Figs 11, 12.

Remarks. — In the collected material most specimens have sharply terminating both inner and outer lobes. There also occur forms with a bluntly terminating outer lobe and in which the outer margin of the platform is slightly convex posteriorly. These forms resemble specimens that were illustrated by Youngquist & Miller (1948, Pl. 68, Fig. 16) and by Ethington & Furnish (1962, Pl. 172, Fig. 11). They are very similar to *Ancyrognathus princeps*.

Occurrence. — According to Ziegler (1962b, Table 2), the range of *A. asymmetrica* is limited to the Upper Palmatolepis gigas Zone (*to Iδ*). The specimens under study come from Kostomłoty (*KT. 19, 33; KE. 20; Y. 5*), Śluchowice (*S. 37, 38*), Psie Górki (*P. 8c*).

Ancyrognathus princeps (Miller & Youngquist, 1947)
(Pl. 6, Fig. 2a—b)

1947. *Ancyroides princeps* n.sp.; Miller & Youngquist, p. 505, Pl. 75, Fig. 3 [non Fig. 2 = *A. asymmetrica*].
1966. *Ancyrognathus princeps* (Miller & Youngquist); Glenister & Klapper, pp. 801—802, Pl. 87, Figs 6, 7 [give synonymy].

Remarks. — *Ancyrognathus uddeni* was considered by Glenister & Klapper (1966, p. 802) as a junior synonym of *A. princeps*. They also pointed out that *A. princeps* is apparently transitional between *A. calvini* and *A. asymmetrica*.

A. princeps differs from *A. asymmetrica* by having a wider platform, a pronouncedly rounded outer lobe and in the trace of the outer margin of platform, which, in typical specimens, runs near the blade, then suddenly deflects outwards

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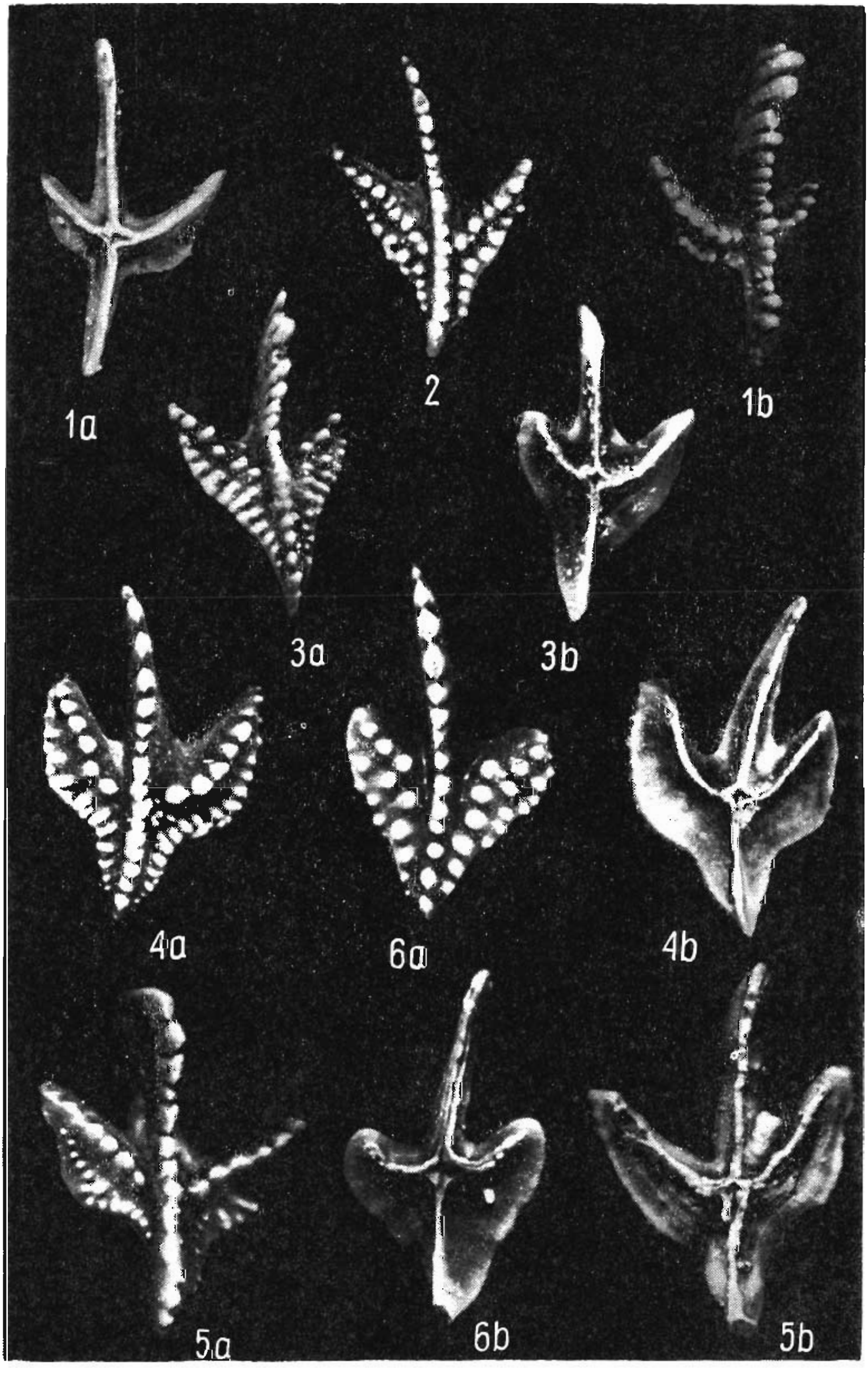
PL. 5

1a-b — *Ancyrodella ioides* Ziegler; lower and upper-lateral views of hypotype (IGP/S. 7) from Psie Górki (P. 7).

2—5 — *Ancyrodella nodosa* Ulrich & Bassler; *2* upper view of hypotype (IGP/S. 9) from Wietrznia II (V. 34), *3a-b* upper-lateral and lower views of hypotype (IGP/S. 8) from Wietrznia II (V. 34) ornamented with ridges and nodes, *4a-b* upper and lower views of hypotype (IGP/S. 10) from Górno (G. 5), *5a-b* upper-lateral and lower views of hypotype (IGP/S. 12), from Kostomłoty (KS. 6), transitional to *A. ioides*.

6a-b — *Ancyrodella* sp. *A*; upper and lower views of specimen (IGP/S. 21) from Wietrznia I (W. 52).

All photographs are × 36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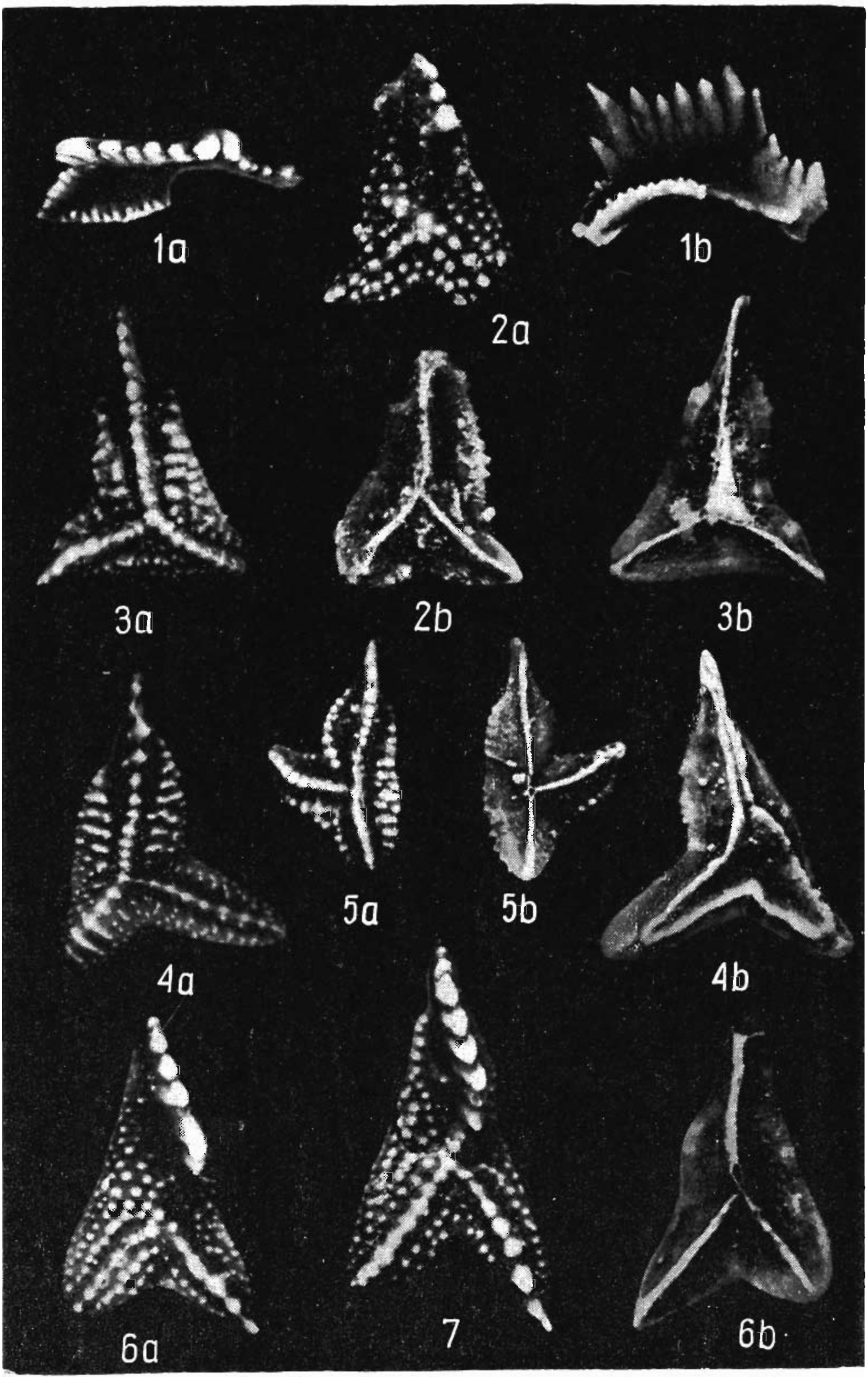
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and, further on, forms an arcuate line reaching to the end of the outer lobe of platform. In contrast, the outer margin of *A. asymmetrica* is concave or straight. In the trace of the outer margin *A. princeps* resembles *A. calvini*, but the latter has rounded both, inner and outer, lobes rounded.

Occurrence. — *A. princeps* has not so far been known from Europe. According to Glenister & Klapper (1966, p. 802, Table 7), it was found sometimes in the Upper Palmatolepis Zone (*to Iδ*) in Iowa and Australia. The specimen under study comes from Kostomłoty (*Y. 18*).

Ancyrognathus sinelamina (Branson & Mehl, 1934)

1934. *Polygnathus sinelamina* n.sp.; Branson & Mehl, p. 248, Pl. 20, Figs 20, 22.
1955. *Polygnathus sinelamina* Branson & Mehl; Sannemann (1955b), p. 150, Pl. 1, Figs 8, 9.
1962. *Ancyrognathus sinelamina* (Branson & Mehl); Ziegler (1962b), pp. 50—51, Pl. 9, Figs 7—12.
1967. *Polygnathus sinelamina* Branson & Mehl; Nehring, p. 150, Pl. 2, Fig. 9.
1967. *Ancyrognathus sinelamina* (Branson & Mehl); Wolska, p. 374, Pl. 1, Fig. 11.

Remarks. — *Ancyrognathus sinelamina* from the Holy Cross Mts was described and illustrated by Wolska (1967). Wolska's specimens as well as the material under study exactly correspond to the holotype of Branson & Mehl.

Occurrence. — Ziegler (1962b, p. 51) recorded the range of *A. sinelamina* from the Middle Palmatolepis triangularis Zone (*to Iδ?*) to the Upper Palmatolepis crepida Zone (*to IIα*). *A. sinelamina* was found by Wolska in the Palmatolepis crepida Zone at Jabłonna. The specimens under study come from Śluchowice (*S. 41*), Kadzielnia (*X. 3*), Psie Górki (*PG. 2*).

Ancyrognathus triangularis Youngquist, 1945
(Pl. 6, Figs 3—5)

1945. *Ancyrognathus triangularis* n.sp.; Youngquist, pp. 356—357, Pl. 54, Fig. 7.
1947. *Ancyrognathus iowanensis* n.sp.; Youngquist, p. 97, Pl. 25, Fig. 22.
1960. *Ancyrognathus euglypheus* Stauffer; Freyer, p. 33 [pars], Pl. 1, Fig. 8 [non Fig. 7 = *A. asymmetrica*].
1968. *Ancyrognathus triangularis* Youngquist; Mound, pp. 471—472, Pl. 65, Figs 19—22 [gives synonymy].

Remarks. — The collected specimens excellently demonstrate a wide variability in the platform outline of *Ancyrognathus triangularis*, presented by

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PL. 6

1a-b — *Nothognathella* sp.; upper and inner lateral views of specimen (IGP/S. 53) from Czarnów (C. 19).
2a-b — *Ancyrognathus princeps* (Miller & Youngquist); upper and lower views of hypotype (IGP/S. 31) from Kostomłoty (Y. 18).
3—5 — *Ancyrognathus triangularis* Youngquist; *3a-b* upper and lower views of hypotype (IGP/S. 32) from Wietrznia II (V. 20), *4a-b* upper and lower views of hypotype (IGP/S. 33) from Wietrznia III (W. 34) having basal plate preserved, *5a-b* upper and lower views of hypotype (IGP/S. 34) from Kostomłoty (KT. 7).
6, 7 — *Ancyrognathus asymmetrica* (Ulrich & Bassler); *6a-b* upper and lower views of hypotype (IGP/S. 30) from Śluchowice (S. 38), *7* upper view of hypotype (IGP/S. 29) from Psie Górki (P. 8c).

All photographs are × 36

Ziegler (1958, Text-fig. 6). Large forms are ornamented with fused nodes or ridges perpendicular to the axis of lobes, much the same as those observed by Ethington & Furnish (1962, p. 1263).

Occurrence. — Ziegler (1962b, Table 2) recorded the range of *A. triangularis* from the base of the Ancyrognathus triangularis Zone (*to Iγ*) to the lower part of the Upper Palmatolepis gigas Zone (*to Iδ*). The specimens under study come from Kostomłoty (*KT. 7; Y. 5*), Psie Górki (*P. 5, 9a, 10b*), Wietrznia II (*V. 18, 20, 34, 56*), Kowala (*KW. 19*).

Genus *AVIGNATHUS* Lys & Serre, 1957(a)
Type species *Avignathus beckmanni* Lys & Serre, 1957(a)
Avignathus orthoptera Ziegler, 1958
(Pl. 7, Fig. 6)

1958. *Avignathus orthoptera* n.sp.; Ziegler, pp. 51—52, Pl. 12, Figs 13, 14.

Remarks. — *Avignathus orthoptera* differs from *A. beckmanni* in its posterior processes which are straight or inwardly convex, while in *A. beckmanni* they are outwardly convex. The remaining differences indicated by Ziegler (1958, p. 52) may result from the state of preservation of the holotype of *A. beckmanni*. The last-named species has so far been represented only by the holotype.

Occurrence. — The genus *Avignathus* is known only from the Manticoceras Stage. According to Ziegler (1958, p. 52), *A. orthoptera* appears in the *Middle Adorfstufe* and is frequent in the *Upper Adorfstufe*. The specimens under study come from Kostomłoty (*KT. 19*), Śluchowice (*S. 23, 30*), Wietrznia III (*V. 56*).

Genus *ENANTIOGNATHUS* Mosher & Clark, 1965
Type species *Apatognathus inversa* Sannemann, 1955(b)
Enantiognathus lipperti (Bischoff, 1956)
(Pl. 7, Fig. 9)

1956. *Apatognathus lipperti* n.sp.; Bischoff, pp. 121—122, Pl. 9, Figs 27, 31.
1961. *Apatognathus lipperti* Bischoff; Scott & Collinson, p. 122, Pl. 2, Fig. 10.
1967. *Gnamptognathus? lipperti* (Bischoff); Wolska, p. 377, Pl. 1, Fig. 7.
1968. *Enantiognathus lipperti* (Bischoff); Mound, p. 481, Pl. 65, Figs 30, 46, 51—54 [gives synonymy].

Remarks. — This species, previously described as *Apatognathus* or *Gnamptognathus*, was included by Mosher & Clark (1965, p. 559) to a new genus *Enantiognathus*. Specimens from the Holy Cross Mts similar to the specimens under study were described by Wolska (1967, p. 377).

Occurrence. — Ziegler (1958, Table 2) recorded the range of the species from the Upper Polygnathus asymmetricus Zone (*to Iβ*) to the Upper Palmatolepis gigas Zone (*to Iδ*), but in Australia (Glenister & Klapper 1966, p. 304) *E. lipperti* first appears in the Lower Polygnathus asymmetricus Zone (*to Iα*). Wolska's specimens come from the Palmatolepis triangularis Zone at Płucki (cf. reservation on p. 35). In the material under study *E. lipperti* ranges as low as the Lower or Middle Polygnathus asymmetricus Zone (*to Iα*). The specimens under study come from Kostomłoty (*Y. 1, 5, 14, 18, 20*), Czarnów (*C. 10*), Śluchowice (*S. 22, 30*), Kadzielnia (*XB. 5*), Psie Górki (*P. 8a*), Wietrznia III (*V. 16, 18, 34*), Kowala (*KW. 10, 18*).

Genus *ICRIODUS* Branson & Mehl, 1938
Type species *Icriodus expansus* Branson & Mehl, 1938
Icriodus alternatus Branson & Mehl, 1934
(Pl. 7, Fig. 2)

1934. *Icriodus alternatus* n.sp.; Branson & Mehl, pp. 225—226, Pl. 13, Figs 4—6.
1938. *Icriodus alternatus* Branson & Mehl; Branson & Mehl, p. 161, Pl. 26, Figs 4—6.
1938. *Icriodus elegantulus* n.sp.; Stauffer, p. 430, Pl. 52, Figs 26, 27.
1947. *Icriodus alternatus* Branson & Mehl; Youngquist & Peterson, p. 246, Pl. 37, Figs 18, 19, 21.
1947. *Icriodus expansus* Branson & Mehl; Youngquist & Peterson, pp. 246—247, Pl. 37, Figs 5—7, 10, 20.
[non] 1950. *Icriodus alternatus* Branson & Mehl; Downs & Youngquist, p. 669, Pl. 87, Figs 8, 11, 12 [= *I. expansus*].
1957. *Icriodus elegantulus* Stauffer; Lys & Serre (1957a), p. 801, Pl. 9, Fig. 2.
1957. *Icriodus elegantulus* Stauffer; Lys & Serre (1957b), p. 1045, Pl. 3, Fig .8.
1959. *Icriodus alternatus* Branson & Mehl; Helms, p. 642, Pl. 1, Fig. 1; Pl. 4, Fig. 7.
1959. *Icriodus* cf. *nodosus* Branson & Mehl; Helms, p. 642, Pl. 4, Fig. 8.
1962. *Icriodus alternatus* Branson & Mehl; Ziegler (1962b), p. 51—52.
1964. *Icriodus alternatus* Branson & Mehl; Orr, p. 9, Pl. 2, Fig. 11 [non Fig. 12 = *I. expansus*].
[non] 1965. *Icriodus alternatus* Branson & Mehl; Ethington, p. 573, Pl. 67, Fig. 8 [= *I. expansus*].
1966. *Icriodus alternatus* Branson & Mehl; Glenister & Klapper, p. 804.
1966. *Icriodus alternatus* Branson & Mehl; Anderson, p. 405, Pl. 52, Figs 11, 12.
1967. *Icriodus alternatus* Branson & Mehl; Wolska, pp. 379—380, Pl. 2, Fig. 6 [non Fig. 4 = *I. cornutus*].
1968. *Icriodus alternatus* Branson & Mehl; Mound, pp. 486—487, Pl. 66, Figs 13, 15, 19, 24.

Remarks. — A considerable divergence is observed in various authors' presentation of *Icriodus alternatus*. They result from the differences in importance ascribed to particular morphological characters. Particularly differently is shown the relation between *I. alternatus* and *I. expansus*. In conformity with the character of the holotypes of both species, *I. alternatus* differs from *I. expansus* in an almost parallel arrangement of lateral rows of denticles, whereas lateral rows are convex outwards. The middle row denticles in *I. alternatus* are weakly developed and frequently compressed, while in *I. expansus* they are well developed. The alternation of the middle and lateral row denticles is more conspicuous in *I. alternatus* than in *I. expansus*.

Occurrence. — *I. alternatus* was found by Ziegler (1958, 1962b) from the Ancyrognathus triangularis Zone (*to Iγ*) to the Upper Palmatolepis quadrantinodosa Zone (*to IIIa*). The specimens under study come from Kostomłoty (*Y. 11, 23, 27*), Śluchowice (*S. 22, 36, 37, 38, 40, 41, 42*), Dalnia (*D. 1*), Kadzielnia (*XA. 8, 9; XB. 4, 5*), Psie Górki (*P. 7, 8a, 9, 10c, 11, 12*), Wietrznia II (*V. 20, 34*), Górno (*G. 2, 7*), Kowala (*KW. 28*).

Icriodus cornutus Sannemann, 1955(b)
(Pl. 7, Fig. 3)

1955. *Icriodus cornutus* n.sp.; Sannemann (1955b), p. 130, Pl. 4, Figs 19—21.
[non] 1960. *Icriodus cornutus* Sannemann; Freyer, p. 47, Pl. 1, Fig. 32; Pl. 2, Fig. 33.
1962. *Icriodus cornutus* Sannemann; Ethington & Furnish, p. 1269, Pl. 172, Figs 7, 8.
1966. *Icriodus costatus* (Thomas); Anderson, p. 406 [pars], Pl. 52, Figs 1, 2 [only].
1966. *Icriodus cornutus* Sannemann; Glenister & Klapper, pp. 804—805, Pl. 95, Figs 2, 3 [give synonymy].
1967. *Icriodus cornutus* Sannemann; Nehring, pp. 130—131, Pl. 3, Fig. 1, Text-fig. 8.
[non] 1968. *Icriodus cornutus* Sannemann; Mound, pp. 487—488, Pl. 66, Figs 32, 34, 35.

Remarks. — *Icriodus cornutus* was regarded by Anderson (1966, p. 407) as conspecific with *I. rectus*. Due to the fact that the holotype and the specimens of *I. cornutus* described later differ from *I. rectus* in a distinct alternation in position of the middle and lateral row denticles and do not display a variability observed in *I. rectus*, *I. cornutus* is considered in the present paper as a valid species.

In the specimens under study, the main cusp is conspicuous and strongly inclined posteriorly, but the posterior part of the lower margin is only slightly bent downwards. In this character the specimens under study differ from some, previously described, specimens of *I. cornutus*, but do not depart from Sannemann's holotype.

Occurrence. — According to Ziegler (1962b, p. 52), *I. cornutus* ranges from the Upper Palmatolepis triangularis Zone (*to I/II*) to the Upper Palmatolepis quadrantinodosa Zone (*to IIIa*). Wolska's (1967, p. 380) specimens came from Płucki and Kadzielnia from the Palmatolepis triangularis and Palmatolepis crepida zones. The specimens under study come from Śluchowice (*S. 41*), Kadzielnia (*X. 4*), Psie Górki (*P. 11, 12*).

Icriodus iowanensis Youngquist & Peterson, 1947

1947. *Icriodus iowanensis* n.sp.; Youngquist & Peterson, p. 247, Pl. 37, Figs 22—24, 27—29.
1966. *Icriodus iowanensis* Youngquist & Peterson; Anderson, p. 406, Pl. 52, Figs 8, 9, 13, 17—21 [gives synonymy].

Remarks. — *Icriodus iowanensis* differs from *I. expansus* by the presence of transverse ridges connecting lateral and median rows of denticles. These ridges are conspicuously marked only in the anterior part of the unit. One specimen, a large, gerontic individual is ornamented in its anterior part only with transverse ridges divided by furrows which run continuously throughout the width of the specimen. The middle row denticles are not developed at all. The specimens under study differ from those described thus far in the lack of a prominent cusp.

Occurrence. — Kostomłoty (*Y. 23*).

Icriodus nodosus (Huddle, 1934) s. l. (Pl. 7, Fig. 1)

1934. *Gondolella? nodosa* n.sp.; Huddle, p. 94, Pl. 8, Figs 14, 15.
1957. *Icriodus symmetricus* Branson & Mehl; Bischoff & Ziegler, p. 64, Pl. 6, Figs 1, 4.
1960. *Icriodus nodosus* (Huddle); Freyer, pp. 47—48, Pl. 2, Fig. 35 [gives synonymy].
[non] 1961. *Icriodus nodosus* Huddle; Budurov, p. 263, Pl. 2, Figs 1—4, 6, 8, 13.
1967. *Icriodus nodosus* (Huddle); Nehring, pp. 131—132, Text-fig. 9 [non Pl. 3, Fig. 2 = *I. alternatus?*].
1967. *Icriodus nodosus* (Huddle); Wolska, pp. 380—381, Pl. 2, Figs 1—3.

Remarks. — The provisionary term „*Icriodus nodosus* s. l". has here been used in conformity with Glenister's & Klapper's (1966, p. 805) suggestion. This was caused by the breaking-off of the margin of basal cavity in the holotype of *I. nodosus* and the resulting impossibility to separate *I. nodosus* from *I. symmetricus*. *I. nodosus* is here understood in conformity with a commonly accepted practice and includes specimens which have a sinus in the trace of the margin on the inner side of the posterior expansion of the basal cavity, forming a prominent and anteriorly directed spur. Both the specimens described so far and the available specimens of *I. nodosus* s. l. differ from each other in the ornamentation of the upper surface. Some of them have an ornamentation resembling that in *I. symmetricus* or *I. expansus*, in some others (*e.g.*, Wolska 1967, Pl. 2, Figs 1—3), the middle row denticles alternate in position with those of the lateral rows and are only weakly developed. The denticulation of these specimens resembles that in *I. alternatus*. It is likely that a taxonomic importance should be ascribed to these differences. At any rate, all the specimens described so far as *I. nodosus* do not seem to fall within the range of variability of *I. expansus* as suggested by Clark & Ethington (1966, p. 680).

Occurrence. — Czarnów (*C. 10, 15, 17*), Śluchowice (*S. 6*), Wietrznia II (*V. 16, 17*), Kowala (*KW. 21*).

Icriodus symmetricus Branson & Mehl, 1934
(Pl. 7, Figs 4—5)

1934. *Icriodus symmetricus* n.sp.; Branson & Mehl, p. 226, Pl. 13, Figs 1—3.
1949. *Icriodus symmetricus* Branson & Mehl; Beckmann, p. 155, Pl. 1, Fig. 6; Pl. 3, Fig. 1; Pl. 4, Fig. 5.
[non] 1957. *Icriodus symmetricus* Branson & Mehl; Bischoff & Ziegler, p. 64, Pl. 6, Figs 1, 4 [= *I. nodosus* s. l].
1961. *Icriodus simmetricus* [sic] Branson & Mehl; Budurov, p. 293, Pl. 2, Figs 11, 12.
1965. *Icriodus symmetricus* Branson & Mehl; Ethington, pp. 574—575.
1966. *Icriodus symmetricus* Branson & Mehl; Anderson, p. 407, Pl. 52, Fig. 7 [gives synonymy].
1966. *Icriodus symmetricus* Branson & Mehl; Glenister & Klapper, pp. 805—806, Pl. 95, Figs 4, 5.
1966. *Icriodus symmetricus* Branson & Mehl; Clark & Ethington, p. 680, Pl. 83, Fig. 4.
1968. *Icriodus symmetricus* Branson & Mehl; Mound, pp. 488—489, Pl. 66, Figs 40, 41.

Remarks. — Most of the collected specimens are slightly bent laterally, but their asymmetry is lower than in *Icriodus curvatus.* In the remaining characters they do not depart from typical specimens.

Occurrence. — According to Ziegler (1958, Table 2), in the Upper Devonian, *Icriodus symmetricus* ranges from the Lower Polygnathus asymmetricus Zone (*to Ia*) to the Upper Palmatolepis gigas Zone (*to Iδ*). The specimens under study come from Kostomłoty (*KS. 6*), Czarnów (*C. 9, 10, 15*), Śluchowice (*S. 6, 7, 22, 27, 30*), Kadzielnia (*XB. 2, X. 1*), Psie Górki (*P. 5, 7*), Wietrznia III (*V. 16, 17, 17a*), Kowala (*KW. 8, 9, 10, 11, 12, 13, 14, 18, 21*).

Genus *NOTHOGNATHELLA* Branson & Mehl, 1934
Type species *Nothognathella typicalis* Branson & Mehl, 1934
Nothognathella condita Branson & Mehl, 1934
(Pl. 8, Fig. 4)

1934. *Nothognathella condita* n.sp.; Branson & Mehl, p. 230, Pl. 13, Figs 25, 26.
1955. *Nothognathella condita* Branson & Mehl; Sannemann (1955b), p. 132, Pl. 3, Fig. 9.
1959. *Nothognathella typicalis* Branson & Mehl; Helms, p. 645, Pl. 1, Figs 8, 9 [only]; Pl. 4, Figs 26, 27 [only].
1960. *Nothognathella condita* Branson & Mehl; Freyer, p. 56, Pl. 2, Figs 55—58.
1967. *Nothognathella typicalis* Branson & Mehl; Wolska, pp. 384—385, Pl. 3, Fig. 10.

Remarks. — *Nothognathella condita* differs from *N. typicalis* by the presence of a prominent apical denticle which is considerably higher than the remaining ones. In a lateral view, the specimens under study have a characteristically arched platform similar to that in the specimen illustrated by Sannemann (1955b).

Occurrence. — Sannemann (1955b) found *N. condita* in *to IIa*. Freyer (1960, p. 56) gives the range of this species from *to I* — *to VI*. The specimens under study come from Śluchowice (*S. 39*), Kadzielnia (*X. 5*), Psie Górki (*P. 10c*).

Nothognathella iowanensis Youngquist, 1945
(Pl. 8, Fig. 10)

1945. *Nothognathella iowanensis* n.sp.; Youngquist, p. 363, Pl. 55, Fig. 7.
1960. *Nothognathella iowanensis* Youngquist; Freyer, p. 56, Pl. 2, Fig. 59; Pl. 3, Fig. 60.
1967. *Nothognathella iowanensis* Youngquist; Kościelniakowska, Pl. 8, Fig. 14.
1966. *Nothognathella iowanensis* Youngquist; Anderson, pp. 407—408, Pl. 50, Fig. 3 [gives synonymy].

Remarks. — The specimens under study are in conformity with the holotype of *Nothognathella iowanensis* except of a large apical denticle which does not occur in the holotype. A similarly large apical denticle is recorded in specimen *N. iowanensis* illustrated by Anderson (1966).

Occurrence. — The presence of *N. iowanensis* from *to I* — *to V* was found by Freyer (1960, p. 56). The specimens under study come from Kostomłoty (*KT. 19, Y. 5*), Kadzielnia (*XB. 5*), Wietrznia III (*V. 20*).

Nothognathella klapperi Uyeno, 1967
(Pl. 8, Figs 2, 5, 8)

1967. *Nothognathella klapperi* n.sp.; Uyeno, pp. 5—7, Pl. 1, Figs 7, 8; Pl. 2, Fig. 1.

Remarks. — The specimens under study are in conformity with the typical material in having two apices, a strongly incurved posterior end of the blade of its posterior branch with extremely inclined posterior denticles and in a more uneven development of the platform on the inner and outer side of the blade. In possessing two apices *Nothognathella klapperi* resembles *N. bicristata* Youngquist & Miller and *N. brevidonta* Youngquist, from which it, however, differs in a strong lateral bend of the blade and inclination of the denticles in its pasterior part. *N. brevidonta* has equal-sized platforms on both sides of the blade while *N. klapperi* has the outer platform confined to the apical region and smaller than inner one.

Nothognathella? sp. *C*, described by Pollock (1968), is very closely related to if not identical with *N. klapperi*, from which it differs only in the lack of ornamentation of the platform, whose absence is also recorded in small specimens of

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PL. 7

1a-b — *Icriodus nodosus* (Huddle) s. 1.; lower and upper views of hypotype (IGP/S. 33) from Śluchowice (S. 6).

2a-b — *Icriodus alternatus* Branson & Mehl; upper and lower-lateral views of hypotype (IGP/S. 37) from Śluchowice (S. 41) with extremely reduced middle row denticles.

3a-b — *Icriodus cornutus* Sannemann; lateral and upper views of hypotype (IGP/S. 38) from Śluchowice (S. 41).

4, 5 — *Icriodus symmetricus* Branson & Mehl; *4* upper view of hypotype (IGP/S. 41) from Wietrznia III (V. 16), *5a-b* upper and lateral views of hypotype (IGP/S. 40) from Wietrznia III (V. 16).

6a-b — *Avignathus orthoptera* Ziegler; upper and lateral views of hypotype (IGP/ /S. 35) from Wietrznia III (V. 56).

7 — *Playfordia primitiva* (Bischoff & Ziegler); lateral view of hypotype (IGP/S. 161) from Śluchowice (S. 6).

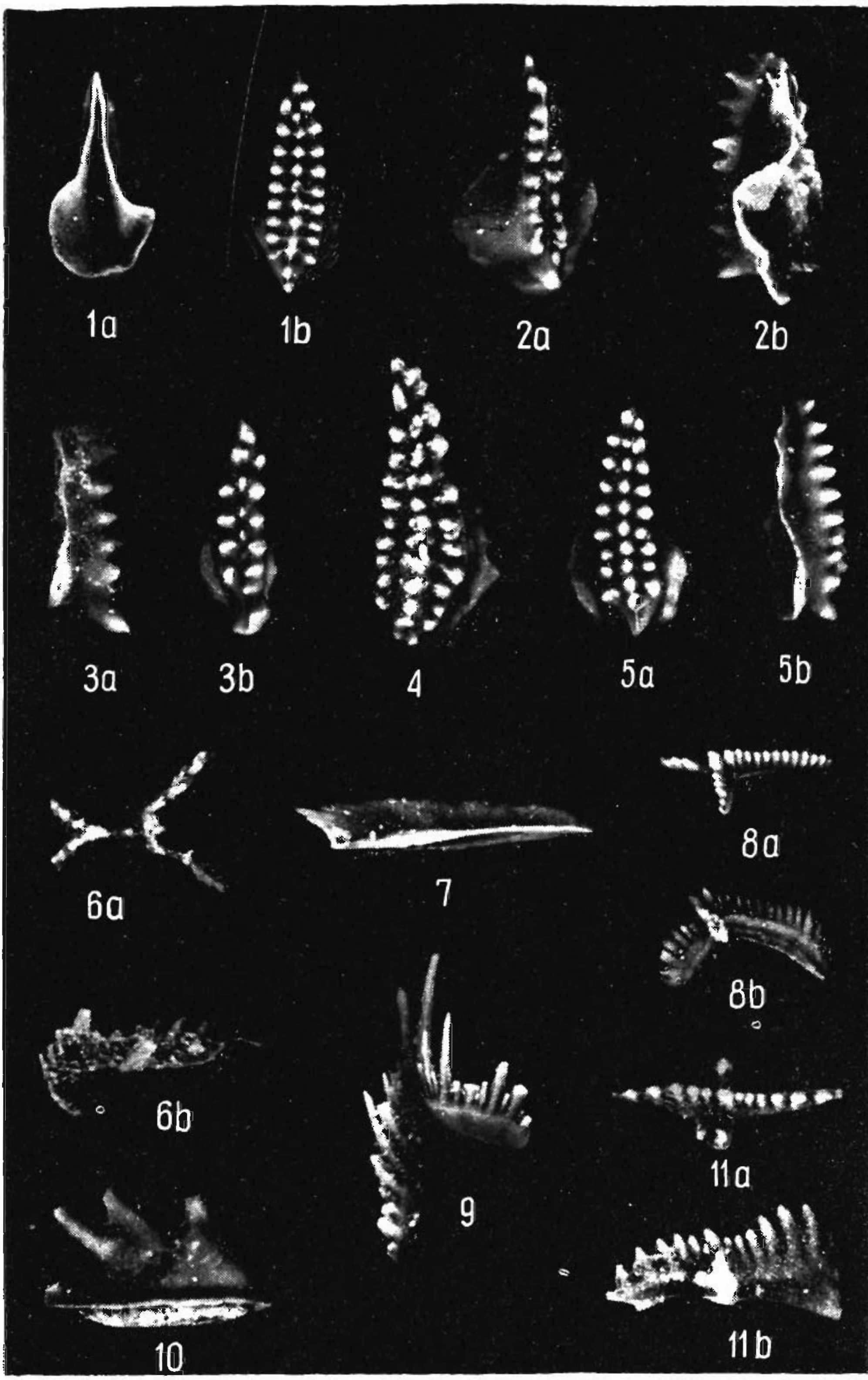
8a-b — *Nothognathella? abnormis* Branson & Mehl; upper and inner-lateral views of hypotype (IGP/S. 54) from Śluchowice (S. 36); specimen with prominent inner lateral extension.

9 — *Enantiognathus lipperti* (Bischoff); outer view of hypotype (IGP/S. 36) from Wietrznia III (V. 34).

10 — *Pelekysgnathus?* sp.n.; lateral view of specimen (IGP/S. 160) from Kostomłoty (Y. 5); tips of denticles broken.

11a-b — *Spathognathodus sannemanni sannemanni* Bischoff & Ziegler; upper and outer-lateral views of hypotype (IGP/S. 170) from Wietrznia I (W. 28).

All photographs are × 36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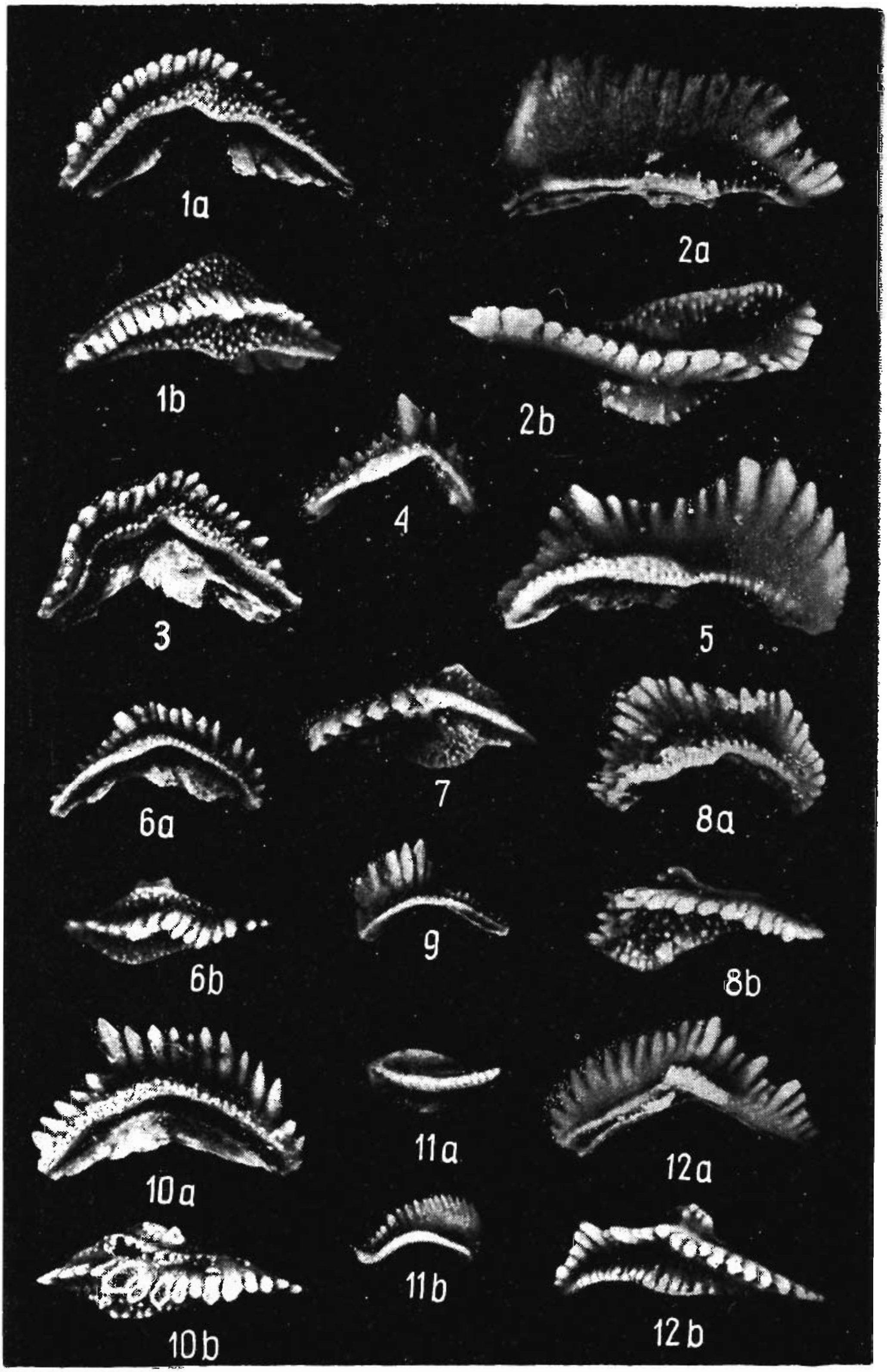
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N. klapperi. Uyeno (1967, p. 6) and Pollock (1968, p. 433) point out to the similarity of *N. klapperi* and related forms to the genus *Elictognathus* Cooper. Pollock maintains that the forms assigned by him to *Nothognathella* with a reservation may either be a homeomorph of *Elictognathus*, or take a phylogenetic position transitional between these two genera. Uyeno's opinion in this respect is in conformity with the former of these two possibilities. His views are confirmed by the fact that such forms are known only from the Manticoceras Stage, while *Elictognathus* appears as late as the Tournaisian and is restricted to this stage and its equivalents.

Occurrence. — *N. klapperi* was found by Uyeno (1967, Table 2) in the Lower and Middle Pylygnathus asymmetricus Zone (*to Ia*). The specimens under study come from Śluchowice (*S. 6, 7*), Wietrznia I (*W. 52, 56*).

Nothognathella aff. *klapperi* Uyeno, 1967 (Pl. 8, Fig. 12)

1968. *Nothognathella? sp. D;* Pollock, pp. 434—435, Pl. 2, Figs 4, 7, 8.

Remarks. — The specimen under study differs from the typical forms of *Nothognathella klapperi* in a less distinct anterior apice of the blade, slighter lateral bend of the blade and smaller inclination of denticles in its posterior part. Its platform is similarly developed and ornamented as that in typical specimens of *N. klapperi.* The manner of the development of platform differs the specimen under study from *N. brevidonta* and *N. iowanensis.*

Occurrence. — Psie Górki (*P. 5*).

Nothognathella polygnathoidea Branson & Mehl, 1934 (Pl. 8, Figs 1, 3, 6)

1934. *Nothognathella polygnathoidea* n.sp.; Branson & Mehl, pp. 228—229, Pl. 13, Figs 16—20.
1960. *Nothognathella polygnathoidea* Branson & Mehl; Freyer, p. 56, Pl. 3, Fig. 61.

PL. 8

1, 3, 6 — *Nothognathella polygnathoidea* Branson & Mehl; *1a-b, 6a-b* inner-lateral and upper views of two hypotypes (IGP/S. 46, 48) from Kostomłoty (Y. 5), *3* inner-lateral view of hypotype (IGP/S. 47) from Kostomłoty (Y. 5).

2, 5, 8 — *Nothognathella klapperi* Uyeno; *2a-b* outer-lateral and upper views of hypotype (IGP/S. 43), *5* inner-lateral view of hypotype (IGP/S. 49) both from Wietrznia I (W. 52), *8a-b* inner-lateral and upper views of hypotype (IGP/S. 44) from Wietrznia I (W. 56).

4 — *Nothognathella condita* Branson & Mehl; inner-lateral view of hypotype (IGP/S. 42) from Kadzielnia (X. 5).

7, 9 — *Nothognathella typicalis* Branson & Mehl; *7* upper view of hypotype (IGP/S. 52), *9* inner-lateral view of hypotype (IGP/S. 51) both from Śluchowice (S. 41).

10a-b — *Nothognathella iowanensis* Youngquist; inner-lateral and upper views of hypotype (IGP/S. 47) from Kostomłoty (Y. 5).

11a-b — *Nothognathella sublaevis* Sannemann; upper and outer-lateral views of hypotype (IGP/S. 50) from Kadzielnia (X. 5).

12a-b — *Nothognathella* aff. *klapperi* Uyeno; outer-lateral and upper views of hypotype (IGP/S. 45) from Psie Górki (P. 5).

All photographs are × 36

Remarks. — The specimens available are in conformity with typical specimens of Branson & Mehl in having the inner and outer platform reaching both ends of the blade and in a small variability in the size of denticles. The specimens under study are more strongly arcuated than the typical ones. In both branches denticles are low. Some of the specimens have their apical denticle larger than the remaining ones. In the upper view, the blade and platform are incurved. The anterior branch in some of the specimens is, in addition, sigmoidally bent. The platform is ornamented only with irregularly arranged nodes.

Nothognathella polygnathoidea differs from *N. iowanensis* in a more complete development of the platform.

Occurrence. — *N. polygnathoidea* was found by Freyer (1960, p. 56) from *to I* — *to V*. The specimens under study come from Kostomłoty (*KT. 33; Y. 5*).

Nothognathella sublaevis Sannemann, 1955(b)
(Pl. 8, Fig. 11)

1955. *Nothognathella sublaevis* n.sp.; Sannemann (1955b), pp. 132—133, Pl. 3, Figs 10, 12.
1956. *Nothognathella sublaevis* Sannemann; Bischoff, p. 127, Pl. 10, Figs 30, 31.
1960. *Nothognathella sublaevis* Sannemann; Freyer, p. 56, Pl. 3, Fig. 62.
?1966. *Nothognathella sublaevis* Sannemann; Glenister & Klapper, p. 806, Pl. 95, Figs 7—9.
1967. *Nothognathella sublaevis* Sannemann; Nehring, p. 136, Pl. 4, Fig. 8, Text-fig. 4.
1967. *Nothognathella sublaevis* Sannemann; Wolska, p. 384, Pl. 3, Figs 6, 7.

Remarks. — The specimens under study are very similar to typical specimens of *Nothognathella sublaevis* and have the carina only slightly bent laterally. Different specimens of *N. sublaevis* with strongly sigmoid carina and platform were presented by Glenister & Klapper (1966); these specimens are transitional from *N. sublaevis* to *N. postsublaevis* Helms & Wolska. In contradistinction to them, typical *N. postsublaevis* have a folded margin and bear ridges on their posterior inner platform.

Occurrence. — The range of *N. sublaevis*, given by Freyer (1960, p. 56), reaches from *to I* — *to V* and that, given by Glenister & Klapper (1966, p. 806) and Wolska (1967, p. 384), from the Palmatolepis crepida (*to IIa*) to the Scaphignathus velifera Zone (*to III* — *to IV*). The specimens under study come from Kadzielnia (*X. 4, 5*).

Nothognathella typicalis Branson & Mehl, 1934
(Pl. 8, Figs 7, 9)

1934. *Nothognathella typicalis* n.sp.; Branson & Mehl, pp. 227—228, Pl. 13, Figs 7, 8.
1955. *Nothognathella typicalis* Branson & Mehl; Sannemann (1955b), p. 133, Pl. 3, Fig. 11.
1959. *Nothognathella typicalis* Branson & Mehl; Helms, p. 645, Pl. 1, Fig. 10 [non Figs 8, 9 = *N. condita*]; Pl. 4, Fig. 28 [non Figs 26, 27 = *N. condita*].
1961. *Nothognathella typicalis* Branson & Mehl; Helms (1961b), Pl. 3, Fig. 9.
1967. *Nothognathella typicalis* Branson & Mehl; Nehring, pp. 134—135, Pl. 2, Fig. 7a [non Fig. 7b], Text-fig. 11.
[non] 1967. *Nothognathella typicalis* Branson & Mehl; Wolska, pp. 384—385, Pl. 3, Fig. 10 [= *N. condita*].

Remarks. — The differences between *Nothognathella typicalis* and *N. condita* have been discussed in the remarks concerning the latter species. The specimens under study are in a full conformity with typical forms.

Occurrence. — *N. typicalis* was found by Sannemann (1955b) in *to IIa* and by Freyer (1960, p. 57) in *to Iδ* and *to V*. The specimens under study come from Kostomłoty (*Y. 27*), Śluchowice (*S. 41*), Psie Górki (*P. 10b*).

Nothognathella sp.
(Pl. 6, Fig. 1)

Description. — The specimen has a tripartite carina whose all three parts are strongly varying in height. The anterior part consists of low denticles fused with each other. The middle part consists of very high denticles. The upper edge of this segment of carina is concave. The denticles of the posterior part are, the same as those of the anterior segment, about five times lower than the denticles of the middle part. Changes in the height of denticles are abrupt. The highermost denticles are situated at the beginning and at the end of the middle segment. In relation to the middle segment, the anterior one is slightly shifted inwards. The posterior segment runs at an obtuse angle to it. The inner platform begins suddenly in the anterior part of the middle segment of the blade and reaches the end of the unit. Its margins are ornamented with elongate nodes. A list, running anteriorly along the free blade in the extension of the platform does not, however, reach the anterior end of the specimen. The outer platform is only incipiently developed in the form of a narrow list running along the middle segment of carina, consisting of high denticles. On the lower surface, a distinct keel is bent in the place in which, on the upper surface, the direction of the trace of blade is changed in its posterior part.

Remarks. — The specimen described is most similar to *Nothognathella bicristata* Youngquist & Miller, from which it differs in a considerable differentiation in the size of denticles forming three parts of carina and in an inward shift of its anterior segment.

Occurrence. — Czarnów (*C. 19*).

Nothognathella? abnormis Branson & Mehl, 1934
(Pl. 7, Fig. 8)

1934. *Nothognathella(?) abnormis* n.sp.; Branson & Mehl, pp. 231—232, Pl. 14, Figs 1, 2.
1948. *Nothognathella? abnormis* Branson & Mehl; Youngquist & Miller, p. 447, Pl. 67, Fig. 5.
1955. *Nothognathella? abnormis* Branson & Mehl; Sannemann (1955b), p. 132, Pl. 6, Figs 16, 17.
1957. *Nothognathella(?) abnormis* Branson & Mehl; Lys & Serre (1957b), p. 1047, Pl. 4, Figs 6a, b.
1959. *Nothognathella(?) abnormis* Branson & Mehl; Helms, Pl. 1, Figs 1, 5; Pl. 4, Figs 5, 6.
1960. *Nothognathella abnormis* Branson & Mehl; Freyer, p. 55.
1967. *Nothognathella abnormis* Branson & Mehl; Nehring, pp. 135—136, Pl. 5, Figs 4, 5, Text-fig. 12.
1967. *Nothognathella? abnormis* Branson & Mehl; Wolska, pp. 383—384, Pl. 3, Fig. 9.

Remarks. — The only collected specimen is probably a pathological form of *Nothognathella? abnormis.* Its blade is developed similarly as in typical *N.? abnormis*, but in the place in which change takes place in the height of denticles a short, stipelike extension bearing a few denticles is developed on the outer side of the blade. At the same level, a short and narrow platform, situated in a corner between two segments of blade which contact each other at an obtuse angle, is marked on the inner side. A specimen of *N.? abnormis* having a lateral extension was also presented by Sannemann (1955b, Pl. 6, Fig. 17). A small, lip-like extension also occurs in one of the specimens figured by Branson & Mehl (1934, Pl. 14, Fig. 1).

Occurrence. — The range of the species, given by Freyer (1960, p. 55) reaches from *to Iδ* to *to IIα* and its presence was found by Wolska in the Palmatolepis triangularis and Palmatolepis crepida zones of the Holy Cross Mts. The specimen described comes from Kostomłoty (*Y. 11, 27*), Śluchowice (*S. 36*).

Genus *PALMATOLEPIS* Ulrich & Bassler, 1926
Type species *Palmatolepis perlobata* Ulrich & Bassler, 1926
Palmatolepis circularis sp.n.
(Pl. 15, Figs 5—7)

1967. *Palmatolepis infexa* Müller; Nehring, p. 144, Pl. 4, Fig. 7 [non Fig. 13 = *Palmatolepis* sp. indet.].
1967. *Palmatolepis* sp.; Wolska, p. 410, Pl. 9, Figs 4—6.

Holotype: specimen numbered *IGP/S.55*, figured in Pl. 15, Fig. 6.
Type horizon: Middle or Upper Palmatolepis crepida Zone (*to IIa*).
Type locality: Kadzielnia quarry in Kielce.
Derivation of name: in Latin circularis = round, after the outline of the platform.

Diagnosis. — A species of *Palmatolepis* with an extensive platform subcircular in outline. Inner lobe distinctly differentiated, short. Anterior inner platform extends to the anterior end of the blade. Anterior outer platform margin reaches the blade carina halfway between its anterior end and a distinct azygous node. Blade-carina strongly bent. Posteriorly of the azygous node, carina does not occur. In very few specimens, only one or two small nodes appear posteriorly of the azygous node. The posterior end of the platform is smooth or shagreenlike. On the lower surface, the keel is strongly bent up to the place below the azygous node, but further posteriorly it is straight and usually does not reach the posterior tip of the platform. Secondary keel present.

Remarks. — The specimen illustrated by Nehring (1967, Pl. 4, Fig. 7) and now considered as *Palmatolepis circularis* n.sp., was regarded by Ziegler (1969, P. 15) as *P. subperlobata*. The differences between some of the specimens considered at present as *P. circularis* and *P. subperlobata* were indicated by Wolska (1967, p. 411). *P. circularis* probably takes a position transitional between *P. superlobata* and *P. quadrantinodosa*, from which it differs decidedly in the presence of the inner lobe. In *P. circularis*, the inner lobe is, however, always small which differs this species from *P. subperlobata*, having the inner lobe strongly extended laterally. In addition, *P. circularis* differs from *P. subperlobata* in the lack of carina posteriorly of the azygous node, in a more strongly bent blade carina and in a less elongate outline of the platform.

Occurrence. — All the specimens come from the Middle or Upper Palmatolepis crepida Zone (*to IIa*) from Kadzielnia (*X. 4*). The assemblage of conodonts described by Nehring (1967) and including *P. circularis* sp.n. is also indicative of the Upper Palmotolepis crepida Zone (*to IIa*). Wolska (1967, p. 411) also maintains that *Palma-*

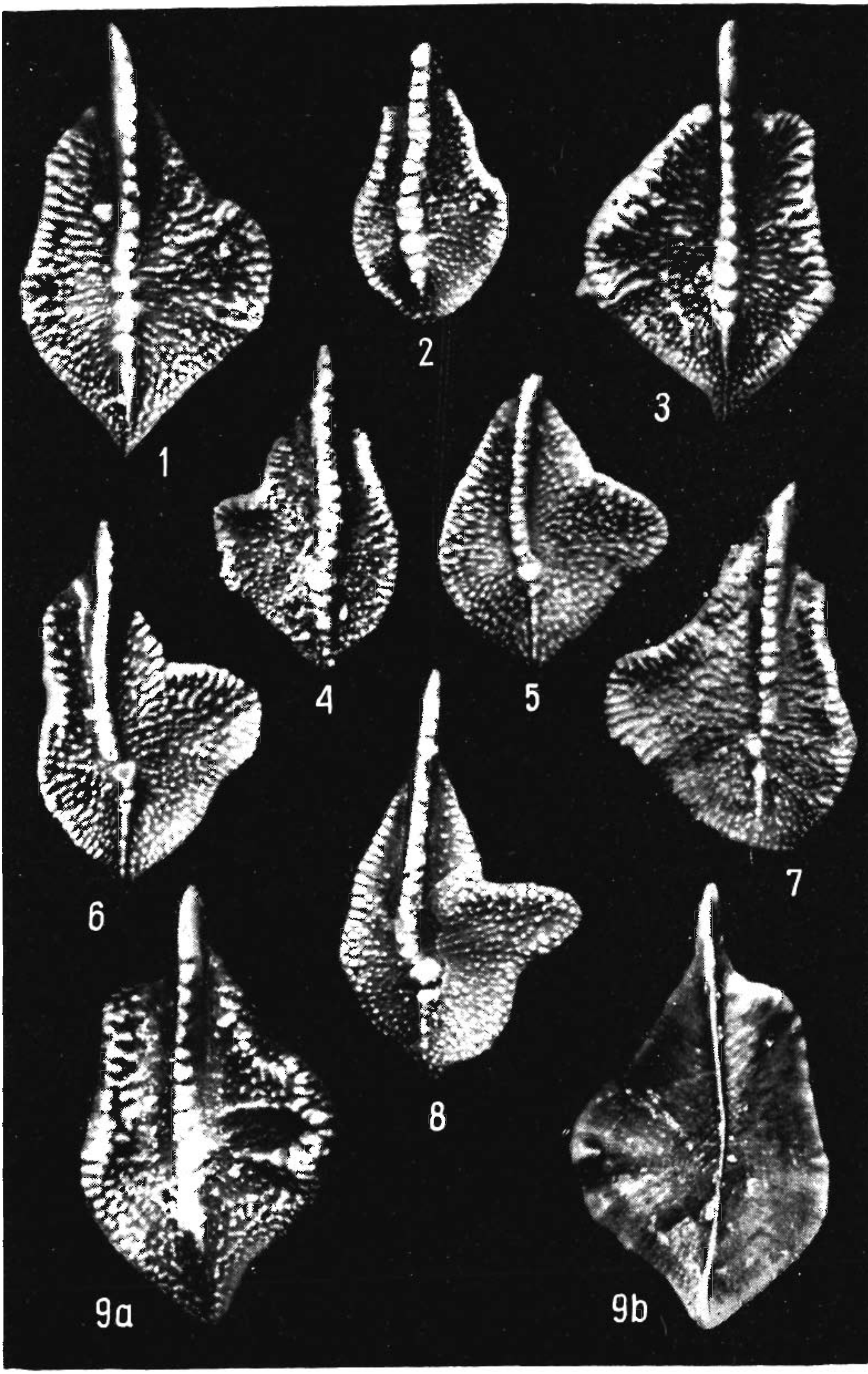
PL. 9

1—4, 7, 9 — *Palmatolepis transitans* Müller; *1—4, 7* upper views of five specimens: *1* hypotype (IGP/S. 122) from Śluchowice (S. 13), *2* hypotype (IGP/S. 114) from Górno (G. 1), *3* hypotype (IGP/S. 110) from Wietrznia I (W. 56), *4* hypotype (IGP/S. 113) from Górno (G. 1), *7* hypotype (IGP/S. 115) from Śluchowice (S. 20); *9a-b* upper and lower views of hypotype (IGP/S. 111) from Śluchowice (S. 13).

5, 6 — *Palmatolepis punctata* (Hinde); *5* hypotype (IGP/S. 91) from Śluchowice (S. 17) with broken free blade, *6* hypotype (IGP/S. 92) from Śluchowice (S. 17).

8 — *Palmatolepis proversa* Ziegler; hypotype (IGP/S. 93) from Górno (G. 3).

All photographs are × 36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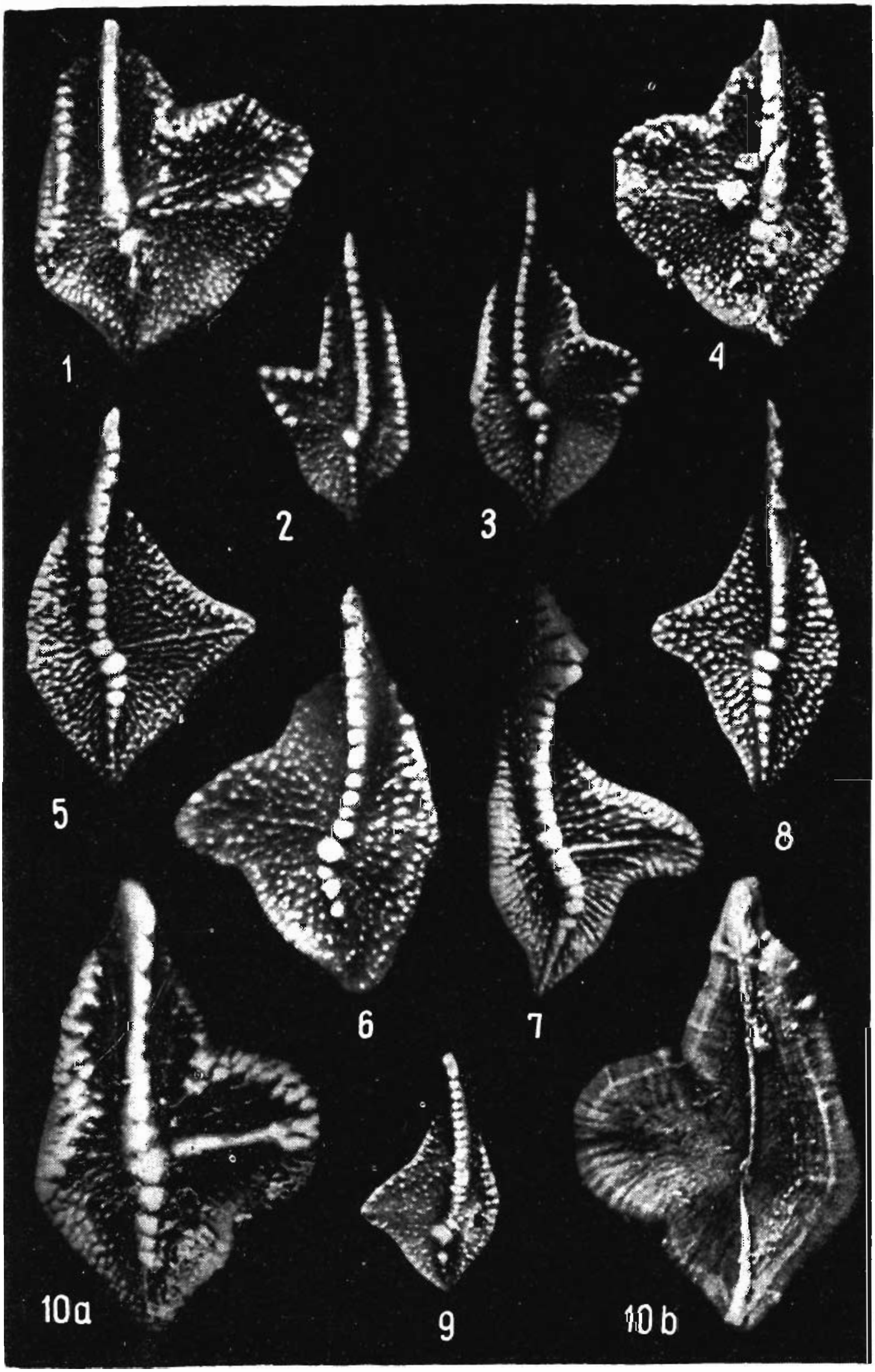
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tolepis sp. of hers (= *P. circularis*) occurs in the Palmatolepis crepida Zone. The assemblage of conodonts with which this species concurs (Wolska 1967, p. 368, Tables 1 and 2) indicates that *P. circularis* occurs in the Middle and Upper Palmatolepis crepida Zone (*to IIa*).

Palmatolepis crepida Sannemann, 1955(b)
(Pl. 13, Figs 8—9)

1955. *Palmatolepis crepida* n.sp.; Sannemann (1955b), p. 134, Pl. 6, Fig. 21.
1956. *Palmatolepis crepida* Sannemann; Bischoff, p. 128, Pl. 8, Figs 31, 32; Pl. 10, Fig. 9.
1959. *Palmatolepis crepida* Sannemann; Scott & Collinson, p. 562, Text-fig. 4, Fig. 5.
1960. *Palmatolepis (Palmatolepis)* sp. aff. *crepida* Sannemann; Clark & Becker, p. 1671, Pl. 2, Figs 4, 5, 9, 10 [non Fig. 3 = *P. glabra glabra*].
1961. *Palmatolepis crepida* Sannemann; Helms (1961b), Pl. 1, Fig. 9.
1962. *Palmatolepis crepida crepida* Sannemann; Ziegler (1962b), p. 55, Pl. 6, Figs 12—19, Text-fig. 3.
1963. *Palmatolepis (Palmatolepis) crepida* Sannemann; Helms, Pl. 1, Fig. 25, Text-fig. 2, Fig. 42.
1963. *Palmatolepis (Palmatolepis) perlobata* n. subsp. *a*; Helms, Pl. 1, Fig. 23.
[non] 1964. *Palmatolepis crepida* Sannemann; Friàkova, Text-fig. 1, Fig. 6 [= *P. linguiformis*].
1965. *Palmatolepis crepida* Sannemann; Bouckaert & Ziegler, Pl. 2, Figs 1—3.
1967. *Palmatolepis crepida* Sannemann; Wolska, pp. 387—388, Pl. 6, Figs 1—5, Text-fig. 6.

Remarks. — The variability of *Palmatolepis crepida* was illustrated by Ziegler (1962b, Text-fig. 3). A similar variability of the specimens occurring on the Holy Cross Mts was presented by Wolska (1967, Text-fig. 6).

Occurrence. — According to Ziegler (1962b, Table 2), the range of *P. crepida* is limited to the Palmatolepis crepida Zone (*to IIa*). The specimens under study come from Kadzielnia (*X. 3*), Psie Górki (*PG. 3*).

Palmatolepis delicatula delicatula Branson & Mehl, 1934

1934. *Palmatolepis delicatula* n.sp.; Branson & Mehl, p. 327, Pl. 18, Figs 4, 10.
1965. *Palmatolepis delicatula delicatula* Branson & Mehl; Bouckaert & Ziegler, Pl. 2, Fig. 9.
1966. *Palmatolepis delicatula delicatula* Branson & Mehl; Glenister & Klapper, pp. 807—808, Pl. 95, Fig. 17 [give synonymy].
1967. *Palmatolepis delicatula delicatula* Branson & Mehl; Wolska, p. 389, Pl. 6, Figs 6, 7.

Remarks. — The specimens under study are in conformity with those of this subspecies from the Holy Cross Mts, described and illustrated by Wolska (1967).

PL. 10

1—4 — *Palmatolepis proversa* Ziegler; *1* large hypotype (IGP/S. 89) from Wietrznia I (W. 56) with broken free blade, *2* hypotype (IGP/S. 88) from Wietrznia I (W. 56) with crystalls of pyrite on the upper surface, *3* hypotype (IGP/S. 86) from Psie Górki (P. 7), *4* hypotype (IGP/S. 87) from Górno (G. 5).

5, 6 — *Palmatolepis hassi* Müller & Müller; *5* hypotype (IGP/S. 72) from Górno (G. 7), *6* hypotype (IGP/S. 73) from Kadzielnia (XB. 5).

7 — *Palmatolepis gigas* Miller & Youngquist; hypotype (IGP/S. 64) from Śluchowice (S. 38).

8, 9 — *Palmatolepis subrecta* Miller & Youngquist; *8* hypotype (IGP/S. 106) from Kostomłoty (Y. 5), *9* hypotype (IGP/S. 102) from Śluchowice (S. 34).

10a-b — *Palmatolepis punctata* (Hinde); upper and lower views of hypotype (IGP/S. 90) from Śluchowice (S. 34).

All photographs are × 36

Occurrence. — Ziegler (1962b, p. 62) stated that the range of this subspecies is limited to the Middle Palmatolepis triangularis Zone (*to Iδ?*), but in his Table 3 he gives its range as reaching as far as the Lower Palmatolepis crepida Zone (*to IIa*). Glenister & Klapper (1966, p. 808) also found *P. delicatula delicatula* up to the Lower Palmatolepis crepida Zone (*to IIa*). Wolska's specimens came from the Palmatolepis triangularis Zone at Jabłonna. The specimens under study come from Kostomłoty (*Y. 29*), Śluchowice (*S. 40, 41*), Psie Górski (*P. 10c, 12*).

Palmatolepis delicatula clarki Ziegler, 1962(b) (Pl. 13, Figs 1—2)

1960. *Palmatolepis (Deflectolepis) coronata* Müller; Clark & Becker, p. 1673, Pl. 1, Figs 1—5; Pl. 2, Fig. 11.
1962. *Palmatolepis delicatula clarki* n.subsp.; Ziegler (1962b), pp. 62—65, Pl. 2, Figs 20—27, Text-fig. 4b, c.
1965. *Palmatolepis delicatula clarki* Ziegler; Bouckaert & Ziegler, Pl. 2, Fig. 4.
1966. *Palmatolepis delicatula clarki* Ziegler; Glenister & Klapper, p. 808, Pl. 92, Fig. 12 [give synonymy].
1967. *Palmatolepis delicatula clarki* Ziegler; Wolska, p. 389, Pl. 6, Fig. 8.

Remarks. — The differences between *Palmatolepis delicatula clarki* and the nominal subspecies are discussed by Glenister & Klapper (1966, p. 808). Most of the specimens under study have their platform outline characteristic of *P. delicatula clarki* and platform margins up turned. On the other hand, they are ornamented with few ridges or smooth. Some of the specimens have in turn a platform outline resembling that in the nominal subspecies, but their ornamentation is characteristic of *P. delicatula clarki*.

Occurrence. — Ziegler (1962b, p. 65, Table 2) gives the range of *P. delicatula clarki* from the Middle to the Upper Palmatolepis triangularis Zone (*to Iδ? — to I/II*), but in his Table 3 he records that this subspecies occurs up to the Middle Palmatolepis crepida Zone (*to IIa*). Such a great range of this subspecies was also found by Glenister & Klapper (1966, p. 808). Wolska's specimens came from the Palmatolepis triangularis Zone at Jabłonna. The specimens under study come from Kostomłoty (*Y. 29*), Śluchowice (*S. 40, 41*), Psie Górki (*P. 10c, 12*).

Palmatolepis foliacea Youngquist, 1945

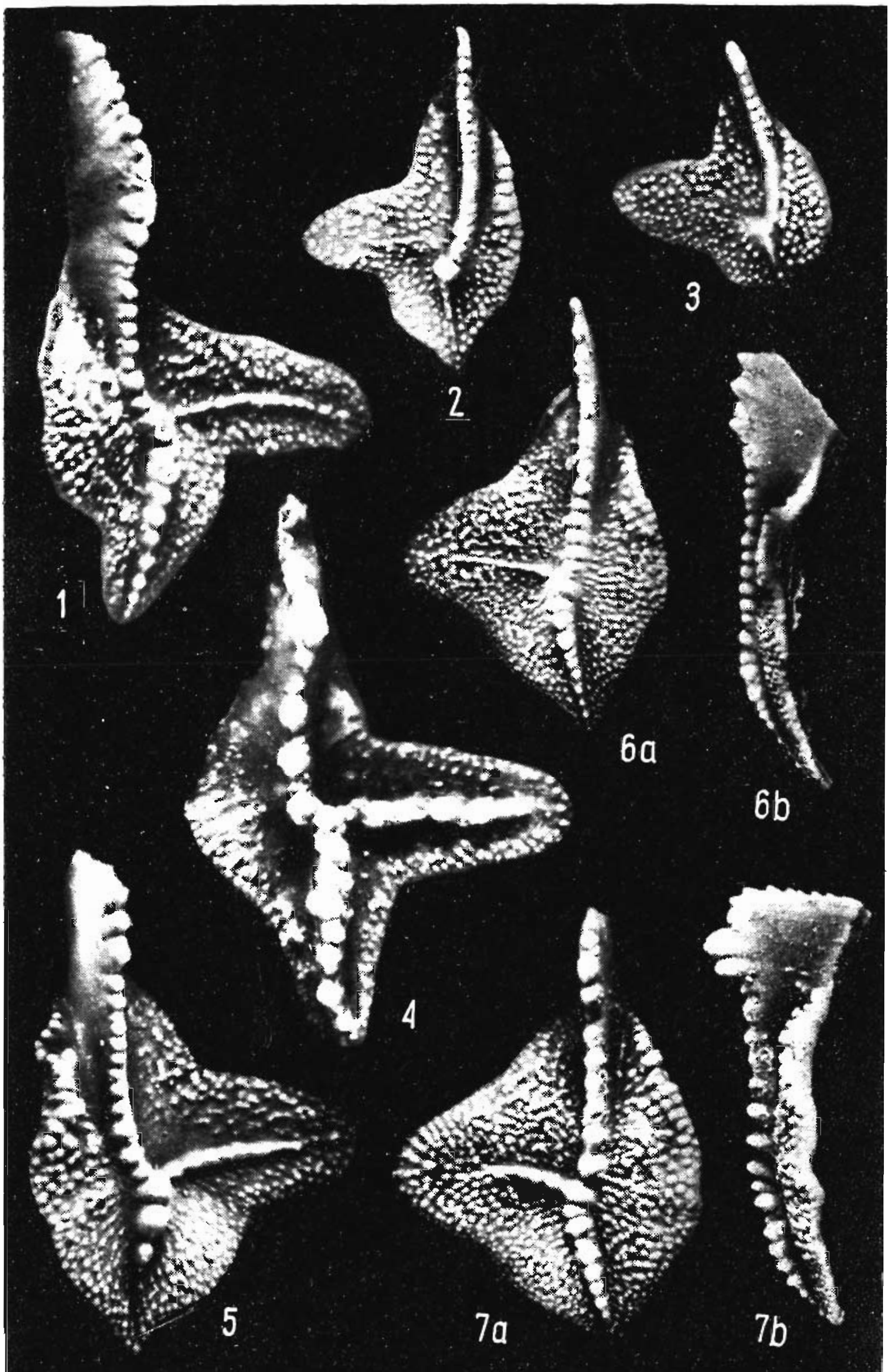
1945. *Palmatolepis foliaceus* n.sp.; Youngquist, pp. 364—365, Pl. 56, Figs 11, 12.
1966. *Palmatolepis foliacea* (Youngquist) [sic]; Anderson, p. 408, Pl. 48, Figs 7, 8.
1966. *Palmatolepis foliacea* Youngquist; Glenister & Klapper, p. 810 [give synonymy].
1968. *Palmatolepis foliacea* Youngquist; Pollock, Pl. 61, Fig. 20.

PL. 11

1—5 — *Palmatolepis gigas* Miller & Youngquist; *1* hypotype (IGP/S. 60) from Kowala (KW. 30), *2* hypotype (IGP/S. 65) from Górno (G. 5), *3* hypotype (IGP/S. 66) from Górno (G. 7), *4* hypotype (IGP/S. 61) from Kostomłoty (Y. 18), *5* hypotype (IGP/S. 63) from Wietrznia III (V. 56).

6, 7 — *Palmatolepis hassi* Müller & Müller; *6a, 7a* upper views, *6b, 7b* lateral views of two hypotypes (IGP/S. 74, 75) both from Górno (G. 7); high free blade denticles show characteristics transitional to *P. unicornis*.

All photographs are × 36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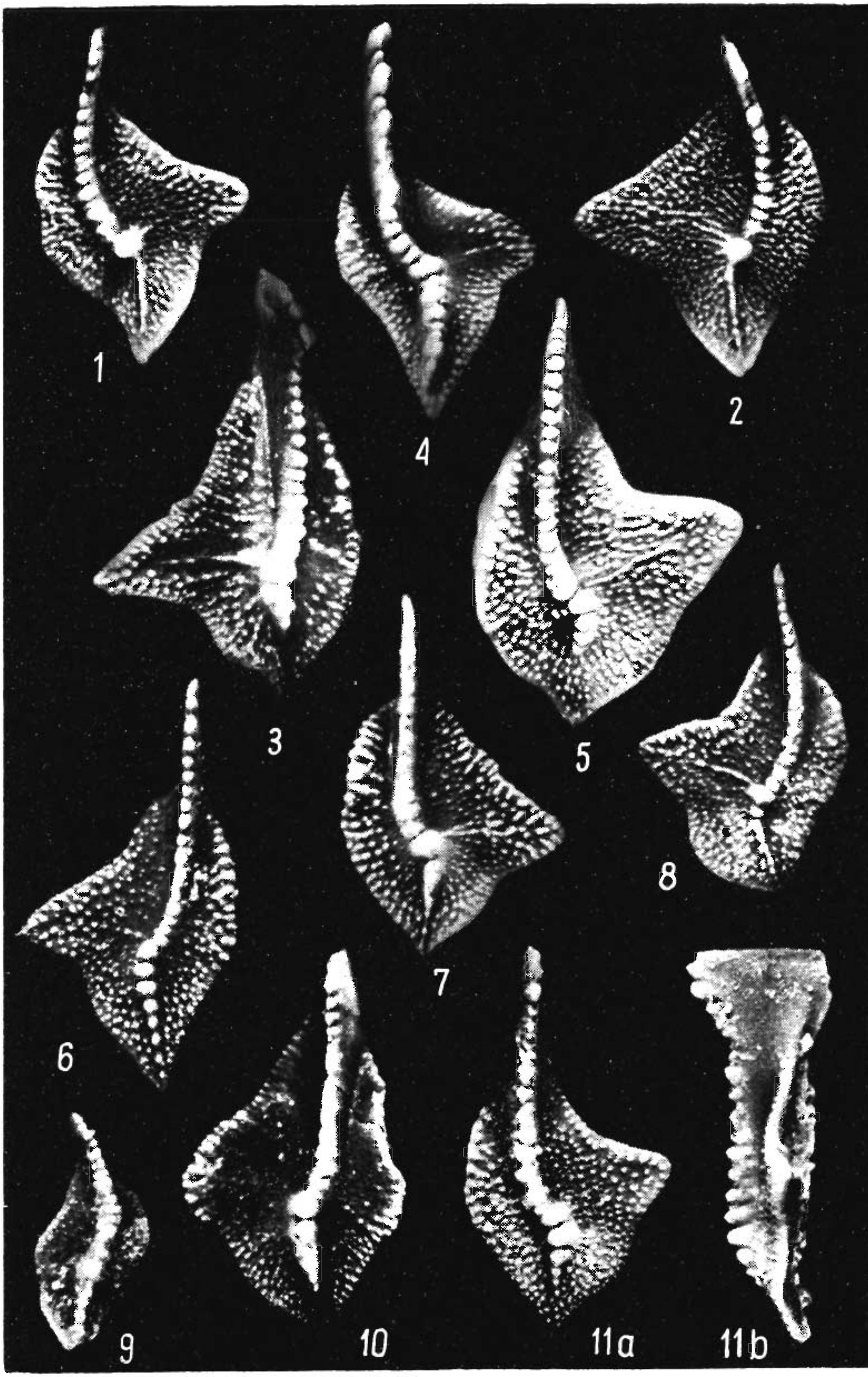
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Remarks. — The specimens under study are small and have a smooth upper surface. The platform-outline corresponds to that of one of the specimens presented by Youngquist (1945, Pl. 56, Fig. 11).

Occurrence. — According to Ziegler (1962b, pp. 20—22, Table 2), the range of this species reach from the upper part of the Ancyrognathus triangularis Zone (*to I*γ) to the Lower Palmatolepis gigas Zone (*to I*γ). The specimen under study come from Śluchowice (*S. 22*), Kadzielnia (*XB. 5*).

Palmatolepis gigas Miller & Youngquist, 1947
(Pl. 10, Fig. 7; Pl. 11, Figs 1—5; Pl. 12, Fig. 3)

1947. *Palmatolepis gigas* n.sp.; Miller & Youngquist, pp. 512—513, Pl. 75, Fig. 1.
1956. *Palmatolepis* sp. *A*; Hass, p. 17, Pl. 3, Fig. 13.
1957. *Palmatolepis (Manticolepis) flabelliformis* (Stauffer)?; Müller & Müller, p. 1101, Pl. 142, Fig. 9.
1965. *Palmatolepis gigas* Miller & Youngquist; Ethington, pp. 579—580, Pl. 68, Figs 14, 16.
1966. *Palmatolepis gigas* Miller & Youngquist; Winder, Pl. 156, Fig. 11.
1966. *Palmatolepis gigas* Miller & Youngquist; Anderson, p. 408, Pl. 49, Figs 1, 2, 4—10, 16, 20.
1966. *Palmatolepis gigas* Miller & Youngquist; Glenister & Klapper, p.810, Pl. 88, Fig. 12 [give synonymy].
1968. *Palmatolepis gigas* Miller & Youngquist; Mound, p. 499, Pl. 68, Figs 1, 2 [non Figs 3, 6 = *P. hassi*].
1968. *Palmatolepis subrecta* Miller & Youngquist; Huddle, pp. 34—35, Pl. 16, Fig. 5 [non Figs 6, 7 = *Palmatolepis* sp. indet.].
1969. *Palmatolepis rhenana* Bischoff; Kononova, pp. 132—133, Pl. 1, Fig. 2.

Remarks. — According to Ziegler's opinion (*in* Klapper & Furnish, 1963, pp. 406—407), *Palmatolepis gigas* is a senior synonym of *P. rhenana* Bischoff. A strongly elongate inner lobe is a character in which *P. gigas* differs from related species *P. hassi*, *P. subrecta* and *P. unicornis*. Ziegler (1958, p. 64) also considers a slender shape of platform as a characteristic feature of *P. gigas*. Specimens of *P. gigas* having a wide platform were, however, presented by Anderson (1966) and Mound (1968).

The specimens under study display an extensive variability in the width of platform shape of inner lobe and denticles of free blade.

Occurrence. — The range of *P. gigas*, given by Ziegler (1962b, p 25), reaches from the bottom of the Lower Palmatolepis gigas Zone (*to I*γ) to the Lower Palmatolepis

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PL. 12

1, 2 — *Palmatolepis triangularis* Sannemann; *1* hypotype (IGP/S. 117) from Kostomłoty (Y. 23), *2* hypotype (IGP/S. 116) from Kostomłoty (Y. 27).
3 — *Palmatolepis gigas* Miller & Youngquist; hypotype (IGP/S. 62) from Wietrznia II (V. 56).
4—8 — *Palmatolepis subrecta* Miller & Youngquist; *4* hypotype (IGP/S. 107) from Wietrznia III (V. 34), *5* hypotype (IGP/S. 104) from Górno (G. 5), *6* hypotype (IGP/S. 105) from Kadzielnia (XB. 5), *7* hypotype (IGP/S. 101) from Kadzielnia (XA. 9), *8* hypotype (IGP/S. 103) from Górno (G. 5).
9 — *Palmatolepis linguiformis* Müller; hypotype (IGP/S. 76) from Kostomłoty (Y. 18).
10, 11 — *Palmatolepis unicornis* Miller & Youngquist; *10* hypotype (IGP/S. 122) from Wietrznia III (V. 34), *11a-b* upper and lateral views of hypotype (IGP/S. 121) from Górno (G. 7).

All photographs are × 36

triangularis Zone (*to Iδ*). Mound (1968, p. 465) cites *P. gigas* from the Ancyrognathus triangularis Zone (*to Iγ*) in Alberta, Canada, but in his presentation *P. gigas* is treated more broadly as it also includes *P. hassi*. The specimens under study come from Kostomłoty (*KT. 7, 19, 25, 33; KS. 6; KE. 20; Y. 5, 14, 18, 20, 21, 27*), Śluchowice (*S. 21, 22, 26, 37, 38*), Kadzielnia (*XA. 9; XB. 4, 5, 6*), Psie Górski (*P. 8c, 9a, 10, 10a, 10b*), Wietrznia III (*V. 20, 34, 56*), Górno (*G. 2, 3, 4, 5, 7*), Kowala (*KW. 23, 29, 30, 31, 32*).

Palmatolepis glabra glabra Ulrich & Bassler, 1926
(Pl. 15, Fig. 10)

1926. *Palmatolepis glaber* n.sp.; Ulrich & Bassler, p. 51, Pl. 9, Fig. 20 [non Figs 18, 19 = *P. glabra* subsp. indet.].
1961. *Palmatolepis glabra* Ulrich & Bassler; Scott & Collinson, Pl. 1, Fig. 1.
1961. *Palmatolepis glabra* Ulrich & Bassler; Dvořák & Freyer, Pl. 1, Fig. 4.
1965. *Palmatolepis glabra glabra* Ulrich & Bassler; Bouckaert & Ziegler, Pl. 3, Fig. 8.
[non] 1966. *Palmatolepis glabra glabra* Ulrich & Bassler; Winder, Pl. 156, Fig. 6 [= *P. glabra elongata*].
1966. *Palmatolepis glabra glabra* Ulrich & Bassler; Glenister & Klapper, p.811, Pl. 89, Figs 6, 7; Pl. 90, Fig. 3; Text-fig. 3, Figs 3—5 [give synonymy].
1967. *Palmatolepis glabra* Ulrich & Bassler; Nehring, pp. 146—147, Pl. 3, Fig. 6.
1967. *Palmatolepis glabra glabra* Ulrich & Bassler; Wolska, pp. 390—391, Pl. 7, Figs 8—12, Text-fig. 7.
1968. *Palmatolepis glabra glabra* Ulrich & Bassler; Manzoni, pp. 659—660, Pl. 62, Fig. 10.
1968. *Palmatolepis glabra* Ulrich & Bassler; Huddle, pp. 29—31 [pars], Pl. 14, Figs 2, 9 [non Figs 3, 5, 11 = *P. glabra elongata*, non Fig. 13 = *P. quadrantinodosa inflexoidea*, non Fig. 14 = *P. glabra pectinata*, non Figs 6, 7, 8, 10, 12 = *P. glabra* subsp. indet.].

Remarks. — The variability of *Palmatolepis glabra glabra* in the material from the Holy Cross Mts has been presented by Wolska (1967, Text-fig. 7). The material in hand falls in the range of variability of Wolska's material.

Occurrence. — According to Ziegler (1962b, pp. 29 and 33), the range of *P. glabra glabra* extends from the Lower Palmatolepis crepida Zone (*to IIα*) to the Upper Palmatolepis quadrantinodosa Zone (*to IIIα*). Wolska's specimens came from the Palmatolepis crepida and Palmatolepis quadrantionodosa zones at Gałęzice, Jabłonna, Kadzielnia, Janczyce and Łagów. The specimens under study come from Kadzielnia (*X. 5*), Psie Górki (*PG. 3*).

PL. 13

1, 2 — *Palmatolepis delicatula clarki* Ziegler; *1* hypotype (IGP/S. 71) from Psie Górki (P. 10c) with platform outline similar to the nominate subspecies, *2* hypotype (IGP/S. 70) from Śluchowice (S. 41).

3—6 — *Palmatolepis* sp.; four specimens (IGP/S. 123—126) from Śluchowice (S. 41).

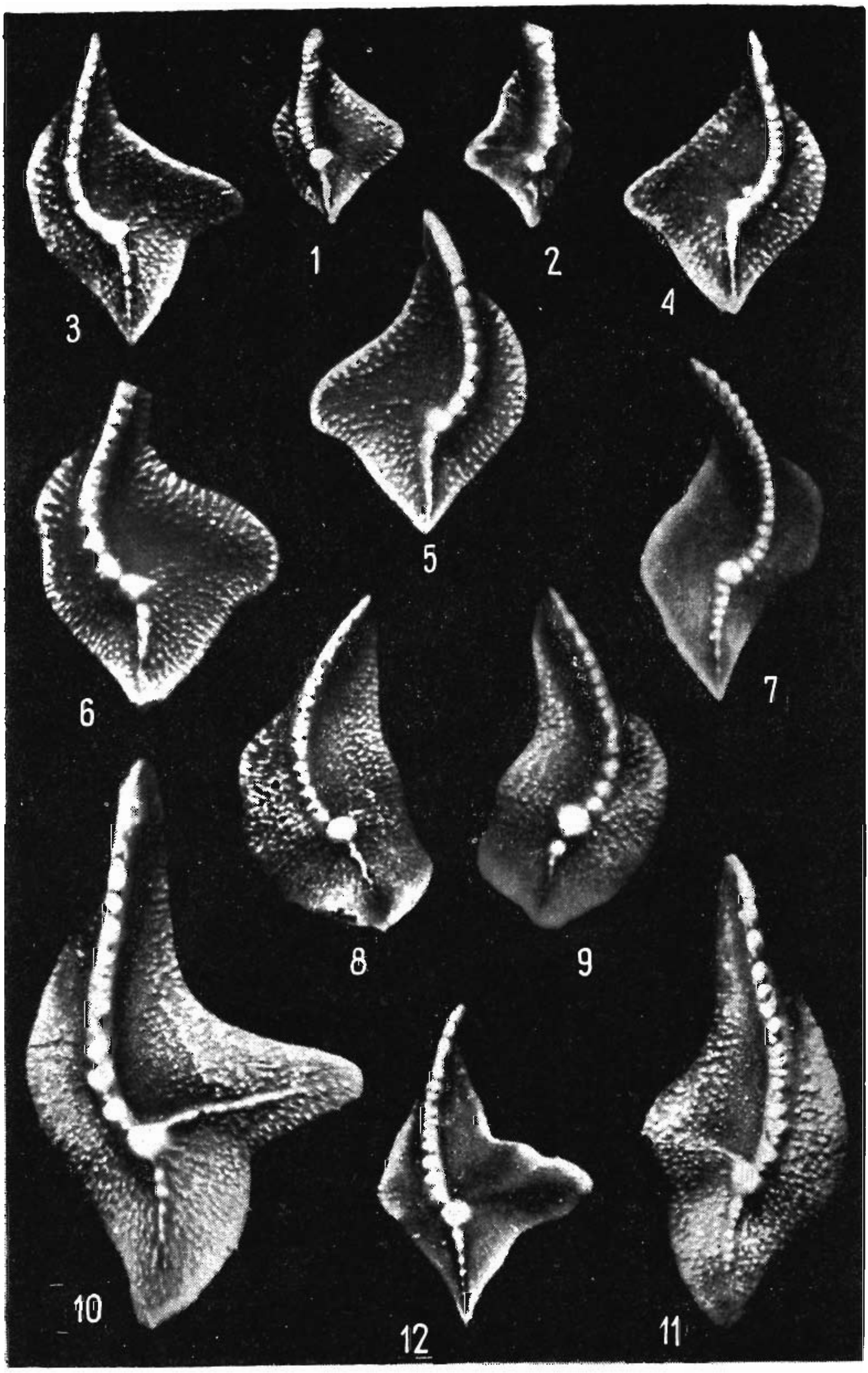
7 — *Palmatolepis* cf. *regularis* Cooper; hypotype (IGP/S. 98) from Kadzielnia (X 3).

8, 9 — *Palmatolepis crepida* Sannemann; *8* hypotype (IGP/S. 59) from Psie Górki (PG. 3), *9* hypotype (IGP/S. 58) from Kadzielnia (X. 3).

10, 11 — *Palmatolepis triangularis* Sannemann; two untypical specimens from Śluchowice (S. 41): *10* hypotype (IGP/S. 119) transitional to *P. perlobata perlobata* having pronouncedly extended inner lobe, *11* hypotype (IGP/S. 120) displaying extremely reduced inner lobe, transitional to *P. crepida*.

12 — *Palmatolepis subperlobata* Branson & Mehl; hypotype (IGP/S. 100) from Psie Górki (PG. 3).

All photographs are × 36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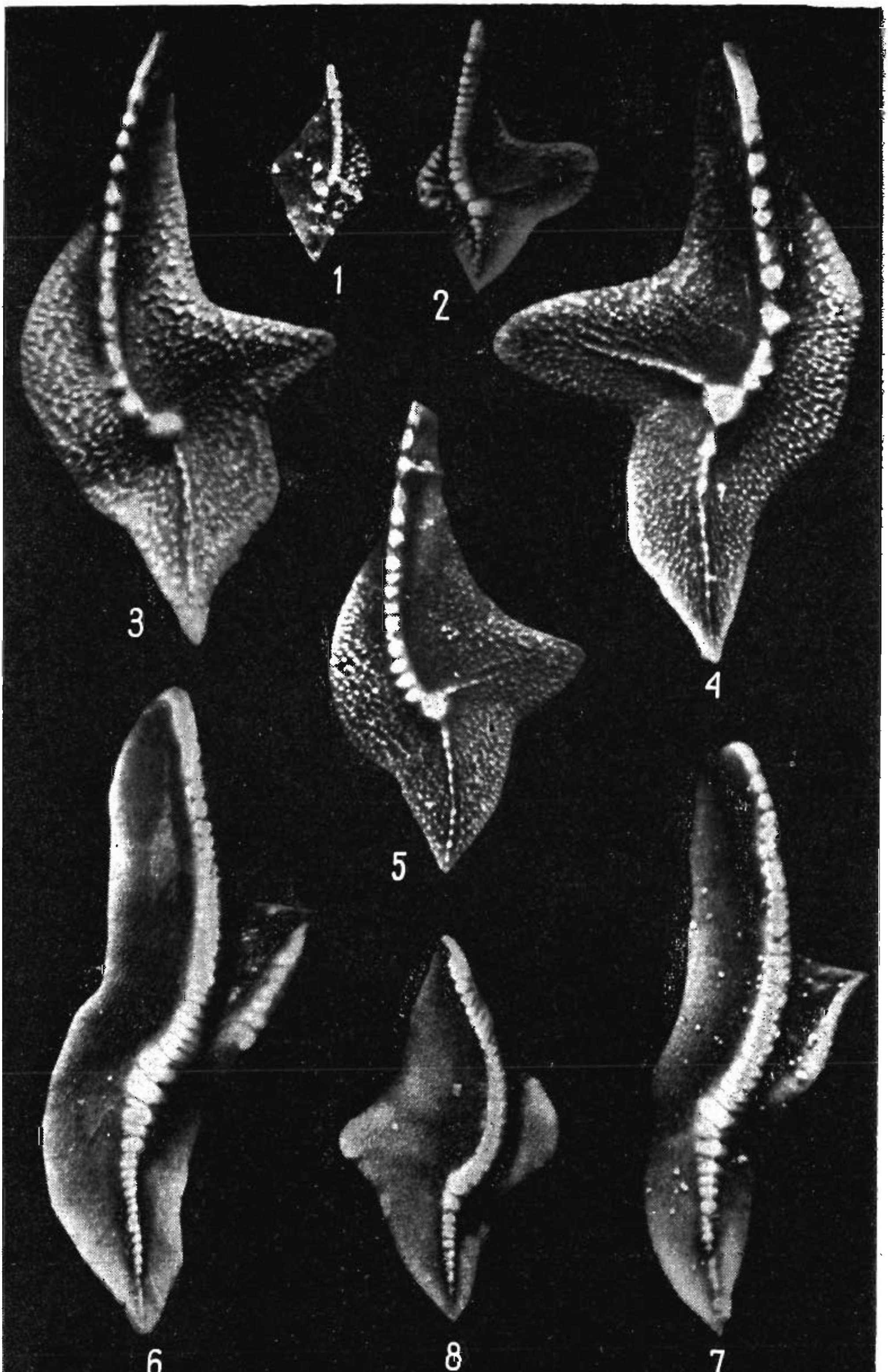
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Palmatolepis glabra acuta Helms, 1963
(Pl. 14, Figs 6—7)

1934. *Palmatolepis glabra* Ulrich & Bassler; Branson & Mehl, pp. 233—234, Pl. 18, Fig. 22 [non Figs 9, 26 = *P. glabra glabra*].
1961. *Palmatolepis glabra* Ulrich & Bassler, morphotype γ; Scott & Collinson, pp. 559—560, Pl. 76, Fig. 12 [non Figs 1—4, 11 = *P. glabra pectinata*].
1962. *Palmatolepis glabra* n.subsp. *A*; Ziegler (1962b), p. 59, Pl. 5, Figs 1, 2.
1963. *Palmatolepis (Panderolepis) serrata acuta* n.subsp.; Helms, pp. 468—469, Pl. 3, Figs 1—4, 6; Text-fig. 2, Fig. 23.
[non] 1965. *Palmatolepis glabra acuta* Helms; Bouckaert & Ziegler, Pl. 3, Fig. 7 [= *P. glabra pectinata*].
1967. *Palmatolepis glabra acuta* Helms; Wolska, p. 394, Pl. 8, Figs 13, 14, Text-fig. 10.

Diagnosis. — A subspecies of *Palmatolepis glabra* with an elongate, slightly sigmoid platform. Its anterior margin reaches perpendicularly the blade and forms a spiny process directed anteriorly and outwards. A high parapet runs obliquely to the blade and ascends above the spiny process.

Remarks. — Helms (1963, p. 468) maintains that in *Palmatolepis glabra acuta* the parapet does not reach the end of the process of platform. However, in some of the specimens under study it does. The denticulation of parapet appears only sporadically like in *P. glabra glabra* and *P. glabra pectinata* which has been found by Glenister & Klapper (1966, p. 814). *P. glabra acuta* differs from the last-named subspecies in the shape of the anterior outer platform. Helms' (1963) typical specimens, as well as those under study, have a narrower and less sigmoid platform than that in *P. glabra pectinata*.

Occurrence. — The range of *P. glabra* n. subsp. *A* (= *P. glabra acuta*), found by Ziegler (1962b, p. 59), extends from the Palmatolepis rhomboidea Zone (*to IIβ*) to the Lower Palmatolepis quadrantinodosa Zone (*to IIβ*). Wolska's (1967) specimens came from the P. quadrantinodosa Zone at Gałęzice and Łagów. The specimens under study come from Kadzielnia (X. 5).

Palmatolepis glabra pectinata Ziegler, 1962(b)

1962. *Palmatolepis glabra pectinata* n. subsp.; Ziegler (1962b), p. 59, Pl. 4, Fig. 16; Pl. 5, Figs 3—5.
1967. *Palmatolepis glabra pectinata* Ziegler; Freyer & Żakowa, p. 116, Pl. 2, Fig. 8.

PL. 14

1, 2 — *Palmatolepis quadrantinodosalobata* Sannemann; *1* hypotype (IGP/S. 97) from Sluchowice (S. 41) possessing only incipiently developed inner lobe, *2* hypotype (IGP/S. 96) from Kadzielnia (X. 4).
3, 4 — *Palmatolepis perlobata perlobata* Ulrich & Bassler; *3* large hypotype (IGP/S. 84) from Kadzielnia (X. 4), *4* large hypotype (IGP/S. 85) from Śluchowice (S. 41) in which prominent inner lobe is developed.
5 — *Palmatolepis triangularis* Sannemann; hypotype (IGP/S. 118) from Dalnia (D. 1)
6, 7 — *Palmatolepis glabra acuta* Helms; two types (IGP/S. 68, 69) from Kadzielnia (X. 5).
8 — *Palmatolepis tenuipunctata* Sannemann; hypotype (IGP/S. 108) from Kadzielnia (X. 4).

All photographs are × 36

1967. *Palmatolepis glabra pectinata* Ziegler; Wolska, pp. 392—394, Pl. 8, Figs 6—9, Text-fig. 9.
1968. *Palmatolepis glabra* Ulrich & Bassler; Huddle, pp. 29—31, Pl. 14, Fig. 14 [only].
1969. *Palmatolepis glabra pectinata* Ziegler; Druce, pp. 87—88, Pl. 17, Figs 7, 8; Pl. 18, Figs 1—3 [gives synonymy].

Remarks. — Glenister & Klapper (1966, pp. 809 and 814) discuss the relationships of *Palmatolepis glabra pectinata* to the nominate subspecies and to *P. distorta.* The variability of *P. glabra pectinata* in the material from the Holy Cross Mts has been presented by Wolska (1967, Text-fig. 9).

Occurrence. — The range of *P. glabra pectinata,* given by Ziegler (1962b, Table 2), reaches from the Upper Palmatolepis crepida Zone (*to IIα*) to the Upper Palmatolepis quadrantinodosa Zone (*to IIIα*). Wolska's (1967) specimens came from the zones ranging between Palmatolepis quadrantinodosa and Scaphignathus velifera at Gałęzice, Jabłonna, Kadzielnia and Łagów. The specimens under study come from Kadzielnia (*X. 5*).

Palmatolepis hassi Müller & Müller, 1957
(Pl. 10, Figs 5—6; Pl. 11, Figs 6—7)

1947. *Palmatolepis subperlobata* Branson & Mehl; Miller & Youngquist, p. 513, Pl. 75, Figs 13, 14.
1956. *Palmatolepis (Manticolepis) triangularis* (Sannemann); Müller (1956a), pp. 21—22, Pl. 3, Fig. 23 [non Figs 22, 24—33 = *P. subrecta*].
1956. *Palmatolepis subrecta* Müller; Hass, p. 19, Pl. 4, Fig. 13 [non Figs 9—12 = *P. subrecta;* non Figs 14, 15 = *P. gigas*].
1957. *Palmatolepis (Manticolepis) hassi* n.sp.; Müller & Müller, p. 1102—1103, Pl. 139, Fig. 2; Pl. 140, Figs 2—4.
1958. *Palmatolepis hassi* Müller & Müller; Ziegler, p. 60, Pl. 7, Figs 3—7, 10, 13.
1958. *Palmatolepis charlottae* Müller; Ziegler, p. 59, Pl. 7, Fig. 11 [non Figs 9, 12 = *P. subrecta*].
1963. *Palmatolepis hassi* Müller & Müller; Klapper & Furnish, Text-fig. 2, Fig. 9.
1968. *Palmatolepis gigas* Miller & Youngquist; Mound, p. 499, Pl. 68, Figs 3, 6 [non Figs 1, 2 = = *P. gigas*].

Remarks. — Ziegler (1962a) believes that *Palmatolepis hassi* makes up a transitional link from *P. martenbergensis* (= *P. punctata*) to *P. subrecta* and from *P. martenbergensis* to *P. rhenana* (= *P. gigas*). However, the validity of *P. hassi* has recently been called in question by some authors: Mound (1968, p. 498) considers *P. hassi* as a junior subjective synonym of *P. gigas,* while Anderson (1966, p. 409) believes that the type material of *P. hassi* is very close, if not identical, to the specimens considered by Ziegler (1958) as *P. subrecta.*

The estimation of the specimens, so far described as *P. hassi,* to be *P. gigas* or *P. subrecta* would be yet more arbitrary than the separation of the last-named two species from *P. hassi.* In addition, the regarding *P. hassi* as a junior synonym of *P. gigas* would extend the range of variability of the latter and, consequently, have to lower its stratigraphic importance.

Palmatolepis hassi differs from *P. gigas* in a shorter inner lobe and from *P. subrecta* in a wider inner platform, less sigmoid blade-carina and more uniformly distributed nodes which cover platform.

Occurrence. — According to Ziegler (1962b, pp. 19 and 23), *P. hassi* occurs from the Middle Polygnathus asymmetricus Zone (*to Iα*) to the lower part of the Upper Palmatolepis gigas Zone (*to Iδ*). The specimens uder study come from Kostomłoty (*Y. 18*), Kadzielnia (*XA. 3; XB. 5*), Wietrznia II (*V. 20*), Górno (*G. 2, 4, 5, 7*), Kowala (*KW. 21, 24, 26*).

Palmatolepis linguiformis Müller, 1956(a)
(Pl. 12, Fig. 9)

1956. *Palmatolepis (Palmatolepis) linguiformis* n.sp.; Müller (1956a), pp. 24—25, Pl. 7, Figs 1—7.
1964. *Palmatolepis crepida* Sannemann; Friàkova, Text-fig. 1, Fig. 6.
1966. *Palmatolepis linguiformis* Müller; Glenister & Klapper, p. 815, Pl. 88, Figs 4, 5 [give synonymy].
1967. *Palmatolepis linguiformis* Müller; Wolska, p. 396, Pl. 6, Figs 9, 10.

Remarks. — The material under study consists of specimens well corresponding to the typical forms of *Palmatolepis linguiformis.* The differences between *P. linguiformis* and *P. crepida* were discussed in detail by Glenister & Klapper (1966, p. 816).

Occurrence. — *P. linguiformis* was found by Ziegler (1962b, Table 2) only in the upper part of the Upper Palmatolepis gigas Zone (*to Iδ*) and by Wolska (1967, pp. 365—366 and 396) in the Palmatolepis triangularis Zone at Płucki, where it seems to be an older, reworked element in a mixed assemblage of a little younger age. The specimens under study come from Kostomłoty (*Y. 18*), Górno (*G. 2, 3*).

Palmatolepis minuta minuta Branson & Mehl, 1934
(Pl. 15, Figs 1, 11)

1934. *Palmatolepis minuta* n.sp.; Branson & Mehl, pp. 236—237, Pl. 18, Figs 1, 6, 7.
1963. *Palmatolepis minuta minuta* Branson & Mehl; Ruchholz, Fig. 13.
1966. *Palmatolepis minuta minuta* Branson & Mehl; Glenister & Klapper, p. 817, Pl. 90, Figs 1, 2, 7—14 [give synonymy].
1967. *Palmatolepis minuta* Branson & Mehl; Kościelniakowska, Pl. 9, Fig. 1.
1967. *Palmatolepis minuta* (Branson & Mehl) [sic]; Nehring, pp. 147—148 [pars], Pl. 3, Fig. 5 [non Pl. 1, Fig. 3 = *P. minuta wolskae*].
1967. *Palmatolepis minuta minuta* Branson & Mehl; Wolska, p. 397, Pl. 7, Figs 1—4, Text-fig. 11 [pars].
1967. *Palmatolepis minuta loba* Helms; Wolska, pp. 398—399, Pl. 7, Figs 5, 7 [non Fig. 6 = *P. minuta wolskae*], Text-fig. 12 [pars].
1969. *Palmatolepis minuta minuta* Branson & Mehl, Druce, pp. 89—90, Pl. 17, Fig. 6.
1969. *Palmatolepis minuta minuta* Branson & Mehl; Kononova, p. 131, Pl. 1, Fig. 7.

Remarks. — The differences between the nominate subspecies and both *Palmatolepis minuta loba* and *P. minuta schleizia* are discussed by Glenister & Klapper (1966, pp. 817—818).

Occurrence. — According to Ziegler (1962b, Table 2), *P. minuta minuta* occurs from the Upper Palmatolepis triangularis Zone (*to I/II*) to the Upper Scaphignathus velifera Zone (*to IIIβ — IV*). The specimens under study come from Kadzielnia (*X. 3, 4, 5*), Psie Górki (*PG. 1, 2, 3*).

Palmatolepis minuta loba Helms, 1963
(Pl. 15, Fig. 15)

1963. *Palmatolepis (Deflectolepis) minuta loba* n.subsp.; Helms, pp. 470—471, Pl. 2, Figs 13, 14; Pl. 3, Fig. 12.
[non] 1967. *Palmatolepis minuta loba* Helms; Kościelniakowska, Pl. 9, Fig. 2 [= *P. minuta wolskae?*].
1967. *Palmatolepis minuta loba* Helms; Wolska, pp. 398—399 [pars], Text-fig. 12 [pars] [non Pl. 7, Figs 5, 7 = *P. minuta minuta*, non Fig. 6 = *P. minuta wolskae*].

Remarks. — *Palmatolepis minuta loba* differs from the remaining subspecies of *P. minuta* in a very strongly elongated and flat inner lobe and from *P. minuta minuta* also in a more conspicuous azygous node which in turn is usually much larger in *P. minuta wolskae.* The last-named subspecies has not the carina posteriorly of the azygous node, while *P. minuta loba* has.

Occurrence. — According to Helms (1963, p. 471), *P. minuta loba* occurs in the upper part of *to IIa*, but Glenister & Klapper (1966, Table 1) found this subspecies in the Lower and Upper Palmatolepis crepida Zone (*to IIa*). The specimens under study come from Kadzielnia (*X. 3, 4, 5*).

Palmatolepis minuta wolskae subsp. n. (Pl. 15, Figs 2, 12—14)

?1967. *Palmatolepis minuta loba* Helms; Kościelniakowska, Pl. 9, Fig. 2.
1967. *Palmatolepis triangularis* Sannemann; Nehring, pp. 142—143, Pl. 4, Fig. 11 [non Pl. 5, Fig. 10 = *P. quadrantinodosalobata*].
1967. *Palmatolepis minuta* (Branson & Mehl) [sic]; Nehring, pp. 147—148 [pars], Pl. 1, Fig. 3 [non Pl. 3, Fig. 5 = *P. minuta minuta*].
1967. *Palmatolepis minuta loba* Helms; Wolska, pp. 398—399 [pars], Pl. 7, Fig. 6 [non Figs 5, 7 = *P. minuta minuta*, non Text-fig. 12 = *P. minuta minuta* and *P. minuta loba*].

Holotype: specimen numbered IGP/S. 80, figured in Pl. 15, Fig. 13.
Type horizon: Middle or Upper Palmatolepis crepida Zone (*to IIa*).
Type locality: Kadzielnia quarry in Kielce.
Derivation of name: in memory of the late Dr Z. Wolska.

Diagnosis. — A subspecies of *Palmatolepis minuta* devoid of the carina posteriorly of the azygous node. Azygous node prominent. Platform elongate, with inner lobe developed. Inner lobe flat.

Remarks. — Ziegler (1969) recognized Nehring's (1967, Pl. 4, Fig. 11) specimen as a new subspecies of *Palmatolepis minuta*. The introduced subspecies *P. minuta wolskae* differs from the remaining subspecies of *P. minuta* in a lack of the carina posteriorly of the azygous node. In addition, from the specimens of *P. minuta minuta* with a similar platform outline, it differs in a more prominent azygous node. The inner lobe in *P. minuta loba* is more strongly extended than in *P. minuta wolskae*.

PL. 15

1, 11 — *Palmatolepis minuta minuta* Branson & Mehl; *1* hypotype (IGP/S. 78) from Kadzielnia (X. 4), *11* hypotype (IGP/S. 77) from Kadzielnia (X. 5).

2, 12—14 — *Palmatolepis minuta wolskae* subsp.n.; *2, 12, 14* three paratypes (IGP/S. 81—83) from Kadzielnia (X. 4), *13* holotype (IGP/S. 80) from Kadzielnia (X. 4).

3 — *Palmatolepis termini* Sannemann; hypotype (IGP/S. 109) from Kadzielnia (X. 4).

4 — *Palmatolepis rhomboidea* Sannemann; hypotype (IGP/S. 99) from Kadzielnia (X. 5).

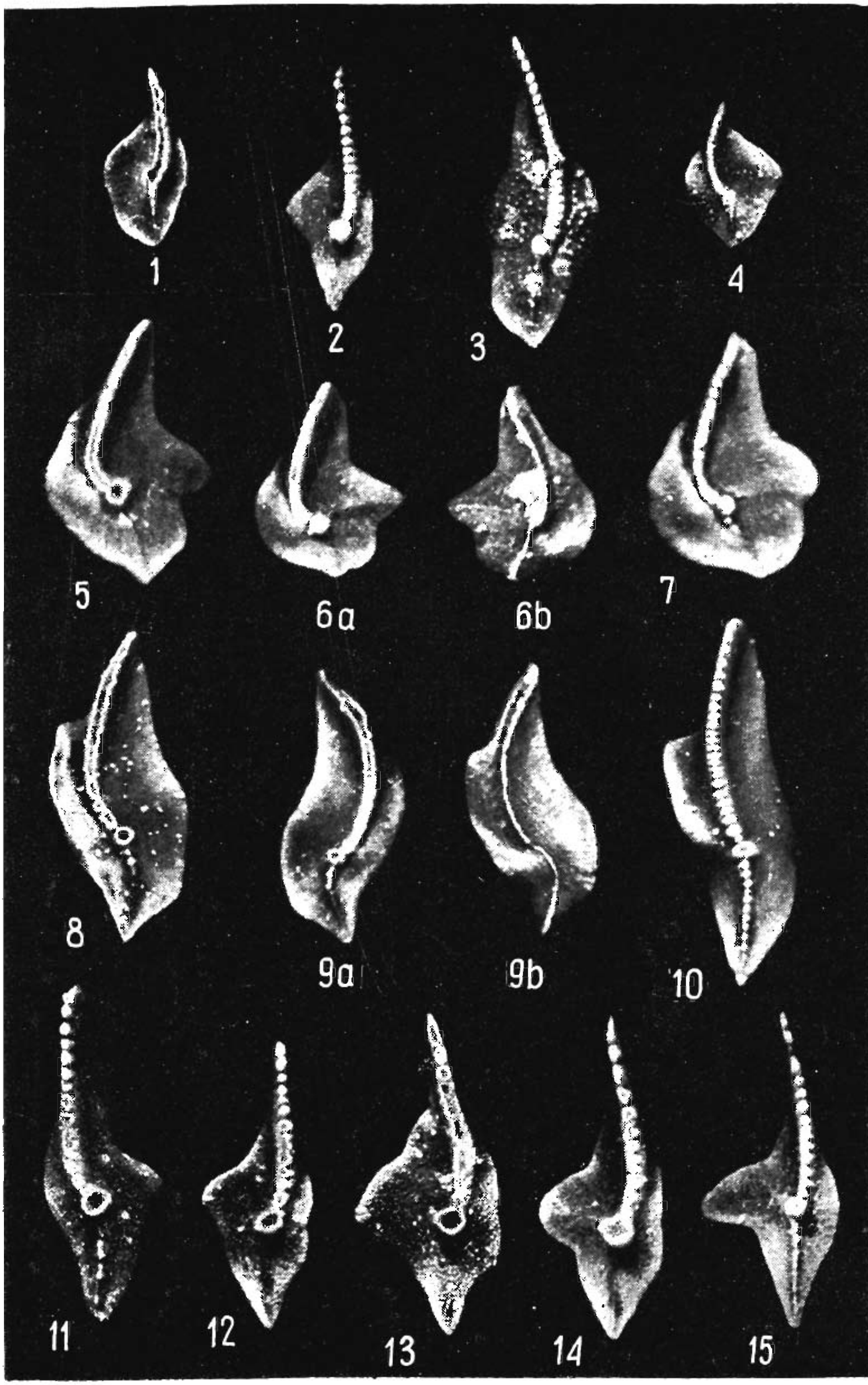
5—7 — *Palmatolepis circularis* sp.n.; *5, 7* two paratypes (IGP/S. 56, 57) from Kadzielnia (X. 4), *6a-b* upper and lower views of holotype (IGP/S. 55) from Kadzielnia (X. 4); part of basal plate preserved on lower side of the holotype.

8, 9 — *Palmatolepis quadrantinodosa* aff. *inflexa* Müller; two specimens from Kadzielnia (X. 5): *8* hypotype (IGP/S. 95), *9a-b* upper and lower views of hypotype (IGP/S. 4, 94).

10 — *Palmatolepis glabra glabra* Ulrich & Bassler; hypotype (IGP/S. 67) from Kadzielnia (X. 5).

15 — *Palmatolepis minuta loba* Helms; hypotype (IGP/S. 79) from Kadzielnia (X. 5)

All photographs are × 36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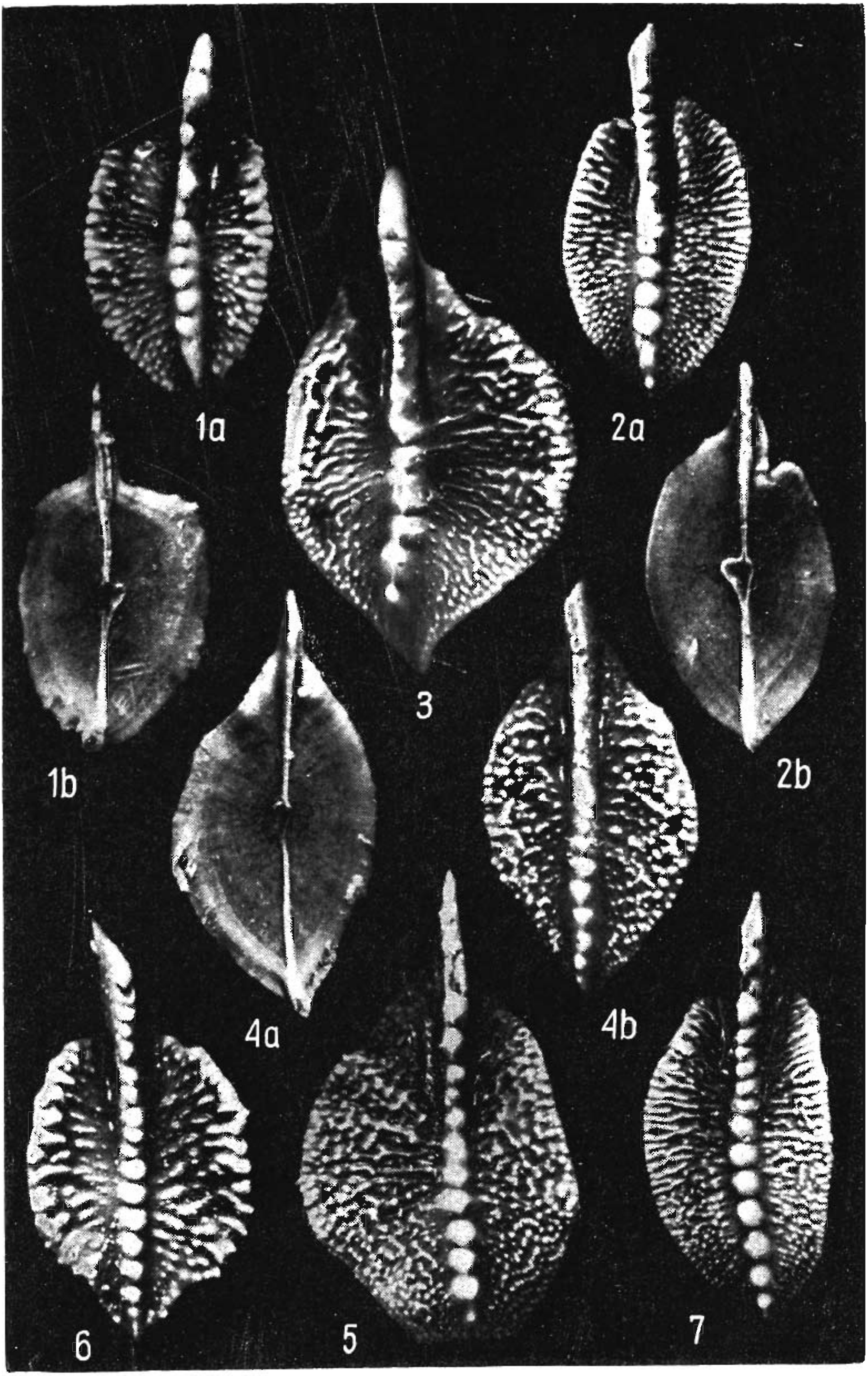
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The differentiation of the inner lobe in *P. minuta wolskae*, is variable. Some of the specimens have their inner lobe pronouncedly separated like in *P. minuta loba*. In others, the lobe is less distinctly separated from the rest of platform like in the nominate species.

Occurrence. — All the specimens, included in the synonymy of *P. minuta wolskae* subsp. n., come from Poland. The assemblage of conodonts described by Nehring (1967, pp. 121—122) and containing *P. minuta wolskae*, after the revision of some determinations, is as a whole indicative of the Upper Palmatolepis crepida Zone (*to IIa*). The specimens under study come from Kadzielnia (*X. 4*), Psie Górki (*PG. 1*), Kowala (*T. 16*).

Palmatolepis perlobata perlobata Ulrich & Bassler, 1926
(Pl. 14, Figs 3—4)

1926. *Palmatolepis perlobata* n.sp.; Ulrich & Bassler, p. 49, Pl. 7, Fig. 22 [non Figs 19, 21 = = *Palmatolepis* sp. indet., non Fig. 20 = *P. triangularis*, non Fig. 23 = *P. gigas*].
1961. *Palmatolepis perlobata schindewolfi* (Müller) [sic]; Dvořák & Freyer, Pl. 1, Figs 6, 7.
1963. *Palmatolepis perlobata schindewolfi* Müller; Forti & Nocchi, pp. 324—325, Pl. 20, Fig. 6.
1963. *Palmatolepis perlobata schindewolfi* Müller; Ruchholz, Fig. 7.
1963. *Palmatolepis perlobata* cf. *schindewolfi* Müller; Ruchholz, Fig. 8.
1965. *Palmatolepis perlobata schindewolfi* Müller; Bouckaert & Ziegler, Pl. 3, Fig. 5.
1966. *Palmatolepis perlobata perlobata* Ulrich & Bassler; Glenister & Klapper, p. 818, Pl. 92, Figs 8, 13; Pl. 93, Figs 1—6 [give synonymy].
1967. *Palmatolepis perlobata schindewolfi* Müller; Freyer & Żakowa, pp. 117—118, Pl. 2, Fig. 1.
1967. *Palmatolepis perlobata perlobata* Ulrich & Bassler; Wolska, pp. 400—401, Pl. 10, Figs 1—8 [non Pl. 12, Figs 8, 9 = *P. tenuipunctata*], Text-fig. 14.
1968. *Palmatolepis perlobata* Ulrich & Bassler; Huddle, pp. 32—33, Pl. 15, Figs 2, 5, 8 [non Figs 1, 3, 4, 6, 7, 9 = *Palmatolepis* sp. indet., non Fig. 10 = *P. perlobata sigmoidalis*; non Pl. 16, Fig. 8 = *P. triangularis*, non Fig. 9 = *Palmatolepis* sp. indet.].
1969. *Palmatolepis perlobata schindewolfi* Müller; Kononova, pp. 131—132, Pl. 1, Fig. 5.

Remarks. — Since both subspecies distinguished by Ziegler (1962b) may have a secondary carina or be devoid of it and in both of them the inner lobe may be directed slightly anteriorly, Glenister & Klapper (1966, p. 818) included *P. perlobata schindewolfi* in *P. perlobata perlobata*. The material here presented confirms this conclusion. In addition to typical forms, in the Palmatolepis crepida Zone there occur the forms with a less sigmoidal platform and resembling some of Ziegler's (1962, Text-fig. 6a—c) specimens. They differ from *P. triangularis* in a long and

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PL. 16

1, 2, 6, 7 — *Polygnathus dengleri* Bischoff & Ziegler; *1a-b* upper and lower views of hypotype (IGP/S. 132) from Wietrznia I (W. 52), *2a-b* upper and lower views of hypotype (IGP/S. 138) from Wietrznia I (W. 28), *6* hypotype (IGP/S. 133) from Sluchowice (S. 15), *7* hypotype (IGP/S. 137) from Wietrznia I (W. 52).

3—5 — *Polygnathus asymmetricus asymmetricus* Bischoff & Ziegler; *3* large hypotype (IGP/S. 127) from Wietrznia I (W. 52), *4a-b* lower and upper views of hypotype (IGP/S. 129) from Śluchowice (S. 6), *5* large hypotype (IGP/S. 128) from Wietrznia I (W. 52) — posterior part of the platform broken. Specimens shown in Figs 3 and 5 have a platform outline tending toward that of *Palmatolepis transitans* but have not a differentiated azygous node.

All photographs are × 36

narrow inner lobe, which may be directed either slightly anteriorly, or slightly posteriorly and which may have a secondary carina or be devoid of it.

Occurrence. — The range of *P. perlobata perlobata*, given by Ziegler (1962b, pp. 70—71), reaches from the Upper Palmatolepis triangularis Zone (*to I/II*) to the Lower Spathognathus bischoffi Zone (*to V*). The specimens under study come from Kostomłoty (*Y. 31*), Śluchowice (*S. 41*), Dalnia (*D. 1*), Kadzielnia (*X. 4, 5*), Psie Górki (*PG. 1, 2*).

Palmatolepis proversa Ziegler, 1958
(Pl. 9, Fig. 8; Pl. 10, Figs 1—4)

1958. *Palmatolepis proversa* n.sp.; Ziegler, pp. 62—63, Pl. 3, Figs 11, 12; Pl. 4, Figs 1—14.
1966. *Palmatolepis proversa* Ziegler; Glenister & Klapper, p. 818 [give synonymy].
[non] 1966. *Palmatolepis proversa* Ziegler; Winder, Pl. 156, Fig. 14 [= *P. punctata?*].
1968. *Palmatolepis proversa* Ziegler; Pollock, Pl. 61, Fig. 22.
[non] 1968. *Palmatolepis proversa* Ziegler; Mound, p. 500, Pl. 68, Figs 14, 16, 21; Pl. 71, Figs 15, 19 [= *P. punctata*].

Remarks. — There are transitions from *Palmatolepis proversa* to *P. punctata* and *P. subrecta*. *P. proversa* differs from *P. punctata* in a slimmer platform and narrower inner lobe. In *P. proversa*, the anterior margin of inner lobe runs obliquely anteriorly or perpendicularly to carina, but the trace of this margin in some specimens of *P. puctata* is similar. This character allows one, however, to distinguish between *P. proversa* and *P. subrecta*.

Occurrence. — The range of *P. proversa*, given by Ziegler (1958, Table 2; 1962b, pp. 19, 20 and 22), stretches from the Middle Polygnathus asymmetricus Zone (*to Iα*) to the lower part of the Lower Palmatolepis gigas Zone (*to Iγ*). The specimens under study come from Kadzielnia (*XA. 2, X.2*), Psie Górki (*P. 5, 7*), Wietrznia I (*W. 56, 58, 73*), Wietrznia III (*V. 17*), Górno (*G. 3, 5, 7*).

Palmatolepis punctata (Hinde, 1879)
(Pl. 9, Fig. 8; Pl. 10, Figs 1—4)

1879. *Polygnathus punctatus* n.sp.; Hinde, p. 367, Pl. 17, Fig. 14.
1958. *Palmatolepis transitans* Müller; Ziegler, p. 66, Pl. 2, Figs 1, 8 [only].
1966. *Palmatolepis punctata* (Hinde); Winder, Pl. 156, Fig. 13.
1966. *Palmatolepis punctata* (Hinde); Glenister & Klapper, p. 819, Pl. 88, Figs 8, 9 [give synonymy].
1968. *Palmatolepis punctata* (Hinde); Pollock, Pl. 61, Fig. 28.
1968. *Palmatolepis punctata* (Hinde); Mound, pp. 500—501, Pl. 68, Figs 4, 5, 10—13.
1968. *Palmatolepis proversa* Ziegler; Mound, p. 500, Pl. 68, Figs 14, 16, 21; Pl. 71, Figs 15, 19.
1968. *Palmatolepis punctata* (Hinde); Orr & Klapper, Pl. 140, Fig. 12.
1968. *Palmatolepis punctata* (Hinde); Huddle, pp. 33—34, Pl. 16, Figs 1, 3 [non Fig. 2 = *Palmatolepis* sp. indet.].

Remarks. — *Palmatolepis punctata* differs from *P. transitans* primarily in a more markedly differentiated inner lobe. Glenister & Klapper (1966, p. 819), as well as Huddle (1968, p. 34) found that specimens, having their platform outline corresponding to that of *P. punctata*, may also have a straight carina. Due to the importance of the platform outline which is decisive in discriminating between the two species, some of the specimens described by Ziegler (1958, Pl. 2, Figs 1 and 8) should now be considered as *P. punctata*.

Occurrence. — The range of *P. punctata*, given by Ziegler (1962b, pp. 19 and 22), reaches from the base of the Middle Polygnathus asymmetricus Zone (*to Iα*) to the Lower Palmatolepis gigas Zone (*to Iγ*). The specimens under study come from Czarnów (*C. 15, 17, 20*), Śluchowice (*S. 17, 20, 24, 29, 34*), Kadzielnia (*XA. 2; XB. 1, 2; X. 2*), Psie Górki (*P. 5, 7*), Wietrznia I (*W. 56, 71, 86*), Wietrznia III (*V. 17*), Górno (*G. 1, 2, 3, 4*), Kowala (*KW. 14, 18, 19, 21, 26*).

Palmatolepis quadrantinodosa aff. *inflexa* Müller, 1956(a) (Pl. 15, Figs 8—9)

[cf.] 1956. *Palmatolepis (Palmatolepis) inflexa* n.sp.; Müller (1956a), pp. 30—31, Pl. 10, Fig. 5 [non Figs 3, 4, 6, 8, 9, 11 = *P. quadrantinodosa marginifera*, non Figs 7, 10 = *P. quadrantinodosa quadrantinodosa*].
1965. *Palmatolepis* sp. *b*; Bouckaert & Ziegler, Pl. 3, Figs 11, 12.

Remarks. — The platform outline and the manner it reaches the free blade in the forms, described as *Palmatolepis quadrantinodosa* aff. *inflexa*, is characteristic of *P. quadrantinodosa*. The platform outline of these forms is most similar to that in *P. quadrantinodosa marginifera*. The specimens under study differ, however, from the last-named subspecies in a lack of parapet on the outer margin of platform. This character relates them, on the other hand, to *P. quadrantinodosa inflexa*. Bouckaert & Ziegler (1965) consider *Palmatolepis* sp. *b* (= *P. quadrantinodosa* aff. *inflexa*) as a probably transitional form between *P. quadrantinodosa inflexa* and *P. rhomboidea*. The forms, described by Ziegler (1962b, p. 159) as *Palmatolepis* sp. and by Glenister & Klapper (1966) and Wolska (1967) as *P. quadrantinodosa* aff. *marginifera*, differ from the forms under study in having bulge on the anterior inner platform.

Occurrence. — Bouckaert & Ziegler (1965, p. 14) found *Palmatolepis* sp. *b* (= *P. quadrantinodosa* aff. *inflexa*) in the upper part of the Palmatolepis rhomboidea Zone (*to IIβ*). The specimens under study also come from the Palmatolepis rhomboidea Zone at Kadzielnia (*X. 5*).

Palmatolepis quadrantinodosalobata Sannemann, 1955(a) (Pl. 14, Figs 1—2)

1955. *Palmatolepis quadrantinodosalobata* n.sp.; Sannemann (1955a), p. 328, Pl. 24, Fig. 6.
1956. *Palmatolepis quadrantinodosalobata* Sannemann; Bischoff, p. 129, Pl. 8, Figs 19—21 [non Fig. 22 = *P. triangularis*].
1960. *Palmatolepis quadrantinodosalobata* Sannemann; Freyer, p. 66, Pl. 4, Fig. 89.
1965. *Palmatolepis quadrantinodosalobata* Sannemann; Bouckaert & Ziegler, Pl. 1, Figs 8—12.
1966. *Palmatolepis quadrantinodosalobata* Sannemann; Glenister & Klapper, p. 821, Pl. 92, Figs 1—3 [give synonymy].
1967. *Palmatolepis quadrantinodosalobata* Sannemann; Nehring, pp. 143—144, Pl. 2, Fig. 1.
1967. *Palmatolepis triangularis* Sannemann; Nehring, pp. 142—143, Pl. 5, Fig. 10 [non Pl. 4, Fig. 11 = *P. minuta wolskae*].
1967. *Palmatolepis quadrantinodosalobata* Sannemann; Wolska, pp. 403—404, Pl. 13, Figs 5—9 [non Fig. 10 = *P. triangularis* transitional to *P. quadrantinodosalobata*].

Remarks. — The specimens of *Palmatolepis quadrantinodosalobata* have platform outlines similar to that in *P. subperlobata* from which they differ in the presence of a cluster of nodes on the anterior outer platform. Less numerous nodes may also occur on other parts of the platform, except, however, for the posterior inner platform. All the specimens available are in conformity with the characteristics given above. Among them there are no transitional forms between *P. triangularis* and *P. quadrantinodosalobata* termed by Ziegler (1962b, p. 73) as „*P. triangularis* → *P. quadrantinodosalobata*", which have nodes scattered all over the platform.

Occurrence. — Ziegler (1962b, p. 73) found that a typical *P. quadrantinodosalobata* occurred only in the Palmatolepis crepida Zone (*to IIa*). Wolska's specimens came from the same zone at Jabłonna, Kadzielnia and Janczyce. The specimens under study come from Śluchowice (*S. 41*), Dalnia (*D. 1*), Kadzielnia (*X. 3, 4*), Psie Górki (*P. 12; PG. 2*), Kowala (*T. 16*).

Palmatolepis cf. *regularis* Cooper, 1931
(Pl. 13, Fig. 7)

[cf.] 1931. *Palmatolepis regularis* n.sp.; Cooper, p. 242, Pl. 28, Fig. 36.
1966. *Palmatolepis* cf. *regularis* Cooper; Glenister & Klapper, pp. 821—822, Pl. 92, Figs 14—16 [give synonymy].
1967. *Palmatolepis regularis* Cooper; Nehring, p. 142, Pl. 4, Fig. 12, Text-fig. 19.
1967. *Palmatolepis* cf. *regularis* Cooper; Wolska, p. 404, Pl. 6, Figs 11—15.

Remarks. — The upper surface of the holotype of *Palmatolepis regularis* is embedded in shale matrix and hence an accurate comparison of the specimens described later with the holotype is impossible. According to Wolska (1967, p. 404), the variability of *P.* cf. *regularis* in the material from the Holy Cross Mts is identical with that presented by Ziegler (1962b, Text-fig. 7).

Occurrence. — The range of *Palmatolepis* cf. *regularis*, given by Ziegler (1962b, p. 77), extends from the Upper Palmatolepis triangularis Zone (*to I/II*) to the Upper Palmatolepis crepida Zone (*to IIa*). Wolska (1967, p. 404) found *P.* cf. *regularis* in the Palmatolepis crepida Zone at Jabłonna, Kadzielnia and Janczyce. The specimens under study come from Kadzielnia (*X. 3, 4*).

Palmatolepis rhomboidea Sannemann, 1955(a)
(Pl. 15, Fig. 4)

1955. *Palmatolepis rhomboidea* n.sp.; Sannemann (1955a), p. 329, Pl. 24, Fig. 14.
1966. *Palmatolepis rhomboidea* Sannemann; Glenister & Klapper, p. 822, Pl. 92, Fig. 4; Pl. 95, Fig. 18 [give synonymy].
1967. *Palmatolepis rhomboidea* Sannemann; Wolska, p. 405, Pl. 9, Figs 1—3.

Remarks. — Glenister & Klapper (1966, p. 822) give a complete diagnosis and discuss relationship of *Palmatolepis rhomboidea* to other species. The specimens from Kadzielnia were described and illustrated by Wolska (1967).

Occurrence. — According to Ziegler (1962b, p. 78) and other authors, this species occurs only in the Palmatolepis rhomboidea Zone (*to IIβ*). The only specimen under study comes from Kadzielnia (*X. 5*).

Palmatolepis subperlobata Branson & Mehl, 1934
(Pl. 13, Fig. 12)

1934. *Palmatolepis subperlobata* n.sp.; Branson & Mehl, p. 235, Pl. 18, Figs 11, 21.
[non] 1957. *Palmatolepis subperlobata* Branson & Mehl; Lys & Serre (1957b), p. 1047, Pl. 5, Fig. 1 [= *P. triangularis*].
1965. *Palmatolepis subperlobata* Branson & Mehl; Bouckaert & Ziegler, Pl. 2, Figs 12, 13.
1966. *Palmatolepis superlobata* [sic] Branson & Mehl; Spasov, Pl. 1, Fig. 16.
1966. *Palmatolepis subperlobata* Branson & Mehl; Glenister & Klapper, pp. 822—823, Pl. 92, Figs 5—7 [give synonymy].
1966. *Palmatolepis subperlobata* Branson & Mehl; Winder, Pl. 156, Fig. 9.
[non] 1966. *Palmatolepis (Manticolepis?) subperlobata* (Branson & Mehl); Koverdynský & Zikmundová, Pl. 1, Fig. 5.
1967. *Palmatolepis subperlobata* Branson & Mehl; Wolska, p. 407, Pl. 12, Figs 7, 10.

Remarks. — From other species with a similar platform outline, *Palmatolepis subperlobata* differs in a shagreenlike upper surface of the platform, devoid of nodes. It differs from *P. tenuipunctata* in a more prominent inner lobe.

Occurrence. — The range of *P. subperlobata*, given by Ziegler (1962b, p. 79), reaches from the Lower Palmatolepis triangularis Zone (*to Iδ*) to the Upper Palmatolepis crepida Zone (*to IIa*). The specimens under study come from Kostomłoty (*Y. 23, 27*), Śluchowice (*S. 40, 41*), Dalnia (*D. 1*), Kadzielnia (*X. 3, 5*), Psie Górki (*P. 12; PG. 1, 2, 3*), Kowala (*T. 16*).

Palmatolepis subrecta Miller & Youngquist, 1947
(Pl. 10, Figs 8—9; Pl. 12, Figs 4—8)

1947. *Palmatolepis subrecta* n.sp.; Miller & Youngquist, p. 513, Pl. 75, Figs 7—11.
1956. *Palmatolepis subrecta* Miller & Youngquist; Hass, p. 19, Pl. 3, Fig. 12 [non Fig. 14 = *P. gigas*], Pl. 4, Figs 9—12 [non Fig. 13 = *P. hassi*, non Figs 14, 15 = *P. gigas*].
1957. *Palmatolepis marginatus* Stauffer; Lys & Serre (1957a), p. 804, Pl. 11, Fig. 4.
1957. *Palmatolepis triangularis* Sannemann; Lys & Serre (1957a), p. 804, Pl. 11, Fig. 5.
1957. *Palmatolepis triangularis* Sannemann; Lys & Serre (1957b), p. 1048, Pl. 5, Fig. 2.
1962. *Palmatolepis subrecta* Miller & Youngquist; Spasov & Stefanovitch, p. 60, Pl. 1, Figs 1, 2, 4—6.
1963. *Palmatolepis subrecta* Miller & Youngquist; Ruchholz, Pl. 1, Figs 9, 10.
1966. *Palmatolepis subrecta* Miller & Youngquist; Anderson, p. 409, Pl. 49, Figs 11—15, 17, 19.
1966. *Palmatolepis subrecta* Miller & Youngquist; Glenister & Klapper, pp. 823—824, Pl. 88, Figs 1—3 [give synonymy].
1966. *Palmatolepis subrecta* Miller & Youngquist; Winder, Pl. 156, Fig. 8.
1967. *Palmatolepis subrecta* Miller & Youngquist; Kościelniakowska, Pl. 9, Figs 4—6.
1967. *Palmatolepis subrecta* Miller & Youngquist; Wolska, p. 407, Pl. 12, Figs 1—6.
1968. *Palmatolepis subrecta* Miller & Youngquist; Pollock, Pl. 61, Fig. 21.
1968. *Palmatolepis subrecta* Miller & Youngquist; Mound, p. 501, Pl. 68, Figs 7, 15, 17; Pl. 71, Figs 5—7, 9, 10.
[non] 1968. *Palmatolepis subrecta* Miller & Youngquist; Huddle, pp. 34—35, Pl. 16, Figs 5, 6 [Fig. 5 = *P. gigas*, Fig. 6 = *Palmatolepis* sp. indet.].
1969. *Palmatolepis subrecta* Miller & Youngquist; Kononova, p. 135, Pl. 1, Fig. 1.

Remarks. — Ziegler (1962a, b) showed that *Palmatolepis subrecta* has a very wide range of morphological variability and transitions to most of the species of *Palmatolepis* which concur with it. The variability of *P. subrecta* in the material under study is also extensive. It is manifested in platform outline, direction of its inner lobe, arrangement of nodes on the upper surface and presence of a secondary carina. *P. subrecta* differs from *P. gigas* in a less differentiated inner lobe. In addition, the free blade in *P. subrecta* has denticles uniform in size, while the denticulation of *P. gigas* is strongly variable. The uniform development of the denticles of free blade also differs *P. subrecta* from *P. unicornis*. The differences between *P. subrecta* and *P. hassi* are discussed with the latter species.

Occurrence. — According to Ziegler (1962b, p. 80), the range of the species extends from the Upper Polygnathus asymmetricus Zone (*to Iβ*) to the Middle Palmatolepis triangularis Zone (to *Iδ?*). Wolska's (1967, p. 407) specimens came from the P. triangularis Zone at Płucki and Jabłonna. The specimens under study come from Kostomłoty (*KT. 7, 9, 19, 25, 33; KS. 6, 34; KE. 20; Y. 1, 5, 11, 14, 18, 20, 21*), Sluchowice (*S. 14, 20, 21, 22, 23, 26, 27, 29, 34, 36, 37, 38*), Kadzielnia (*XA. 4, 5, 7, 9; XB. 2, 4, 5, 6*), Psie Górki (*P. 1, 7, 8a, 8c, 9, 9a, 10, 10a, 10b, 10c*), Wietrznia I (*W. 86, 88*), Wietrznia III (*V. 17, 18, 20, 34, 41, 56, 57*), Górno (*G. 1, 2, 3, 4, 5, 7*), Kowala (*KW. 13, 18, 19, 20, 21, 23, 24, 26, 28, 29, 30, 31, 32*).

Palmatolepis tenuipunctata Sannemann, 1955(b)
(Pl. 14, Fig. 8)

1955. *Palmatolepis tenuipunctata* n.sp.; Sannemann (1955b), p. 136, Pl. 6, Fig. 22.
1965. *Palmatolepis tenuipunctata* Sannemann; Bouckaert & Ziegler, Pl. 2, Figs 10, 11.
1966. *Palmatolepis tenuipunctata* Sannemann; Glenister & Klapper, pp. 824—825, Pl. 89, Fig. 4; Pl. 92, Figs 9—11 [give synonymy].
1967. *Palmatolepis tenuipunctata* Sannemann; Nehring, p. 147, Pl. 1, Figs 1, 2.
1967. *Palmatolepis tenuipunctata* Sannemann; Wolska, p. 408, Pl. 13, Figs 11—13, Text-fig. 16.
1967. *Palmatolepis perlobata perlobata* Ulrich & Bassler; Wolska, pp. 400—401 [pars], Pl. 12, Figs 8, 9 [only].

Remarks. — Glenister & Klapper (1966, p. 824) discuss in detail the relationships of *Palmatolepis tenuipunctata* to *P. glabra glabra*, *P. perlobata perlobata* and

P. subperlobata. Wolska (1967, Text-fig. 16) presents the variability of *P. tenuipunctata* in the material from the Holy Cross Mts, which resembles the variability of this species illustrated by Ziegler (1962b, Text-fig. 8).

Occurrence. — The range of *P. tenuipunctata*, given by Ziegler (1962b, p. 80), reaches from the Upper Palmatolepis triangularis Zone (*to I/II*) to the Upper Palmatolepis crepida Zone (*to IIa*). The presence of this species in the P. triangularis and P. crepida zones was found by Wolska (1967, p. 409) at Jabłonna, Janczyce and Kadzielnia. The specimens under study came from Śluchowice (*S. 41, 42, 45*), Dalnia (*D. 1*), Kadzielnia (*X. 3, 4*), Psie Górki (*P. 12; PG. 1, 2, 3*), Górno (*G. 2*), Kowala (*T. 16*).

Palmatolepis termini Sannemann, 1955(b)
(Pl. 15, Fig. 3)

1955. *Palmatolepis termini* n.sp.; Sannemann (1955b), p. 149, Pl. 1, Figs 1—3.
1956. *Palmatolepis termini* Sannemann; Bischoff, p. 131, Pl. 8, Fig. 37.
1957. *Palmatolepis termini* Sannemann; Ziegler, in Flügel & Ziegler, Pl. 1, Figs 1, 3.
1961. *Palmatolepis termini* Sannemann; Helms (1961b), Pl. 1, Fig. 8.
1962. *Palmatolepis termini* Sannemann; Ziegler (1962b), pp. 81—82, Pl. 6, Figs 1—11, Text-fig. 9.
1963. *Palmatolepis termini* Sannemann; Helms, Pl. 1, Fig. 26, Text-fig. 2, Fig. 43.
1965. *Palmatolepis termini* Sannemann; Bouckaert & Ziegler, Pl. 2, Figs 5—8.
1967. *Palmatolepis termini* Sannemann; Wolska, pp. 409—410, Pl. 12, Fig. 11, Text-fig. 17.

Remarks. — The variability of *Palmatolepis termini* was illustrated by Ziegler (1962b, Text-fig. 9). A similar variability of this species from the Holy Cross Mts was presented by Wolska (1967, Text-fig. 17).

Occurrence. — According to Ziegler (1962b, p. 82), *P. termini* occurs only in the Middle and the lower part of the Upper Palmatolepis crepida zones (*to IIa*). The specimens under study come from Kadzielnia (*X. 3, 4*), Psie Górki (*PG. 1*), Kowala (*T. 16*).

Palmatolepis transitans Müller, 1956(a)
(Pl. 9, Figs 1—4, 7, 9)

1956. *Palmatolepis (Manticolepis) transitans* n.sp.; Müller (1956a), pp. 18—19, Pl. 1, Figs 1, 2.
1956. *Palmatolepis (Manticolepis) martenbergensis* n.sp.; Müller (1956a), pp. 19—20, Pl. 1, Fig. 3 [non Figs 4—8 = *P. punctata*], Pl. 2, Figs 10, 13 [non Figs 11, 12 = *P. punctata*].
1956. *Palmatolepis (Manticolepis) cruciformis* n.sp.; Müller (1956a), p. 19, Pl. 2, Fig. 9.
1957. *Palmatolepis transitans* Müller; Bischoff & Ziegler, p. 81, Pl. 16, Figs 24, 25 [non Figs 23, 26, 27 = *Polygnathus asymmetricus* transitional to *Palmatolepis transitans*].
1958. *Palmatolepis transitans* Müller; Ziegler, p. 66, Pl. 1, Figs 9, 11—13; Pl. 2, Figs 2, 3 [non Figs 1, 8 = *P. punctata*].
1959. *Palmatolepis transitans* Müller; Krebs, Pl. 1, Fig. 2.
1963. *Palmatolepis (Manticolepis) transitans* Müller; Helms, Text-fig. 2, Fig. 3.
1965. *Palmatolepis transitans* Müller; Ziegler (1965a), Pl. 1, Fig. 2.
1968. *Palmatolepis transitans* Müller; Pollock, Pl. 61, Figs 19, 29.
1968. *Palmatolepis transitans* Müller; Orr & Klapper, Pl. 140, Fig. 13.

Remarks. — *Palmatolepis transitans* is very closely related to *P. punctata*. Ziegler (1958, p. 66) was of the opinion that the rectilinear trace of the blade-carina in *P. transitans* enabled its distinction from *P. punctata*. It has, however, been found by Glenister & Klapper (1966, p. 819) and Huddle (1968, p. 34) that its blade-carina might also be straight. It has also been shown that, in contradistinction to Müller's (1956b, p. 20) findings, the manner of the ornamentation of platform and the width of crimp could not be a basis for separating the two species. Huddle (1968, p. 34) supposes *P. transitans* to be a junior synonym of *P. punctata*.

The difficulties in distinguishing between *P. transitans* and *P. punctata* do not occur in the material under study. All specimens considered to be *P. transitans* have a straight carina and an inner lobe less conspicuous than that in *P. punctata*.

Occurrence. — The range of *P. transitans*, given by Ziegler (1962b, pp. 17 and 20), reaches from the base of the Lower Polygnathus asymmetricus Zone (*to Iα*) to the Ancyrognathus triangularis Zone (*to Iγ*). The specimens under study come from Czarnów (*C. 15, 19*), Śluchowice (*S. 6, 10, 13, 14, 15, 20*), Kadzielnia (*XA. 2*), Wietrznia I (*W. 56*), Wietrznia III (*V. 16, 17a*), Górno (*G. 1, 2, 3*), Kowala (*KW. 8*).

Palmatolepis triangularis Sannemann, 1955(a) (Pl. 12, Figs 1—2; Pl. 13, Figs 10—11; Pl. 14, Fig. 5)

1955a. *Palmatolepis triangularis* n.sp.; Sannemann (1955a), pp. 327—328, Pl. 24, Fig. 3.
1956. *Palmatolepis quadrantinodosalobata* Sannemann; Bischoff, p. 129 [pars], Pl. 8, Fig. 22 [only].
[non] 1960. *Palmatolepis triangularis* Sannemann; Freyer, p. 68, Pl. 4, Figs 93—96.
1960. *Palmatolepis prominens* (Müller) [sic]; Freyer, p. 66, Pl. 4, Fig. 88.
[non] 1964. *Palmatolepis triangularis* Sannemann; Friàkova, Text-fig. 1, Fig. 7 [= *P. subrecta?*].
1965. *Palmatolepis triangularis* Sannemann; Bouckaert & Ziegler, Pl. 1, Figs 1—6.
1966. *Palmatolepis triangularis* Sannemann; Anderson, p. 409, Pl. 48, Figs 3, 12; Pl. 49, Fig. 3.
1966. *Palmatolepis triangularis* Sannemann; Glenister & Klapper, pp. 825—826, Pl. 92, Figs 17, 18 [give synonymy].
[non] 1967. *Palmatolepis triangularis* Sannemann; Nehring, pp. 142—143, Pl. 4, Fig. 11 [= *P. minuta wolskae*], Pl. 5, Fig. 10a [= *P. quadrantinodosalobata*], Pl. 5, Fig. 10b [= *Palmatolepis* sp. indet., not the same specimen as that in Fig. 10a].
1967. *Palmatolepis triangularis* Sannemann; Wolska,, p. 410, Pl. 13, Figs 1—4.
1968. *Palmatolepis perlobata* Ulrich & Bassler; Huddle, pp. 32—33 [pars], Pl. 16, Fig. 8 [only].

Remarks. — Differences between *Palmatolepis triangularis* and the related species are discussed by Glenister & Klapper (1966, p. 825). In the material under study, *P. triangularis* displays a considerable variability in platform outline. It is marked in the degree of the sigmoidality of platform and the degree of the development of its inner lobe. Some of the specimens have a strongly reduced inner lobe. Specimens with a more strongly sigmoid platform, as well as those with a narrow and elongate inner lobe are transitional to *P. perlobata perlobata*. The boundary between the two species is, out of necessity, traced arbitrarily, according to the practice of Ziegler (1962b) and Glenister & Klapper (1966).

Occurrence. — The range of *P. triangularis*, given by Ziegler (1962b, p. 85), reaches from the base of the Palmatolepis triangularis Zone (*to Iδ*) to the Middle Palmatolepis crepida Zone (*to IIα*). The presence of this species in the Palmatolepis triangularis and Palmatolepis crepida zones at Płucki, Jabłonna and Kadzielnia was found by Wolska (1967, p. 410). Since the lack of *P. triangularis* in the occurrence list of the conodonts from Kadzielnia (Wolska 1967, Table 2) is at variance with information on Wolska's page 410, the presence of *P. triangularis* on the Kadzielnia hill (layer *50 in* Wolska 1967) arouses a certain doubt. The specimens under study come from Kostomłoty (*Y. 23, 27, 29, 31*), Śluchowice (*S. 39, 40, 41, 42, 45*), Psie Górki (*P. 10c, 11, 12*), Dalnia (*D. 1*), Górno (*G. 2*).

Palmatolepis unicornis Miller & Youngquist, 1947 (Pl. 12, Figs 10—11)

1947. *Palmatolepis unicornis* n.sp.; Miller & Youngquist, p. 514, Pl. 75, Fig. 15.
1968. *Palmatolepis unicornis* Miller & Youngquist; Glenister & Klapper, p. 826, Pl. 88, Figs 10, 11 [give synonymy].

Remarks. — *Palmatolepis unicornis* may have its platform outline and ornamentation identical as those in *P. hassi* and *P. subrecta*, from which it differs in having one or two denticles on the anterior termination of the blade which are decidedly higher than the remaining ones.

Occurrence. — According to Ziegler (1962b, Table 2), the range of *P. unicornis* extends from the Ancyrognathus triangularis Zone (*to* $I\gamma$) to the top of the Palmatolepis gigas Zone (*to* $I\delta$). The specimens under study come from Kostomłoty (*KT. 19, 25; Y. 5, 11, 18*), Śluchowice (*S. 21, 22*), Kadzielnia (*XA. 6; XB. 4*), Psie Górki (*P. 9, 9a, 10*), Wietrznia II (*V. 20, 34, 56*), Górno (*G. 4, 5, 7*), Kowala (*KW. 21, 24, 26*).

Palmatolepis sp.
(Pl. 13, Figs 3—6)

Description. — A *Palmatolepis* with a wide, concave platform having upturned margins. Inner lobe small or elongate, rounded and directed slightly posteriorly. Anterior inner margin of the platform straight or concave, reaching further than the anterior outer one, that is, as far as the anterior end of the blade. Both inner and outer platform are ornamented with nodes only posteriorly of azygous node. In the anterior part of the platform, only its margins are ornamented with nodes or ridges. The middle, concave part, is devoid of nodes and shagreenlike. Blade-carina strongly sigmoid, most strongly bent just anteriorly of azygous node. Carina reaching the posterior tip of the platform. The tip of platform is pointed and upturned.

Remarks. — In a concave platform and ornamentation of its margins, *Palmatolepis* sp. resembles *P. delicatula clarki*, from which it differs, however, in a platform outline, a strongly sigmoid blade-carina and a rich ornamentation of the posterior part of platform. In the outline of the platform, *Palmatolepis* sp. is similar to *P. triangularis* and *P. subperlobata*, from which it differs, however, in a specifically limited ornamentation and concave platform. Transitional specimens from *P. triangularis* to *P. quadrantinodosalobata* also have a limited ornamentation which is, however, concentrated in the anterior part of platform.

Occurrence. — Śluchowice (*S. 41*).

Genus *PELEKYSGNATHUS* Thomas, 1949
Type species *Pelekysgnathus inclinata* Thomas, 1949
Pelekysgnathus? sp.n.
(Pl. 7, Fig. 10)

Description. — Blade short at the base, narrowing upwards into three uniformly sized denticles arranged in a row and inclined posteriorly. A lip bordering the basal cavity elongates to form a low extension running posteriorly. Basal cavity with a basal plate, is oval in outline and has pointed anterior and posterior ends.

Remarks. — The specimen under study is here assigned to the genus *Pelekysgnathus* Thomas with a reservation since it has not a separate main cusp characteristic of this genus.

Occurrence. — Kostomłoty (*Y. 5*).

Genus *PLAYFORDIA* Glenister & Klapper, 1966
Type species *Pelekysgnathus? primitiva* Bischoff & Ziegler, 1957
Playfordia primitiva (Bischoff & Ziegler, 1957)
(Pl. 7, Fig. 7)

1957. *Pelekysgnathus? primitiva* n.sp.; Bischoff & Ziegler, p. 83, Pl. 21, Figs 5—11.
1966. *Playfordia primitiva* (Bischoff & Ziegler); Glenister & Klapper, p. 827, Pl. 95, Figs 19, 20.

Remarks. — The species has initially been assigned by Bischoff & Ziegler (1957), with a reservation, to the genus *Pelekysgnathus*. Glenister & Klapper (1966, p. 827) referred this species, as an only one, to the new genus *Playfordia*.

Occurrence. — Bischoff & Ziegler (1957, p. 83) and Glenister & Klapper (1966, p. 827) found *P. primitiva* only in the Lower Polygnathus asymmetricus Zone (*to Iα*), but Uyeno (1967, Table 1) found it in the Middle Polygnathus asymmetricus Zone (*to Iα*). The specimens under study come from Czarnów (*C. 9, 10*), Śluchowice (*S. 6*).

Genus *POLYGNATHUS* Hinde, 1879

Type species *Polygnathus robusticostatus* Bischoff & Ziegler, 1957

Polygnathus aff. *angustipennatus* Bischoff & Ziegler, 1957
(Pl. 20, Fig. 5)

Remarks. — The specimen under study resembles type specimens in a reduced platform, high carina and outline of its upper edge. However, only part of the unit is strongly deflected downwards, the denticles of the middle and posterior part of blade-carina are completely fused together and the tops of the denticles of free blade are not bent posteriorly. Two denticles of free blade are broken and partly regenerated.

Occurrence. — Psie Górki (*P. 12*).

Polygnathus asymmetricus asymmetricus Bischoff & Ziegler, 1957
(Pl. 16, Figs 3—5)

1949. *Polygnathus dubia* Hinde; Beckmann, pp. 154—155, Pl. 1, Fig. 3; Pl. 2, Fig. 10; Pl. 4, Fig. 4.
1957. *Polygnathus dubia asymmetrica* n.sp.; Bischoff & Ziegler, pp. 88—89, Pl. 16, Figs 18, 20—22; Pl. 21, Fig. 3.
1965. *Polygnathus asymmetrica asymmetrica* Bischoff & Ziegler; Ziegler (1965b), Pl. 5, Figs 7, 8.
1966. *Polygnathus asymmetrica asymmetrica* Bischoff & Ziegler; Glenister & Klapper, p. 828, Pl. 88, Figs 6, 7 [give synonymy].
1968. *Polygnathus asymmetrica asymmetrica* Bischoff & Ziegler; Mound, pp. 503—504, Pl. 68, Figs 8, 9.

Remarks. — Bischoff & Ziegler (1957, p. 89) have found that there exists a transition from *Polygnathus asymmetricus asymmetricus* to *Palmatolepis transitans*. Specimens transitional between these two species have been illustrated by Ziegler (1965b, Pl. 5, Figs 9 and 10).

All the specimens under study are contained within limits of variability of *P. asymmetricus asymmetricus*, although some of them display a distinct tendency to become similar in platform outline to *Palmatolepis transitans*.

Occurrence. — The range of *P. asymmetricus asymmetricus*, given by Ziegler (1962b, p. 16, Table 2), extends from the base to the top of the Polygnathus asymmetricus zones (*to Iα* — *to Iβ*). The specimens under study come from Czarnów (*C. 14*), Śluchowice (*S. 6, 7, 10, 15*), Wietrznia I (*W. 28, 34, 52*), Wietrznia II (*V. 16, 17, 17a*), Kowala (*KW. 8, 9, 10, 12, 13, 14*).

Polygnathus asymmetricus ovalis Ziegler & Klapper, 1964
(Pl. 17, Figs 1—2)

1957. *Polygnathus dubia dubia* Hinde; Bischoff & Ziegler, p. 88, Pl. 16, Fig. 19; Pl. 21, Fig. 1 [non Fig. 2 = *P. asymmetricus asymmetricus*].
1964. *Polygnathus asymmetrica ovalis* n. subsp.; Ziegler & Klapper, in Ziegler, Klapper & Lindström, pp. 422—423.

1965. *Polygnathus asymmetrica ovalis* Ziegler & Klapper; Ethington, pp. 581—582, Pl. 68, Fig. 1.
1965. *Polygnathus asymmetrica ovalis* Ziegler & Klapper; Ziegler (1965a), Pl. 1, Figs 3, 4.
1965. *Polygnathus asymmetrica ovalis* Ziegler & Klapper; Ziegler (1965b), p. 671, Pl. 5, Fig. 6.
1966. *Polygnathus asymmetrica ovalis* Ziegler & Klapper; Glenister & Klapper, p. 828, Pl. 87, Figs 8, 9 [give synonymy].
1967. *Polygnathus dubius* Hinde; Müller & Clark, p. 916, Pl. 115, Fig. 5 [non Fig. 6 = *P. dengleri*].
1968. *Polygnathus asymmetrica ovalis* Ziegler & Klapper; Mound, p. 504, Pl. 69, Figs 4, 5.

Remarks. — The specimens under study are in conformity with the diagnosis, given by Bischoff & Ziegler (1957, p. 88), for *Polygnathus dubia dubia* (= *P. asymmetrica ovalis*). Many specimens, now assigned to *P. asymmetricus ovalis*, have previously been described as *P. dubius dubius* Hinde. *P. dubius* was, however, considered by Ziegler, Klapper & Lindström (1964, p. 422) as *nomen dubium* and the specimens described later as *P. dubius dubius* were included by these authors to the new species and subspecies *P. asymmetricus ovalis*.

Occurrence. — According to Ziegler (1962b, pp. 16—17, Table 2), the range of *P. asymmetricus ovalis* reaches from the base of the Lower Polygnathus asymmetricus Zone (*to Ia*) to the lower part of the Upper Polygnathus asymmetricus Zone (*to Iβ*). The specimens under study come from Czarnów (*C. 10, 14*), Śluchowice (*S. 4, 6, 7*), Wietrznia I (*W. 34, 40*), Wietrznia II (*V. 8, 16, 17, 17a*), Kowala (*KW. 7, 9, 10, 12, 13, 14*).

Polygnathus brevilaminus Branson & Mehl, 1934
(Pl. 18, Figs 5—6, 10)

1934. *Polygnathus brevilamina* n.sp.; Branson & Mehl, p. 246, Pl. 21, Figs 3—6.
1964. *Polygnathus brevilamina* Branson & Mehl; Friàkova, Text-fig. 1, Fig. 8.
1968. *Polygnathus brevilamina* Branson & Mehl; Mound, pp. 504—505, Pl. 69, Figs 6, 7 [gives synonymy].

Remarks. — *Polygnathus brevilaminus* is very close, if not identical to *P. angustidiscus* Youngquist. Differences in the trace of the upper edge of the blade and in the ornamentation of the platform between the holotypes of the two species are very small and probably insufficient for maintaining their separateness. Probably, as suggested by Anderson (1966), the species of Youngquist & Peterson

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PL. 17

1, 2 — *Polygnathus asymmetricus ovalis* Ziegler & Klapper; *1* upper and lower views of hypotype (IGP/S. 130) from Wietrznia II (V. 17), *2* hypotype (IGP/S. 131) from Kowala (KW. 7).

3a-b — *Polygnathus* sp. *A;* lower and upper views of specimen (IGP/S. 158) from Wietrznia I (W. 52).

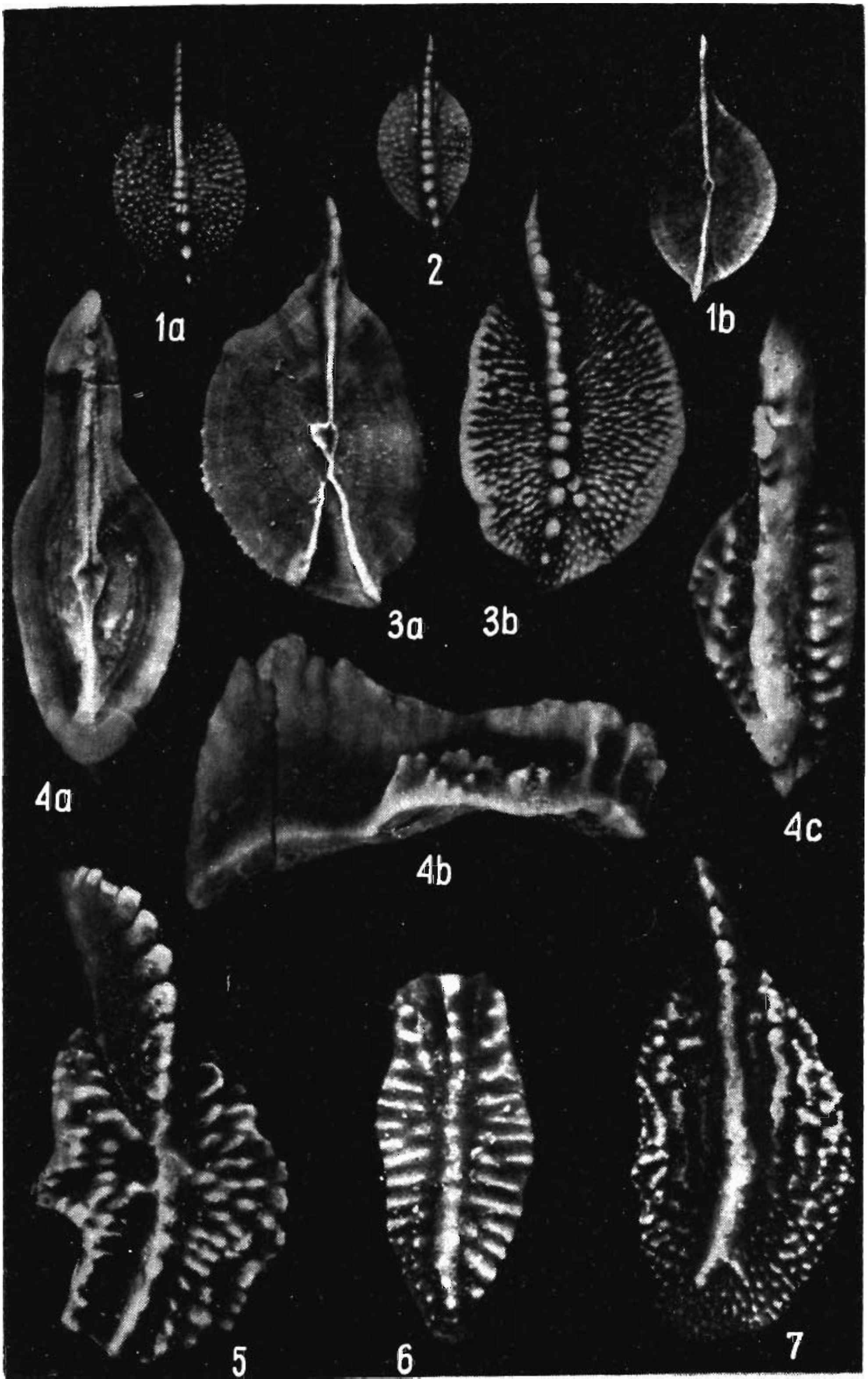
4a-c — *Polygnathus* aff. *caelatus* Bryant; lower, lateral and upper views of specimen (IGP/S. 152) from Wietrznia II (V. 5).

5 — *Polygnathus papillatus* Youngquist & Peterson; hypotype (IGP/S. 146) from Kostomłoty (Y. 23) in which posterior part of the platform is broken.

6 — *Polygnathus rugosus* Huddle; hypotype (IGP/S. 151) from Wietrznia III (V. 1) in which anterior part of specimen is broken.

7 — *Polygnathus nodocostatus nodocostatus* Branson & Mehl; hypotype (IGP/S. 141) from Kadzielnia (X. 5).

All photographs are × 36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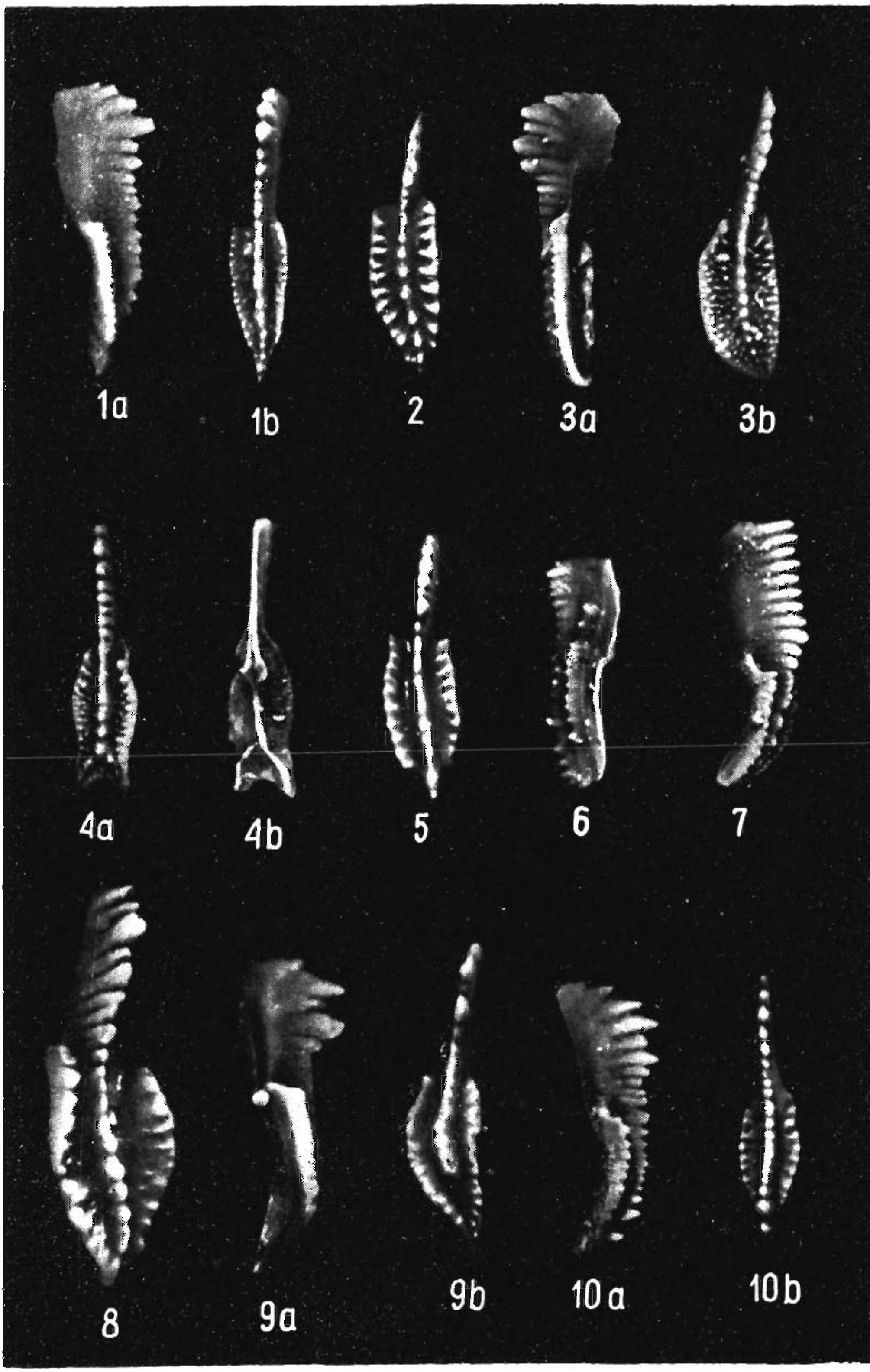
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(1947), that is, *P. carinifera*, *P. iowanensis* and *P. postbrevicornis*, are also junior subjective synonyms of *P. brevilaminus*. The impossibility of examining the holotypes, combined with their insufficient illustrations, prevent one, however, from including the species mentioned above to the synonymy of *P. brevilaminus*.

The specimens under study are in conformity with type specimens of *P. brevilaminus* Branson & Mehl.

Occurrence. — Kostomłoty (*KT. 7; Y. 23, 27, 29*), Śluchowice (*S. 6, 40, 41*), Kadzielnia (*XB. 5*), Psie Górki (*P. 10a, 10c, 12*).

Polygnathus aff. *caelatus* Bryant, 1921
(Pl. 17, Fig. 4)

Remarks. — The specimen under study differs from the specimens of *Polygnathus caelatus*, illustrated so far, in a carina having a strongly undulating trace of its upper edge and in completely fused denticles. The platform, ornamented with nodes, is devoid of ridges. It is probably a gerontic specimen of *P. caelatus*.

Occurrence. — Wietrznia II (*V. 5*).

Polygnathus decorosus Stauffer, 1938
(Pl. 18, Figs 7—8)

1938. *Polygnathus decorosus* n.sp.; Stuffer, p. 438, Pl. 53, Figs 1, 5, 6, 10, 11, 15, 16, 20, 30.
1964. *Polygnathus decorosa* Stauffer; Orr, p. 14, Pl. 1, Figs 3—5, 7; Pl. 3, Fig. 2 [gives synonymy].
1966. *Polygnathus decorosa* Stauffer; Anderson, p. 411, Pl. 50, Figs 6—8, 10, 11, 15, 16.
1968. *Polygnathus decorosa* Stauffer; Mound, pp. 505—506, Pl. 69, Figs 19, 21, 29.

Remarks. — The interpretation of *Polygnathus decorosus* used in the present paper is in conformity with a narrow understanding of this species given by Ethington & Furnish (1962, p. 1282) and Orr (1964, p. 16). According to this

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PL. 18

1a-b — *Polygnathus procerus* Sannemann; lateral and upper views of hypotype (IGP/S. 148) from Kadzielnia (X. 4).

2 — *Polygnathus pennatus* Hinde; upper view of hypotype (IGP/S. 147) from Wietrznia I (W. 28).

3, 4 — *Polygnathus foliatus* Bryant; *3a-b* lateral and upper views of hypotype (IGP/S. 139) from Wietrznia II (V. 16), — basal plate visible in Fig. 3a, *4a-b* upper and lower views of pathological specimen (IGP/S. 150) with bifurcate carina and keel, from Kostomłoty (KS. 6).

5, 6, 10 — *Polygnathus brevilaminus* Branson & Mehl; *5* upper view of hypotype (IGP/S. 135) from Śluchowice (S. 41), *6* lateral view of hypotype (IGP/S. 134) from Śluchowice (S. 6), *10a-b* lateral and upper views of hypotype (IGP/S. 164) from Kadzielnia (X. 4).

7, 8 — *Polygnathus decorosus* Stauffer; *7* upper view of hypotype (IGP/S. 149) from Kostomłoty (KT. 19), *8* upper view of hypotype (IGP/S. 136) from Górno (G. 7).

9a-b — *Polygnathus incompletus* Uyeno; lateral and upper views of hypotype (IGP/S. 140) from Śluchowice (S. 41).

All photographs are × 36

interpretation, *P. decorosus*, *P. foliatus* and *P. pennatus* are considered as separate species. *P. foliatus* differs from *P. decorosus* in the mode of ornamentation. The platform of the former is ornamented with nodes and of the latter with transverse ridges occurring on the margins of the platform. *P. pennatus* has a platform more extensive than that of *P. decorosus* and ornamented with more distinct ridges which, however, do not reach carina.

The transitions from *P. decorosus* to *P. foliatus*, *P. pennatus* and several other species were illustrated by Ziegler (1965b), according to whom (*l.c.*, *p.* 673), the species referred to above make up extremes in the variability of a broadly understood *P. decorosus* s. l.

Occurrence. — Kostomłoty (*KT. 19; KS. 6; Y. 20, 23*), Czarnów (*C. 10, 14, 20*), Śluchowice (*S. 3, 4, 6, 7, 10, 12, 14, 17, 22, 24, 29, 30, 34, 40, 41, 42*), Kadzielnia (*XA. 3, 8; XB. 2, 5; X. 2*), Psie Górki (*P. 1, 2, 3, 4a, 7, 8a, 8c, 9, 10, 10c, 11*), Wietrznia I (*W. 7, 16, 22, 28, 30, 34, 40, 52, 60, 69, 73, 86, 88*), Wietrznia III (*V. 1, 5, 6, 8, 12, 14, 18, 20*), Górno (*G. 2, 4, 7*), Kowala (*KW. 5, 9, 10, 12, 13, 14, 17, 18, 19, 28, 29*).

Polygnathus dengleri Bischoff & Ziegler, 1957
(Pl. 16, Figs 1—2, 6—7)

1957. *Polygnathus dengleri* n.sp.; Bischoff & Ziegler, pp. 87—88, Pl. 15, Figs 14, 15, 17—24; Pl. 16, Figs 1—4.
1959. *Polygnathus dengleri* Bischoff & Ziegler; Krebs, Pl. 1, Figs 1, 4, 5, 9.
1965. *Polygnathus dengleri* Bischoff & Ziegler; Ziegler (1965b), pp. 671, 673, Pl. 6, Figs 1—6.
1967. *Polygnathus dengleri* Bischoff & Ziegler; Müller & Clark, p. 916, Pl. 115, Figs 3, 7.
1967. *Polygnathus dubius* Hinde; Müller & Clark, p. 916 [pars], Pl. 115, Fig. 6 [only].
[non] 1967. *Polygnathus dengleri* Bischoff & Ziegler; Nehring, pp. 151—152, Pl. 3, Figs 7, 8.
1968. *Polygnathus dengleri* Bischoff & Ziegler; Orr & Klapper, Pl. 139, Figs 5—9.

Remarks. — The collected specimens display a considerable variability in the width of the platform. Some of them have narrow and lanceolate platforms, but in the majority of specimens they are wider than in the holotype and most previously illustrated specimens. In the outline of the platform, these forms resemble *Polygnathus asymmetricus ovalis*. Since the last-named also may have the platform ornamented with nodes joining each other to form transverse ridges, the boundary between *P. asymmetricus ovalis* and *P. dengleri* is out of necessity arbitrary in character.

Occurrence. — Ziegler (1958, Tables 2 and 10; 1965b, Tables 1—3, 5), Krebs (1959, p. 379) and Orr & Klapper (1968, p. 1069) found the presence of *P. dengleri* in the Lower Polygnathus asymmetricus Zone (*to Ia*). The specimens under study come from Śluchowice (*S. 15*), Wietrznia I (*W. 28, 52*).

Polygnathus foliatus Bryant, 1921
(Pl. 18, Figs 3—4)

1921. *Polygnathus foliata* n.sp.; Bryant, p. 24, Pl. 10, Figs 13—16.
1959. *Polygnathus foliata* Bryant; Helms, p. 651, Pl. 1, Figs 2, 3.
1965. *Polygnathus foliata* Bryant; Ethington, p. 582 [pars], Pl. 67, Fig. 10.
1967. *Polygnathus foliatus* Bryant; Müller & Clark, p. 916 [pars], Pl. 115, Fig. 4.

Remarks. — The characters that differ *Polygnathus foliatus* from *P. decorosus* have been given in the remarks concerning the latter species. Specimens of Bischoff & Ziegler (1957), described as *P. foliata*, resemble rather those described later by Ziegler (1965b) as *Polygnathus decorosa* s. l. tending to *P. foliata* or *P. pennata*.

Occurrence. — Kostomłoty (*KS. 6*), Wietrznia I (*W. 88*), Wietrznia II (*V. 16*), Kowala (*KW. 17, 19*).

Polygnathus incompletus Uyeno, 1967
(Pl. 18, Fig. 9)

1967. *Polygnathus incompleta* n.sp.; Uyeno, pp. 7, 10, Pl. 2, Figs 6, 7.

Remarks. — The collected specimen corresponds to the typical material in the platform outline and an incompletely developed carina which reaches somewhat further than halfway the platform and whose margins are ornamented with indistinct ridges. Free blade, consisting of alternate high and low denticles, differs from that in type specimens.

Occurrence. — The occurrence of *P. incompletus* was found by Uyeno (1967, Table 2) in the Lower and Middle Polygnathus asymmetricus zones (*to Ia*). The specimens under study come from Śluchowice (*S. 41*).

Polygnathus nodocostatus nodocostatus Branson & Mehl, 1934
(Pl. 17, Fig. 7)

1934. *Polygnathus nodocostata* n.sp.; Branson & Mehl, pp. 246—247, Pl. 20, Figs 9—13; Pl. 21, Fig. 15.
1967. *Polygnathus nodocostata nodocostata* Branson & Mehl; Nehring, pp. 150—151, Pl. 4, Fig. 10, Text-fig. 23.
1967. *Polygnathus nodocostata* Branson & Mehl; Wolska, p. 414, Pl. 17, Figs 1, 2.
1969. *Polygnathus nodocostatus nodocostatus* Branson & Mehl; Druce, p. 101, Pl. 19, Fig. 6 [gives synonymy].

Remarks. — Helms (1961a) distinguished three subspecies of *Polygnathus nodocostatus*. Glenister & Klapper (1966, p. 829) found that one of them, *P. nodocostatus incurvus*, had diagnostic features characteristic of the lectotype of the nominate subspecies. Their observations is correct and finds its expression in the synonymy given above, although none of the specimens available has an X-shaped trace of the row of nodes in the anterior platform. Specimens similar to those under study were described by Wolska (1967) from the Holy Cross Mts.

Occurrence. — Helms (1961a, p. 688) found that *P. nodocostatus nodocostatus* occurred from the upper part of *to Iδ — IIIa*. Glenister & Klapper (1966, Tables 1—3, 5, 6, 8) found it from the Upper Palmatolepis crepida Zone (*to IIa*) to the Lower Scaphignathus velifera Zone (*to IIIa*). Wolska's (1967, p. 414) specimens came from the Palmatolepis quadrantinodosa to Scaphignathus velifera zones at Gałęzice, Jabłonna and Łagów. The specimens under study come from Kadzielnia (*X. 5*), Górno (*G. 3*).

Polygnathus normalis Miller & Youngquist, 1947
(Pl. 19, Figs 2—5)

1947. *Polygnathus normalis* n.sp.; Miller & Youngquist, p. 515, Pl. 74, Fig. 4 [non Fig. 5 = *P. decorosa*].
1966. *Polygnathus normalis* Miller & Youngquist; Glenister & Klapper, pp. 829—830, Pl. 95, Figs 6, 21, 22.
1967. *Polygnathus normalis* Miller & Youngquist; Wolska, p. 415, Pl. 14, Figs 9—11.
1968. *Polygnathus normalis* Miller & Youngquist; Mound, pp. 509—510, Pl. 69, Figs 30, 31; Pl. 70, Figs 1, 2, 5.
1969. *Polygnathus normalis* Miller & Youngquist; Druce, p. 102, Pl. 19, Figs 7—10 [gives synonymy].

Remarks. — The forms, previously described by Müller & Müller (1957) as *Polygnathus granulosa*, were considered by Anderson (1966, p. 413) as gerontic specimens *P. normalis*. The material under study presents a wide variability of *P. normalis*. Smaller specimens have their platforms ornamented with ridges. Nodes occur in them at most only at the posterior end of platform. The anterior platform is usually narrowed in a troughlike manner and frequently smooth. A considerable part of the platform in many large specimens is covered with nodes. In these specimens, widening of the anterior part of the platform and a relative shortening of free blade are observed. Some of the large specimens preserve, however, the type of ornamentation and manner of shaping platform which are characteristic of small forms. The posterior end of platform in *P. normalis* is either pointed or spatulated. One specimen display a pathological bifurcation of the keel in the posterior part of platform.

Occurrence. — The range of *P. normalis,* given by Ziegler (1962b, p. 91), reaches from the upper part of the Middle Devonian to the Upper Palmatolepis triangularis Zone (*to I/II*). Glenister & Klapper (1966, Table 5) found, however, this species as far as the Lower Palmatolepis quadrantinodosa Zone (*to IIβ*). According to Wolska (1967, p. 417), the species occurs at Płucki in the Palmatolepis triangularis Zone and at Gałęzice in the Scaphignathus velifera Zone (*to IIIa — IV*). The specimens under study come from Kostomłoty (*KT. 7, 9, 25, 33; Y. 5, 14, 18, 23, 28*), Czarnów (*C. 14, 15, 17, 19, 20*), Śluchowice (*S. 12, 21, 22, 23, 27, 29, 34, 36, 37, 38, 40, 41*), Kadzielnia (*XA. 2, 3, 4, 5, 7, 9; XB. 1, 2, 4, 5, 6*), Psie Górki (*P. 7, 8a, 8c, 9a, 10, 10a, 10b, 11*), Wietrznia I (*W. 7, 30, 52, 56, 58, 60, 61, 73, 88*), Wietrznia II (*V. 1, 5, 6, 8, 17, 17a, 18, 20, 34, 56*), Górno (*G. 1, 2, 3, 4, 5, 7*), Kowala (*KW. 24, 28*).

Polygnathus papillatus Youngquist & Peterson, 1947
(Pl. 17, Fig. 5)

1947. *Polygnathus papillata* n.sp.; Youngquist & Peterson, p. 251, Pl. 38, Fig. 12.
1947. *Polygnathus retrosa* n.sp.; Youngquist & Peterson, p. 251, Pl. 38, Fig. 11.
1947. *Polygnathus varinodosa* Branson & Mehl; Youngquist & Peterson, p. 252, Pl. 38, Fig. 10.
1947. *Polygnathus verrucosa* n.sp.; Youngquist & Peterson, p. 252, Pl. 38, Fig. 13.
1966. *Polygnathus varinodosa* Branson & Mehl; Anderson, p. 414, Pl. 51, Figs 6, 10.

Remarks. — According to Anderson (1966, p. 414), the species *Polygnathus papillatus, P. retrosus* and *P. verrucosus,* erected by Youngquist & Peterson (1947), are junior synonyms of *P. varinodosus* Branson & Mehl. The specimens of *P. varinodosus,* studied by Anderson, came from this same Sheffield Formation as the holotypes of Youngquist's & Peterson's species called in question. Glenister & Klapper (1966, p. 829) correctly concluded that type specimens of *P. varinodosus* Branson & Mehl belonged to *P. nodocostatus* and *P. pennatuloideus.* The specimens of *P. varinodosus,* presented by Youngquist & Peterson (1947) and Anderson (1966), as well as the holotypes of *P. papillatus, P. retrosus* and *P. verrucosus* differ from both *P. nodocostatus nodocostatus* and *P. pennatuloideus* and fall within a single, separate species. *P. papillatus* is a name which is due to this species according to the principle of priority.

The ornamentation of the platform in *P. papillatus* is less regular than that in *P. pennatuloideus* and *P. nodocostatus nodocostatus.*

Occurrence. — Anderson (1966, pp. 400, 414) found *P. papillatus* in the uppermost part of the Manticoceras Stage and/or in the lower part of the Cheiloceras Stage. The specimen under study comes from Kostomłoty (*Y. 23*).

Polygnathus pennatus Hinde, 1879
(Pl. 18, Fig. 2)

1879. *Polygnathus pennatus* n.sp.; Hinde, p. 366, Pl. 17, Fig. 8.
1961. *Polygnathus pennata* Hinde; Budurov, p. 265, Pl. 1, Figs 3, 4, 6.
1965. *Polygnathus pennata* Hinde; Ziegler (1965b), Pl. 6, Fig. 12.

1967. *Polygnathus pennatus* Hinde; Müller & Clark, p. 917, Pl. 115, Figs 1, 2 [give synonymy].
1968. *Polygnathus pennata* Hinde; Mound, p. 410, Pl. 69, Figs 25, 28, 32, 33.

Remarks. — The differences between *Polygnathus pennatus* and *P. decorosus* have been discussed in the remarks concerning the latter species.

Occurrence. — Kostomłoty (*Y. 23*), Wietrznia I (*W. 28*).

Polygnathus procerus Sannemann, 1955(b) (Pl. 18, Fig. 1)

1955. *Polygnathus procerus* n.sp.; Sannemann (1955b), p. 150, Pl. 1, Fig. 11.
1967. *Polygnathus procerus* Sannemann; Nehring, p. 149, Pl. 3, Fig. 10, Text-fig. 22.
1967. *Polygnathus procera* Sannemann; Wolska, p. 416, Pl. 14, Figs 3, 4, 6.
1968. *Polygnathus procera* Sannemann; Mound, pp. 510—511, Pl. 71, Fig. 1 [gives synonymy].

Remarks. — The specimens under study exactly correspond to the holotype and the material from the Holy Cross Mts presented by Wolska (1967).

Occurrence. — The range of the species, given by Ziegler (1962b, p. 93), reaches from the Upper Palmatolepis triangularis Zone (*to I/II*) to the Upper Palmatolepis crepida Zone (*to IIa*). Its presence was found by Wolska (1967, p. 416) in the Palmatolepis triangularis and Palmatolepis crepida zones at Płucki, Jabłonna, Janczyce and Kadzielnia. The specimens under study come from Kadzielnia (*X. 4*).

Polygnathus rugosus Huddle, 1934 (Pl. 17, Fig. 6)

1934. *Polygnathus rugosa* n.sp.; Huddle, p. 98, Pl. 8, Figs 12, 13.
1957. *Polygnathus rugosa* Huddle; Bischoff & Ziegler, pp. 96—97, Pl. 17, Figs 9—11, 15.
1965. *Polygnathus rugosa* Huddle; Ziegler (1965b), pp. 668—669, Pl. 5, Fig. 14.

Remarks. — An incomplete specimen of *Polygnathus rugosus*, found as an only one, exactly corresponds to the specimen presented by Ziegler (1965b, Pl. 5, Fig. 14).

Occurrence. — *P. rugosus* was found by Ziegler (1965b, Tables 2, 4, 5) in the Schmidtognathus hermanni — Polygnathus cristatus and Polygnathus asymmetricus (*to Ia*) zones. The specimen under study comes from Wietrznia III (*V. 1*).

Polygnathus semicostatus Branson & Mehl, 1934 (Pl. 19, Fig. 6)

1934. *Polygnathus semicostata* n.sp.; Branson & Mehl, pp. 247—248, Pl. 21, Figs 1, 2.
1949. *Polygnathus semicostata* Branson & Mehl; Thomas, Pl. 1, Fig. 23.
1968. *Polygnathus semicostata* Branson & Mehl; Mound, p. 511, Pl. 70, Figs 3, 10 [gives synonymy].

Remarks. — The specimens under study have, like type specimens, a strongly arched platform with a narrowed posterior part. Posterior platform ornamented with transverse ridges. Carina does not reach the posterior end of platform. *Polygnathus semicostatus* resembles *P. linguiformis*. The platform of the former arches, however, gradually, whereas in the latter it strongly deflects laterally and downwards in the place of change in the type of ornamentation. In *P. linguiformis* carina disappears earlier than in *P. semicostatus*.

Occurrence. — Ethington (1965, p. 569) maintains that in Arizona and New Mexico *P. semicostatus* occurs in the *to IIa* Zone. Mound (1968, pp. 449, 453, 511) believes this species to be rare in Alberta in the Ireton Formation (*to I*) and frequent in the upper part of the Wabamun Formation (= Palmatolepis rhomboidea Zone). The specimens under study come from Kadzielnia (*X. 5*).

Polygnathus sinuosus sp. n.
(Pl. 20, Figs 2—4)

Holotype: specimen numbered *IGP/S. 154*, figured in Pl. 20, Fig. 3.
Type horizon: Lower Palmatolepis gigas Zone (*to* Iγ).
Type locality: Kadzielnia quarry in Kielce.
Derivation of name: in Latin *sinuosus* = bent, after a characteristic trace of the blade.

Diagnosis. — A species of *Polygnathus* with a blade sinusoidally bent in the plane of the platform. Platform does not reach a posterior end of blade. Free blade almost the same in length as platform. The posterior, free part of blade is shorter than platform. Free blade arcuate. Within the platform, carina is bent in an opposite direction to that of free blade and this direction is maintained by its posterior, free part. The upper edge of blade is undulating. The anterior edge of the free blade, consisting of 4 to 5 denticles, is inclined anteriorly at an angle of about 45°. Much the same is an angle at which ascends the apical line of the first 2 to 3 denticles. In the posterior part of the free blade and above the platform, the upper edge of the carina at first descends and then once again gradually rises, reaching its second culmination halfway the platform, in its posterior part or posteriorly of it. The last part of the carina consists of 2 to 4 lower and lower denticles. Denticles of the middle part of the blade are confluent and only their summits are free. Denticles of the initial and final part of the blade are free from a point halfway the blade. Denticles in both culminations are wider than the remaining ones. Platform is narrow and ornamented on the edges with nodes or, less frequently, smooth. It is usually asymmetric. The outer platform may begin further posteriorly than the inner one. A sigmoidally bent keel runs on the lower surface. A small basal cavity occurs in the anterior part of platform.

Remarks. — A sinusoid bend of the blade and an undulating trace of its upper edge are the characters in which *P. sinuosus* sp.n. differs from other species of *Polygnathus* in which platform does not reach a posterior end of the carina, for instance, from *P. brevilaminus* or *P. angustipennatus*. Its bend is more regular than that in *P. kockeliana* Bischoff & Ziegler. In *P. deformis* Anderson, only blade is bent.

Occurrence. — Kadzielnia (*XB*. 5).

PL. 19

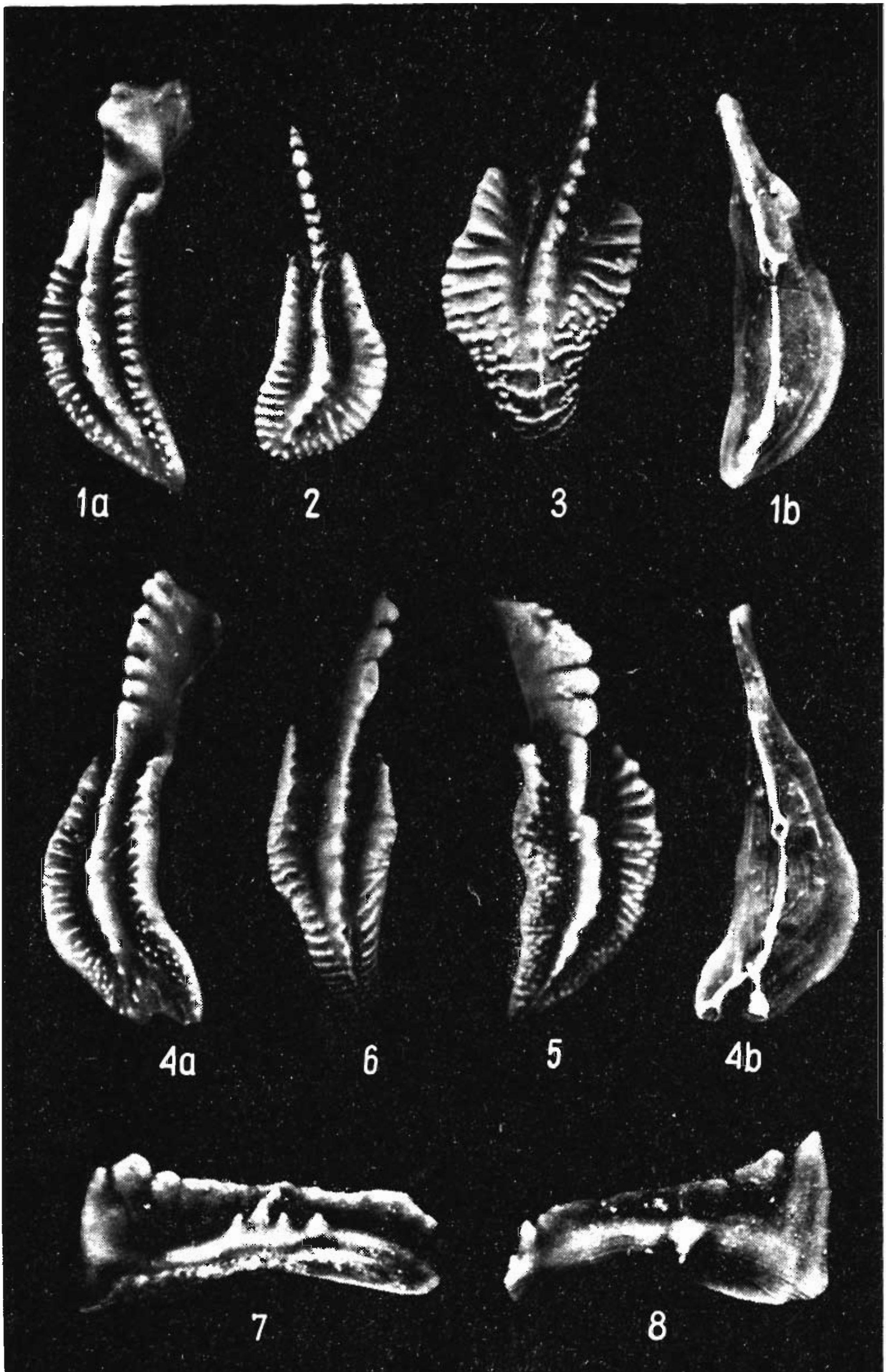
1a-b — *Polygnathus* sp. *B;* upper and lower views of specimen (IGP/S. 159) from Czarnów (C. 14).

2—5 — *Polygnathus normalis* Miller & Youngquist; *2* upper view of hypotype (IGP//S. 142) from Śluchowice (S. 22), *3* upper view of large hypotype (IGP/S. 144) from Kowala (KW. 28), *4a-b* upper and lower views of specimen (IGP/S. 145) from Czarnów (C. 14) with pathological bifurcation of the keel, *5* upper view of large hypotype (IGP/S. 143) from Górno (G. 7).

6 — *Polygnathus semicostatus* Branson & Mehl; upper view of hypotype (IGP//S. 153) from Kadzielnia (X. 5).

7, 8 — *Polygnathus? variabilis* Bischoff & Ziegler; lateral views of two hypotypes (IGP/S. 162, 163) from Kadzielnia (XB. 5).

All photographs are × 36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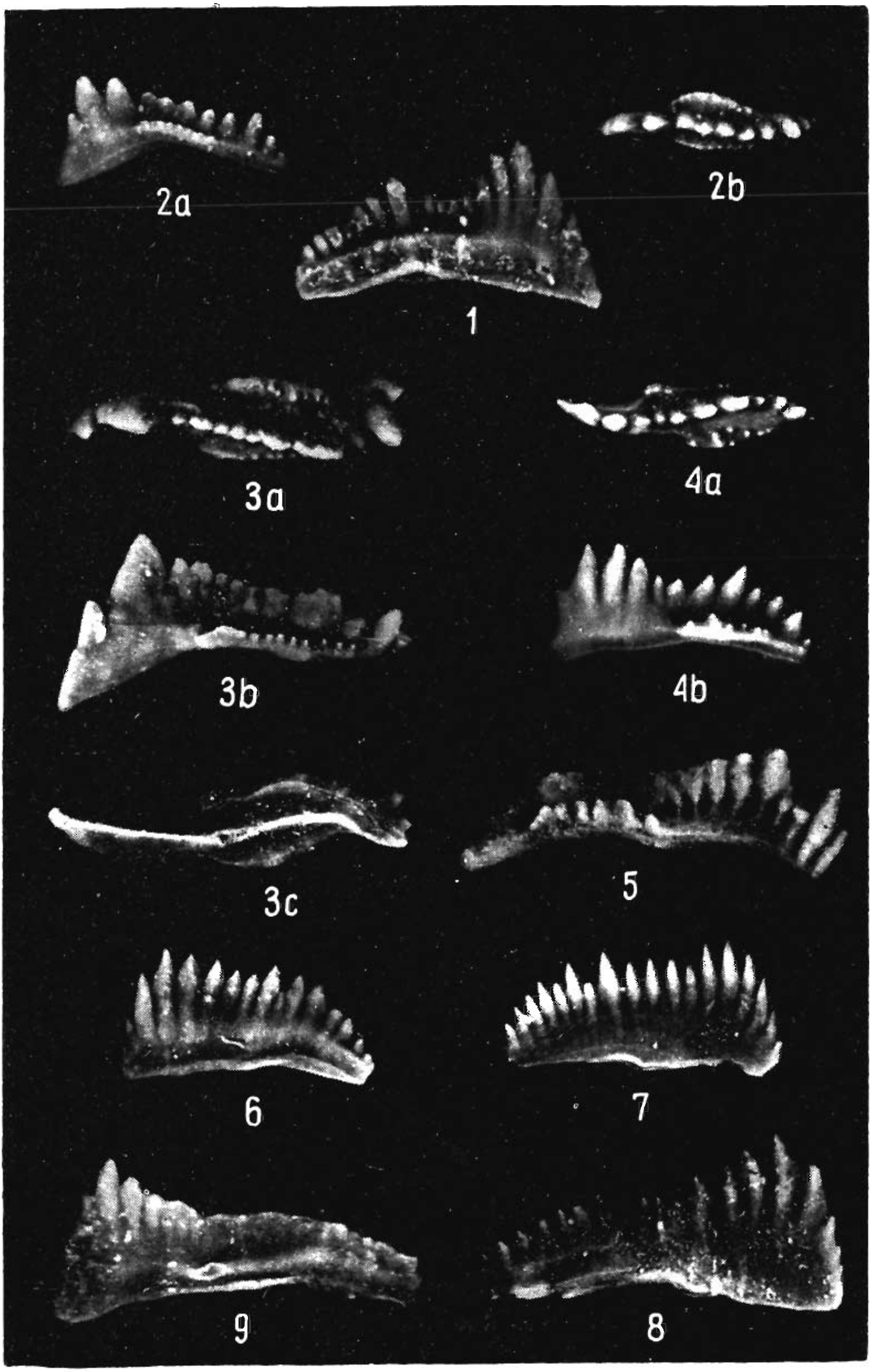
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Polygnathus sp. *A*
(Pl. 17, Fig. 3)

Description. — Platform wide, suboval, pointed. Inner and outer edge strongly convex. Free blade short, consisting of denticles fused with each other. Carina, running in the form of an arch through platform, divides it into two uneven parts of which the inner one is smaller. In its anterior part, the carina consists of closely spaced nodes and in the posterior part of discrete ones which posteriorly depart from each other gradually. Platform ornamented with fine nodes which near the edges are arrange in rows perpendicular to them. In the posterior inner part of the platform, two large nodes imitating a secondary carina detach themselves from the carina postero-obliquely. Lower surface of the platform is smooth. A large basal cavity occurs in the middle of the platform. A keel, running exactly below carina, bifurcates slightly posteriorly of basal cavity. A secondary keel is directed outwards at an angle of about 35° to the main kell. The latter reaches the posterior end of platform, while the secondary keel — the inner margin of platform, but it does not cause a bend of platform.

Remarks. — The specimen under study has been assigned to the genus *Polygnathus* although its bifurcating keel makes it similar to forms of the genus *Ancyrognathus* older evolutionarily. Ziegler (1956, p. 47; 1962a, p. 151) mentions that sometimes there occur juvenile specimens of *Ancyrognathus bifurcata* whose platform outline is similar to that of the *Polygnathus*. The specimen described is, however, mature and its platform has neither separated lobes, nor a sinus in the posterior edge of the platform, which differs it from *A. bifurcata* (probably identical with *A. irregularis*). In the pattern of its ornamentation, it resembles *Polygnathus dengleri* or *P. asymmetricus*. Thus, the bifurcation of the keel is probably pathological and the specimen belongs to *P. asymmetricus* to which it is similar in a very extensive platform, but it is also possible that the specimen is transitional from *P. asymmetricus* to *Ancyrognathus bifurcata*.

Occurrence. — Wietrznia I (*W. 52*).

PL. 20

1, 6—8 — *Spathognathodus gradatus* (Youngquist); lateral views of four hypotypes: *1* hypotype (IGP/S. 167) from Śluchowice (S. 6), *6* hypotype (IGP/S. 168) from Wietrznia I (W. 52), *7* hypotype (IGP/S. 169) from Śluchowice (S. 6), *8* hypotype (IGP/S. 166) from Kadzielnia (X. 5).

2—4 — *Polygnathus sinuosus* sp.n.; *2a-b* outer-lateral and upper views of small paratype (IGP/S. 156), *3a-c* upper, outer-lateral and lower views of holotype (IGP/S. 154), *4a-b* upper and inner-lateral views of paratype (IGP/S. 155); all specimens from Kadzielnia (XB. 5).

5 — *Polygnathus* aff. *angustipennatus* Bischoff & Ziegler; lateral view of specimen (IGP/S. 157) from Psie Górki (P. 12). Note regeneration of two denticles of the free blade.

9 — *Spathognathodus* aff. *acutus* (Branson & Mehl); lateral view of specimen (IGP/S. 165) from Kadzielnia (X. 5).

All photographs are × 36

Polygnathus sp. *B*
(Pl. 19, Fig. 1)

Description. — Platform narrow, strongly bent and arched. Its anterior part narrowed and troughlike in transverse section. Anterior part of the platform is ornamented with only slightly marked ridges, in the middle is covered with distinct ridges and in the posterior part with irregularly arranged nodes. In the middle part, the margins of the platform are denticulate. Free blade is hornlike, formed of two high, confluent denticles. A denticulate carina, considerably lower than the free blade runs in the latter's extension, not reaching the end of the platform. A distinct keel runs across the lower surface of the platform in a position corresponding to that of carina. Basal cavity is situated in the anterior part of the platform in a place in which the platform extends behind an initial flexural constriction.

Remarks. — The material under study contains only one specimen which corresponds to the characteristics given above. It has a free blade identical with that of *Polygnathus unicornis* but markedly differing in the outline and ornamentation of the platform.

Occurrence. — Czarnów (*C. 14*).

Polygnathus? variabilis Bischoff & Ziegler, 1957
(Pl. 19, Figs 7—8)

1957. *Polygnathus? variabilis* n.sp.; Bischoff & Ziegler, pp. 99—100, Pl. 18, Figs 8—17; Pl. 19, Figs 10, 11, 17.

Remarks. — Bischoff & Ziegler (1957) relate this species with a reservation to the genus *Polygnathus* and maintain that the forms with an incipient platform should be referred to *Spathognathodus*. The specimens under study are of precisely such a nature. One of them has a smooth platform, in the other it is ornamented with few nodes.

Occurrence. — The occurrence of *P.? variabilis* was found by Ziegler (1965b, Table 5) in the Polygnathus asymmetricus zones (*to Ia—β*). The specimens under study come from Kadzielnia (*XB. 5*).

Genus *SPATHOGNATHODUS* Branson & Mehl, 1941
Type species *Spathodus primus* Branson & Mehl, 1933

Spathognathodus aff. *acutus* (Branson & Mehl, 1934)
(Pl. 20, Fig. 9)

Remarks. — The specimens under study correspond to the holotype of *Spathognathodus acutus* of Branson & Mehl (1934) in having their denticles completely confluent except for a few anterior ones whose summits are free. They differ, however, from the holotype of *S. acutus* in the trace of the upper edge of the blade, which is not almost straight as in the holotype of *S. acutus*, but steeply ascends from the anterior end and, afterwards, promptly drops, running further in the form of a gentle arch towards the posterior end. *S. acutus* has so far been represented by the holotype. Since, in addition, the collected material is really scarce, it is difficult to decide what is the taxonomic importance of the difference indicated.

Occurrence. — Kadzielnia (*X. 5*).

Spathognathodus gradatus (Youngquist, 1945) (Pl. 20, Figs 1, 6—8)

1934. *Spathodus strigosus* n.sp.; Branson & Mehl, p. 187, Pl. 17, Fig. 17.
1945. *Mehlina irregularis* n.sp.; Youngquist, p. 363, Pl. 56, Fig. 2.
1945. *Mehlina gradatus* n.sp.; Youngquist, p. 363, Pl. 56, Fig. 3.
1949. *Spathognathodus strigosus* (Branson & Mehl); Thomas, Pl. 2, Figs 19, 21; Pl. 4, Fig. 15.
1956. *Spathognathodus strigosus* (Branson & Mehl); Bischoff & Ziegler, p. 167, Pl. 13, Fig. 15.
1957. *Ctenognathus gradata* (Youngquist); Müller & Müller, p. 1083, Pl. 135, Figs 10, 11.
1958. *Spathognathodus gradatus* (Youngquist); Ziegler, pp. 71—72, Pl. 11, Figs 15, 16.
1961. *Spathognathodus strigosus* (Branson & Mehl); Dvořák & Freyer, Pl. 1, Fig. 17.
1962. *Spathognathodus strigosus* (Branson & Mehl); Ziegler (1962b), pp. 111—112, Pl. 12, Figs 21—23.
1965. *Spathognathodus strigosus* (Branson & Mehl); Bouckaert & Ziegler, Pl. 5, Fig. 8.
1967. *Spathognathodus gradatus* (Youngquist); Wolska, p. 427, Pl. 18, Fig. 16.
1967. *Spathognathodus strigosus* (Branson & Mehl); Wolska, pp. 428—429, Pl. 18, Figs 9—15.
1968. *Spathognathodus gradatus* (Youngquist); Mound, p. 514, Pl. 70, Figs 22, 24—27.

Remarks. — Mound (1968, p. 514) recognized *Spathognathodus gradatus* and *S. strigosus* to be conspecific. According to this opinion, in the present paper, *S. gradatus* includes specimens which correspond to the forms previously described under both these specific names.

Occurrence. — Czarnów (*C. 9, 10*), Śluchowice (*S. 6*), Kadzielnia (*XA. 8*), Wietrznia I (*W. 52*).

Spathognathodus sannemanni sannemanni Bischoff & Ziegler, 1957 (Pl. 7, Fig. 11)

1957. *Spathognathodus sannemanni* n.sp.; Bischoff & Ziegler, pp. 117—118, Pl. 19, Figs 15, 19—23, 25.
1958. *Spathognathodus sannemanni sannemanni* Bischoff & Ziegler; Ziegler, p. 72, Pl. 9, Fig. 15.
1962. *Spathognathodus sannemanni sannemanni* Bischoff & Ziegler; Bartenstein & Bischoff, p. 52, Pl. 5, Figs 6, 7, Table 3.
1968. *Spathognathodus sannemanni sannemanni* Bischoff & Ziegler; Pollock, Pl. 63, Figs 10, 11.

Remarks. — On the basis of the number of denticles occurring on lateral extensions, a few new subspecies of *Spathognathodus sannemanni* were erected by Pollock (1968). The only specimen collected exactly corresponds to the nominate subspecies as it has one denticle on the inner and two on the outer extension.

Occurrence. — Ziegler (1962b, pp. 17, 19) recorded *S. sannemanni* from the Lower and Middle Polygnathus asymmetricus zones (*to Ia*) but, later on, he also mentions it from the Polygnathus varcus and Schmidtognathus hermanni — Polygnathus cristatus zones (Ziegler 1965b, Tables 1, 2, 4 and 5). The presence of this subspecies in the Schmidtognathus hermanni — Polygnathus cristatus Zone has also been found by Orr & Klapper (1968, p. 1068). The specimen under study comes from Wietrznia I (*W. 28*).

CONODONT ZONATION

Methodological remarks

Studies on the succession of the Upper Devonian conodonts have for a long time been conducted successfully. A detailed stratification of the Upper Devonian was made by Ziegler (1962b) in the Rhine Slate Mts, where conodont zones were correlated with the orthostratigraphic ammonoid *Stufen*. Due to the abundance of both ammonoids and conodonts, well as due to the state of knowledge of their succession, the Rhine Slate Mts play a leading role in the studies on the conodont zonation. Widely used terms of the Frasnian and Famennian stages, derived from the Ardennes, could not so far be precisely correlated with the ammonoid *Stufen* on account of the poverty of the ammonoids in the last-named area. After describing conodonts from the Famennian Stage of Belgium (Bouckaert & Ziegler 1965), both conodonts zones and ammonoid *Stufen* could be precisely placed in the Ardennian division into the stages. The standart zonation, established in the Rhine Slate Mts, was subsequently confirmed in other, geographically distant areas, such as, North America (Ethington 1965, Clark & Ethington 1966, Klapper 1966, Anderson 1966, Mound 1968, Pollock 1968 and others), Australia (Glenister & Klapper 1966, Druce 1969), Malaya (Alexander & Müller 1963) and Ural (Kononova 1969). It was also in Poland that standard conodont zones were found by Wolska (1967) in the late Upper Devonian. As shown by Glenister & Klapper (1966), not only conodont succession is intercontinental in character, but also conodont/ammonoid interzonation is identical on a worldwide scale.

Certain slight corrections have later on been introduced to Ziegler's zonation. They consist in changes in the specific names of some zone-name givers (Klapper & Furnish 1963, Ziegler, Klapper & Lindström 1964, Ziegler *in* Glenister & Klapper 1966) and specification of the conodont/ammonoid interzonation (Glenister & Klapper 1966). In addition, Ziegler (1965b) introduced a new, Schmidtognathus hermanni — Polygnathus cristatus Zone which occurs between the Givetian Polygnathus varcus Zone and the lower Upper Devonian Polygnathus asymmetricus Zone (former Polygnathus dubia Zone). All the complements were taken into account by Glenister & Klapper (1966, Text-fig. 2). Rhodes, Austin & Druce (1969) have recently found that the forms so far described from the Upper Devonian as *Spathognathodus costatus costatus* did not belong to this species but are a separate species *S. bischoffi*. Consequently, the previous Spathognathodus costatus Zone is called in the present paper Spathognathodus bischoffi Zone.

The generally accepted standard schema of the Upper Devonian conodont stratigraphy employs a concept of conodont zones which were defined by Ziegler (1962b). In their definition, the upper and lower boundary of each zone are determined by the appearance of selected new species. Since they are characterized by conodont assemblages, these zones are of the nature of assemblage zones. According to the definition, the procedure of tracing boundaries between zones in a place in which selected new species appear may be employed without reservations only in the case of exceptionally abundant samples. In the case in which samples are poorer quantitatively, it is difficult to reach a certainty whether or not the lack of a species marking a next stratigraphic zone results from a limited representativeness of a sample. The practice of dating the samples in such cases resolves itself into distinguishing the narrowest possible concurrence zones of the species present in a sample (comp. Glenister & Klapper 1966). Such a procedure requires basing one's studies to an equal extent on both extinction and appearance moments of particular species, established by previous explorers. Precisely such a practice has been adopted in the present work. Consequently, datings of some of the samples employ determinations which indicate a possible age of a sample exceeding the limits of one zone. With the acceptance of such a procedure, some of the standard zones cannot, however, be distinguished for uncontrollable reasons. This concerns the zones in which no species disappears on their upper boundary. Such zones are the Upper Palmatolepis triangularis and the Middle Palmatolepis crepida zones. This does not, however, contradict a general justification of distinguishing these zones.

It is obvious that the possibility of distinguishing stratigraphic zones depends directly on solutions concerning the taxonomy of the conodonts. Against this background, a certain crisis has recently been noted in the stratigraphy of the Frasnian. Mound (1968, p. 499) finds that the degree of differentiation of some Frasnian species of the genus *Palmatolepis* corresponds rather to the differentiation at the subspecific level. In fact, this differentiation concerns relatively few characters. Anderson (1966, p. 409) doubts in the separateness of *Palmatolepis subrecta* and *P. hassi* and Mound (1968, p. 499) considers the last-named species as a junior synonym of *P. gigas*. Each of these taxonomic solutions would, however, have to be reflected in stratigraphy, while Mound's connecting *Palmatolepis gigas* with *P. hassi* and, at the same time, continuing to maintain the Palmatolepis gigas Zone is an inconsistency. As a consequence of extending the limits of the intraspecific variability of *Palmatolepis gigas* by the forms described as *P. hassi,* the lower boundary of the Palmatolepis gigas Zone ceases to exist. Now, in turn, connecting *Palmatolepis hassi* with *P. subrecta* diminishes the possibility of distinguishing the Upper Polygnathus asymmetricus Zone with the assumption that the boundaries of zones are traced in places where new species appear.

Clearly, then, an incorrect acceptation of any species which should be rejected for paleontological reasons, is detrimental to stratigraphy. However, when the limits between many species of conodonts are of necessity put arbitrarily, a reserve and consideration to stratigraphic consequences seem to be commendable. The separateness of *Palmatolepis gigas, P. hassi* and *P. subrecta,* as well as of *P. transitans* and *P. punctata,* called in question by Huddle (1968, p. 34), for the reasons indicated in detailed remarks concerning these species, has been maintained in the present paper.

Analytic profiles

Representative profiles of the Upper Devonian of the western part of the Holy Cross Mts are presented below. They concern almost all larger Upper Devonian outcrops now recorded in this part of the Holy Cross Mts. The conodonts have been described from these profiles, and used as a basis for elaborating stratigraphy. On the other hand, observations were made concerning petrography, sedimentation and assemblages of fossils. The profiles presented (cf. Fig. 7) give a full stratigraphic column and facial distribution of the Upper Devonian of the region under study. Limited technical possibilities did not allow the writer for preparing a detailed stratigraphy, based on conodonts, for all the existing outcrops. Secondary outcrops, exposing only fragmentary profiles, were, therefore, omitted. In the localities, in which outcrops related lithologically and faunally and having a similar stratigraphic range adjoin each other in a larger area (*e.g.*, the area of Wietrznia and Zagórze or the Kostomłoty hills), profiles were made in selected, most convenient places. Since no conodonts were found in the Frasnian limestones occurring in the Bolechowice-Panek quarry, this locality was also omitted in the descriptions of profiles.

Such outcrops as those on the Karczówka hill, as well as Famennian outcrops in the Sieklucki brickyard and on the Cmentarna hill and Psiarnia, well known from old literature (cf. Gürich 1896, Sobolev 1912a, Dybczyński 1913) and once very important to the studies on the stratigraphy of the Upper Devonian of the Holy Cross Mts, now do not exist any more.

Nevertheless, observations made in all outcrops known to the writer (cf. Fig. 1) are taken into account in further considerations, along with information on now non-extant outcrops taken from old literature. The profiles characterized below play, among them, the role of a groundwork and the stratigraphy of the region has been worked out for them on the basis of conodonts.

Kostomłoty hills

The Frasnian profile at Kostomłoty for a long time have been the subject of geologists' interest (Zeuschner 1968; Gürich 1896; Siemiradzki 1903, 1922; Sobolev 1909). On the basis of conodonts, Kościelniakowska (1967) believed the Kostomłoty Frasnian to belong to the *to* $I\beta/\gamma$ horizon.

The chain of the Frasnian, which forms the Kostomłoty hills is intersected by a fault perpendicular to its trace. The fault runs about 150 m east of the Kielce — Miedziana Góra highway. Upper Devonian deposits varying in age (Table 2 and Fig. 7) are exposed in its limbs. The Frasnian of the western part of the Kostomłoty hills, situated in the lower

Table 2

Distribution and frequency of conodonts at Kostomłoty

KOSTOMŁOTY /KT, KS, KE, Y/ Zone	7	7–8	8–9			7–8	7–9	8–9	5–8	8	8–9		9	9–10		10		11–13	12–14
Sample	KT.7	KT.9	KT.19	KT.25	KT.33	KS.6	KS.34	KE.20	Y.1	Y.5	Y.11	Y.14	Y.18	Y.20	Y.21	Y.23	Y.27	Y.29	Y.31
Ancyrodella ioides	13																		
Polygnathus normalis	15	3		29	13					62		10	12			1		3	
Palmatolepis subrecta	44	3	13	14	12	7	4	28	12	129	11	49	15	65	5				
Ancyrognathus triangularis	7									1									
Palmatolepis gigas	4		5	23	6	1		3		25		3	56	3	2		1		
Polygnathus brevilaminus	3															3	3	2	
Polygnathus decorosus			3			7								2		1			
Palmatolepis unicornis			1	3						16	1		4						
Ancyrodella nodosa			7			1				3									
Ancyrognathus asymmetrica			2		2			1		1									
Nothognathella iowanensis			2							1									
Avignathus orthoptera			3																
Ancyrodella curvata				6	14					30	4	2	13	1			1		
Nothognathella polygnathoidea					1					4									
Ancyrodella gigas						2				1									
Ancyrodella lobata						1				1									
Polygnathus foliatus						1													
Icriodus symmetricus						19													
Enantiognathus lipperti									1	1		2	1	9					
Ancyrodella buckeyensis										3									
Pelekysgnathus? sp.n.										1									
Icriodus alternatus											1					18	21		
Nothognathella? abnormis											3						1		
Palmatolepis hassi													19						
Palmatolepis linguiformis													2						
Ancyrognathus princeps													1						
Palmatolepis triangularis																10	13	5	2
Palmatolepis subperlobata																1	2		
Icriodus iowanensis																3			
Polygnathus pennatus																1			
Polygnathus papillatus																1			
Nothognathella typicalis																	1		
Palmatolepis delicatula delicatula						*												1	
Palmatolepis delicatula clarki																		4	
Palmatolepis perlobata perlobata																			1

Lacation of profiles marked *KT* and Y shown in Fig. 1, places of sampling in the profiles — in Fig. 7; samples marked *KS* come from the lowermost layers outcropped in the eastern part of the Kostomłoty hills; sample *KE. 20* comes from the uppermost layer of detrital limestones with flints at the eastern end of the hills; numerical symbols of conodont zones explained in Table 1

(NW) limb of the fault, is older and belongs to the Lower and Upper Palmatolepis gigas Zone (*to Iγ—δ*). The Devonian of the eastern part of the Kostomłoty hills starts with the Upper Palmatolepis gigas (*to Iδ*) and terminates with the Upper Palmatolepis triangularis (*to I/II*) or even Palmatolepis crepida Zone (*to IIα*). In the locality, the succession of conodonts is analogous to a commonly occurring one and there are no mixed-age assemblages. Thus, the reservations (Szulczewski 1968) concerning Kościelniakowska's views have been confirmed. The oldest Frasnian deposits found belong to the Lower Palmatolepis gigas Zone (*to Iγ*) and the profile includes the upper part of the Manticoceras Stage up to the layers bordering on the Cheiloceras Stage inclusively. The entire thickness of the Upper Devonian, found within this stratigraphic framework, amounts to 30—40 m (according to Kościelniakowska, 135 m).

The Lower Palmatolepis gigas Zone (*to Iγ*) is developed as intraformational breccia intercalated with micritic limestones and calcarenites. The Upper Palmatolepis gigas Zone (*to Iδ*) in the western part of the Kostomłoty hills is similarly developed but contains more calcarenites. An intercalation of crinoid limestone appears in its uppermost exposed member. In the eastern part of the Kostomłoty hills, this zone is mostly composed of calcarenites accompanied by micritic limestones, intraformational calcarenites and marly limestones. Calcarenites with black flints make up the uppermost part of the Upper Palmatolepis gigas Zone (*to Iδ*) which probably has not any equivalent in the western part of the hills. This is the uppermost member observed by Kościelniakowska (1967, bed *b*). They are overlaid with about 5 m thick calcarenites which already belong to the Palmatolepis triangularis zones. A characteristic, flat pebble conglomerate of a slump origin about 1 m in thickness, consisting of limestone plates reaching 60 cm, forms the uppermost outcropped bed of the Upper Devonian. It represents the Upper Palmatolepis triangularis (*to I/ /II*) or even Palmatolepis crepida Zone (*to IIα*). Upper deposits of the Upper Devonian are eroded and the layer mentioned above is overlain by a transgressive Zechstein conglomerate.

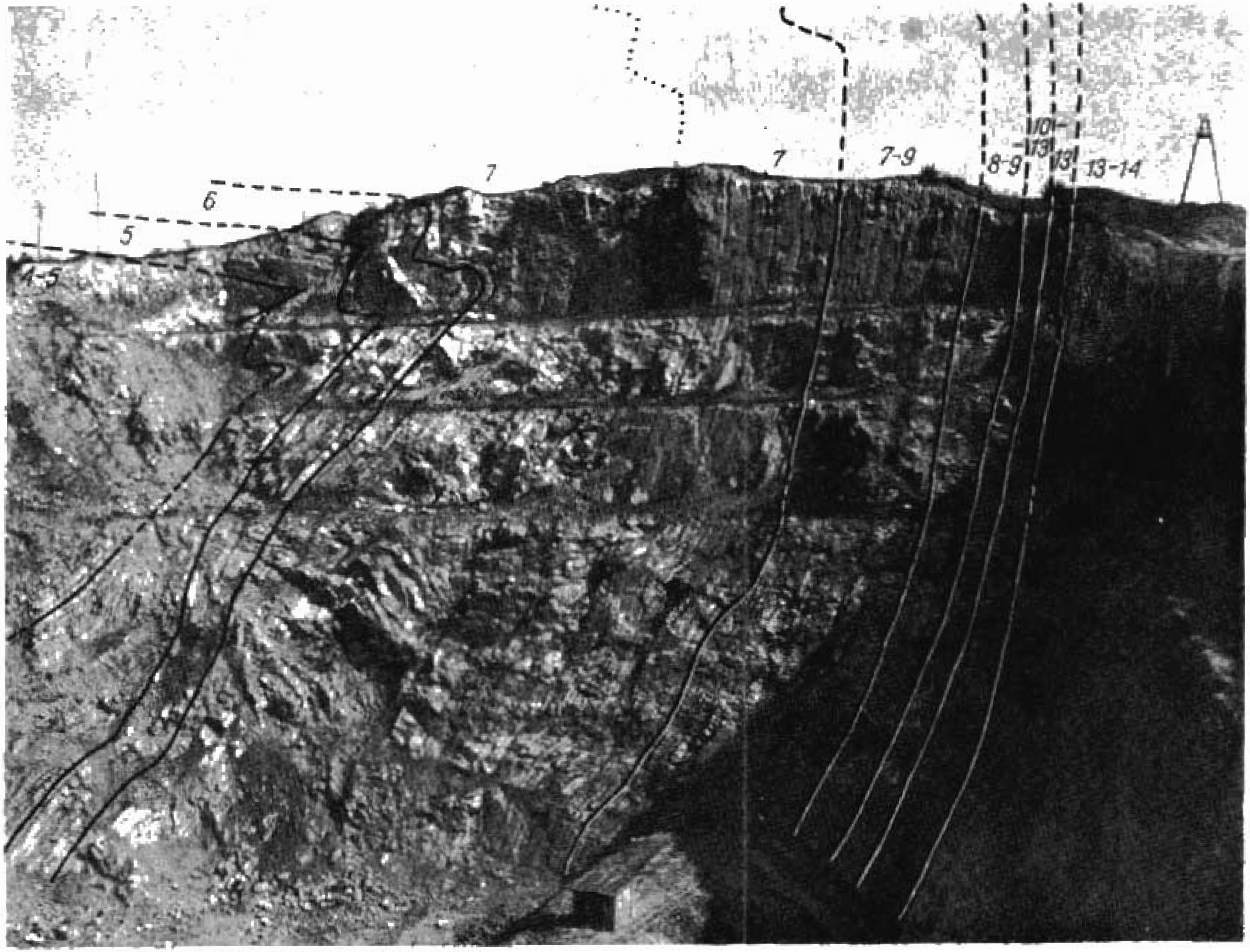
Czarnów

Frasnian deposits, exploited by peasants in small quarries (Czarnocki 1938), are exposed on a not very high hill about 300 m NE of the Śluchowice quarry. In this locality, the layers are in a reversed position, which is indicated by a succession of conodonts and reversed sedimentary phenomena (loadcasted stromatoporoids, erosional surfaces). This outcrop belongs to the inner part of the overturned limb of the recumbent Śluchowice fold. The profile (Table 3) represents the Middle and maybe even part of the Lower Polygnathus asymmetricus Zone (*to Iα*). It is formed (Fig. 7) by alternating coarse calcarenites, calcirudites and flat pebble conglomerates. An abundant benthic fauna contains massive stromatoporoids, massive (*Alveolites*) and ramose (*Thamnopora*) tabulate corals, ramose and cerioid rugose corals and brachiopods. The fauna is redeposited and has not so far been elaborated palaeontologically.

Śluchowice

The Śluchowice quarry (Fig. 2), situated between the village Czarnów and the Kielce-Herby railroad station, is the largest Upper Devonian outcrop in the Łysogóry region. The Frasnian is here strongly folded tectonically. Having at his disposal deposits exposed to a smaller extent than they now are, Czarnocki (1948) found at Śluchowice the presence of Frasnian deposits developed in a facies typical for the Łysogóry region. He

Western part of the Śluchowice quarry



observed shales and marls with *"Leiorhynchus" polonicus* Roem., overlain by coarse-bedded limestones, as well as thin-bedded bituminous limestones belonging to the upper part of the Frasnian. Różkowska (1953, p. 6) determined from the last-named limestones the species *Phillipsastraea goldfussi* Milne-Edwards & Haime indicative of the Upper Frasnian. Czarnocki (1948) found that the transition from the Frasnian to the Famennian was in this locality imperceptible.

Observations of a more complete profile of the Upper Devonian were facilitated by a considerable advance in the exploitation of the quarry. The profile (Fig. 7) starts with the Lower or Middle Polygnathus asymmetricus Zone (*to Iα*) which are here about 9 m thick. Its lower part consists of shales and marls with *„Leiorhynchus" polonicus* Roem., mentioned by Czarnocki, and upper of coarse-bedded calcirudites with abundantly redeposited fauna of tabulate and rugose corals and brachiopods. They are intercalated with intraformational flat pebble conglomerates. The sedimentation of the thin-bedded limestones (about 85 m thick) starts with the beginning of the Upper Polygnathus asymmetricus Zone (*to Iβ*) and persists to the Upper Palmatolepis gigas Zone (*to Iδ*). All transitional conodont zones may here be distinguished (Fig. 2, Table 3). In this part of the profile, autochthonous deposits (micritic, knobby and wavy-bedded limestones, marly shales) alternate many times with redeposited sediments (calcarenites, calcirudites and among them many intraformational conglomerates). Erosional surfaces in the bottom of redeposited sediments, as well as graded bedding and slump structures in redeposited sediments are common in this part of the profile. An oblique stratification is rarely met with. As indicated previously (Szulczewski 1968), subaqueous gravitational movements (slumps, turbidity currents) were the most important factors of the transportation of the redeposited material. A part of the material was probably redeposited by bottom currents.

A slump origin bed of flat pebble conglomerate rests in the top of the deposits described. Its undersurface is clearly erosional. This bed belongs to the Palmatolepis triangularis or even Lower Palmatolepis crepida Zone (*to IIα*). The erosion is likely to be resulted in the small thickness or even with the lack of the uppermost Frasnian in the profile. An overlying bed of a brachiopod limestone is already clearly a part of the Lower Palmatolepis crepida Zone (*to IIα*), although probably of its lowermost horizons (sample *S. 41*). Over a flat pebble conglomerate covering it, there begins a sequence of rhythmically bedded, alternating limestones and marly shales. The beds of limestones are frequently irregular and discontinuous. Flow rolls aboundant in these deposits were interpreted by Radwański & Roniewicz (1962) as slump structures.

In deposits higher than the Middle Polygnathus asymmetricus Zone (*to Iα*), fossils are few. Fragmentary corals, massive stromatoporoids and

Table 3

Distribution and frequency of conodonts at Czarnów and Śluchowice

CZARNÓW /C/ ŚLUCHOWICE /S/ — Zone	3–4		4					3–4			4	4–5		5			6		7									7–9	8–9		10–13	11–13	13	13–14	
Sample	C.9	C.10	C.14	C.15	C.17	C.19	C.20	S.3	S.4	S.6	S.7	S.10	S.12	S.13	S.14	S.15	S.17	S.20	S.21	S.22	S.23	S.24	S.26	S.27	S.29	S.30	S.34	S.36	S.37	S.38	S.39	S.40	S.41	S.42	S.45
Icriodus symmetricus	4	3		1						5	1									2				1		1									
Spathognathodus gradatus	2	1								5																									
Playfordia primitiva	1	1								1																									
Ancyrodella sinecarina	3							2																											
Polygnathus decorosus		8	12				2	2	2	14	3	4	35		11		3			11		4			2	1	5					8	16	4	
Ancyrodella rotundiloba rotundiloba			3				1	1			4																								
Ancyrodella rotundiloba alata								1	2	3																									
Polygnathus asymmetricus ovalis		2	1						1	1	3																								
Polygnathus asymmetricus asymmetricus			5							14	3	1				7																			
Icriodus nodosus s.l.		2		1	1					6																									
Nothognathella klapperi										3	1																								
Polygnathus brevilaminus										1																						2	5		
Enantiognathus lipperti		1																		1						1									
Polygnathus sp. B			1																																
Ancyrodella gigas			4				1				1			1	1			10			2														
Polygnathus normalis			3	2	8	3	2						1						23	53	2			1	2		1	3	8	1		1	6		
Palmatolepis transitans				4		1				1		1		4	2	1		2																	
Palmatolepis punctata				1	3		2										6	1				2			1		2								
Ancyrodella lobata					5	3	1							4			6	4	1	1	1	1				2									
Nothognathella sp.						1																													
Ancyrodella curvata														1	1													4	5	4					
Palmatolepis subrecta															1			1	12	15	2		5	1	3		34	3	10	8					
Ancyrodella rugosa																1																			
Polygnathus dengleri																2																			
Ancyrodella nodosa																	1	3	9	1	5	2						2							
Palmatolepis unicornis																			1	2															
Palmatolepis gigas																			1	1			1						6	4					
Palmatolepis foliacea																				2															
Ancyrodella ioides																				1							1								
Icriodus alternatus																				1								2	2	2		11	7	3	
Avignathus orthoptera																					1					1									
Nothognathella? abnormis																												1							
Ancyrognathus asymmetrica																													1	2					
Palmatolepis triangularis																															3	15	40	3	2
Nothognathella condita																															1				
Palmatolepis subperlobata																																1	1		
Palmatolepis delicatula delicatula																																2	14		
Palmatolepis delicatula clarki																																1	5		
Palmatolepis tenuipunctata																																	6	1	2
Palmatolepis perlobata perlobata																																	4		
Palmatolepis quadrantinodosalobata																																	2		
Palmatolepis sp.																																	6		
Icriodus cornutus																																	1		
Ancyrognathus sinelamina																																	2		
Nothognathella typicalis																																	4		
Polygnathus incompletus																																	1		

Places of sampling in the profiles shown in Fig. 7; numerical symbols of conodont zones explained in Table 1 a detritus of crinoids are recorded in calcareous, redeposited sediments. Few ramose stromatoporoids, tentaculitoids and brachiopods are present in autochthonous limestones.

Dalnia

Dalnia, the next hill in the Kadzielnia chain of the Upper Devonian west of Karczówka, is marked on Czarnocki's map (1938) as that built of Frasnian limestones. Despite the Dalnia hill being situated about 1.5 km in a straight line from Śluchowice, the Frasnian of this locality is developed in a quite different facies (Fig. 7). These are non-bedded limestones with a visible thickness of about 20 m, containing a rich benthic fauna of tabular and massive stromatoporoids, ramose rugose corals, many large gastropods of the genus *Pleurotomaria* and a detritus of crinoids. Stromatoporoids occur as a rule in growth position (Fig. 6), and tabular stromatoporoids reach a width of 130 cm. Limestones are as a rule micritic and contain small amounts of a detrital material. Positive results were yielded by only one conodont sample (*D. 8*) from these limestones which extensively confirmed the Frasnian age of their top part (Table 4).

The stromatoporoidal limestones are overlain by an about 2 m thick complex of oolitic limestones, connected with them by a continuous sedimentary transition and very poor in benthic fauna. Only one scant conodont sample from the upper part of the oolitic limestones yielded a positive result. It contained a mixed fauna representing some of the conodont zones corresponding to the *to III*, as well as species from the Spathognathodus costatus Zone (*to V/VI—VI*). Oolitic limestones are probably the entire Famennian or its considerable part condensed. Such a development of the Famennian is unique in the Holy Cross Mts. A cleft, filled with reddish and green marly limestones, as well as red clay, occurs in the uppermost part of oolitic limestones, intersecting them vertically and almost perpendicularly to the bedding surface. Its infilling is a "clastic" dike formed by superficial filling. The fissure was partly filled with a loose, not yet consolidated material which penetrated into oolitic limestones through fine branchings running from the main cleft. Its infilling, that is, limestone and clay are extremely rich in fossils such as tabulate and rugose corals, trilobites and conodonts. Less numerous are cephalopods, brachiopods, crinoids and bryozoans. Corals, trilobites and conodonts will be the subject of a separate work (Osmólska, Różkowska, Stasińska & Szulczewski, *in preparation*). The rich assemblage of conodonts indicates the age of the infilling of the fissure as the Spathognathodus bischoffi (*to V—VI*) and the Gattendorfia (*cu I*) zones. Although both present in the infilling of the fissure, the conodont assemblages of these two zones are never mixed with each other. Culmian shales are probably the youngest sediment found in the dike. The formation of the dike was most likely connected with seismic or tectonic phenomena at the beginning of the Lower Carboniferous. Detailed conclusions will be given only after a full elaboration of the fossils.

A block of pelitic limestone, many meters thick and containing few cephalopods, embedded in the Quaternary sands, rests at the foot of the hill on its southern side. The assemblage of conodonts it contains indicates that they come from the Lower and Middle Palmatolepis crepida Zone (*to IIa*). Any longer transportation of a block of such a size is hardly imaginable and in the profile of Dalnia no Palmatolepis crepida Zone occurs with such a manner of development. This additionally indicates a vast and sudden facial differentiation of the Upper Devonian over a small space. Besides, it can be recalled that the Cheiloceras Famennian containing cephalopods was known to Czarnocki & Samsonowicz (1911, p. 319), Gürich (1896, p. 88) and Sobolev (1912a, p. 38) from the eastern slopes of the nearby Karczówka hill.

Kadzielnia

The Upper Devonian of the Kadzielnia hill in Kielce has for more than 100 years been the source of fauna, the richest and most interesting of all in the Holy Cross Mts, as well as one of the main objects of stratigraphers' interest. It is also now that the geology of the Kadzielnia hill is of the most importance to the solution of fundamental problems of the stratigraphy and sedimentation of the Upper Devonian in the Holy Cross Mts.

The Kadzielnia hill is composed mostly of a stromatoporoid-coral limestone. Roemer (1866) termed it as the *Kadzielnia-Kalk* and Sobolev (1912b, p. 2) pointed out its identity with the Iberg Limestone. The fauna was successively described by Zeuschner (1865), Roemer (1866) and Gürich (1896) and supplied, both then and through later works, many new species (cf. *e.g.* Biernat 1971). Gürich (1896, p. 86) found that in the eastern part of the hill, the Kadzielnia limestone is directly overlain by cephalopod limestones with *Manticoceras intumescens* (i.e. the *Cephalopoden-Schichten* = *Intumescens-Kalk*). Sobolev (1912b, pp. 3—5) observed, however, that in the western part of the northern slope of the Kadzielnia hill, the Kadzielnia limestone was directly overlain by limestones with many cephalopods which still belonged to the lower part of the Cheiloceras Stage. Above them, outcropping marly shales, interbedded with limestones also containing cephalopods, were assigned to the upper part of the Cheiloceras Stage. At the same time, Sobolev concluded that the layers with *Manticoceras intumescens* did not form a separate horizon of the Kadzielnia hill covering in all places the Kadzielnia limestone, but that they were of the same age and replaced it facially. This problem has been undertaken in the present paper and its examination confirmed in principle Sobolev's supposition.

Table 4

Distribution and frequency of conodonts at Kadzielnia and Dalnia

KADZIELNIA /XA, XB, X/ Zone	6	6–8						7–8	4–7	5–7	7		7–10	4–7		14–15		16	13–14	4–8
DALNIA /D/ Sample	XA.2	XA.3	XA.4	XA.5	XA.6	XA.7	XA.8	XA.9	XB.1	XB.2	XB.4	XB.5	XB.6	X.1	X.2	X.3	X.4	X.5	D.1	D.8
Polygnathus normalis	2	1	14	1		1		4	2	2	3	1[illegible]	1							
Palmatolepis transitans	1																			
Palmatolepis punctata	2								1	2					1					
Palmatolepis proversa	1														1					
Ancyrodella nodosa	1										1	5								
Polygnathus decorosus		1					1			8		2			3					
Palmatolepis hassi		1										11								
Icriodus symmetricus										2				2						
Ancyrodella lobata								2		2	1			1	3					1
Palmatolepis subrecta			1	4		2		9		1	1	64	1							
Palmatolepis unicornis					1						1									
Icriodus alternatus							1	2			2	2							12	
Spathognathodus gradatus							1													
Ancyrodella curvata							1													
Palmatolepis gigas								1			2	3	1							
Ancyrodella ioides												1								
Polygnathus brevilaminus												2								
Polygnathus sinuosus												9								
Palmatolepis foliacea												1								
Polygnathus? variabilis												2								
Nothognathella iowanensis												3								
Enantiognathus lipperti												1								
Palmatolepis subperlobata																2		1	1	
Palmatolepis tenuipunctata																11	111		1	
Palmatolepis cf. regularis																3	1			
Palmatolepis crepida																5				
Palmatolepis quadrantinodosalobata																5	64		1	
Palmatolepis termini																2	31			
Palmatolepis minuta minuta																8	65	23		
Palmatolepis minuta loba																2	18	2		
Ancyrognathus sinelamina																1				
Icriodus cornutus																	2			
Palmatolepis minuta wolskae																	19			
Palmatolepis circularis																	17			
Palmatolepis perlobata perlobata																	2	7	1	
Nothognathella sublaevis																	2	1		
Polygnathus procerus																	20			
Palmatolepis glabra glabra																		12		
Palmatolepis glabra pectinata																		4		
Palmatolepis glabra acuta																		6		
Palmatolepis rhomboidea																		2		
Palmatolepis quadrantinodosa aff. inflexa																		5		
Polygnathus nodocostatus nodocostatus																		5		
Polygnathus semicostatus																		3		
Spathognathodus aff. acutus																		2		
Nothognathella condita																		3		
Palmatolepis triangularis																			9	

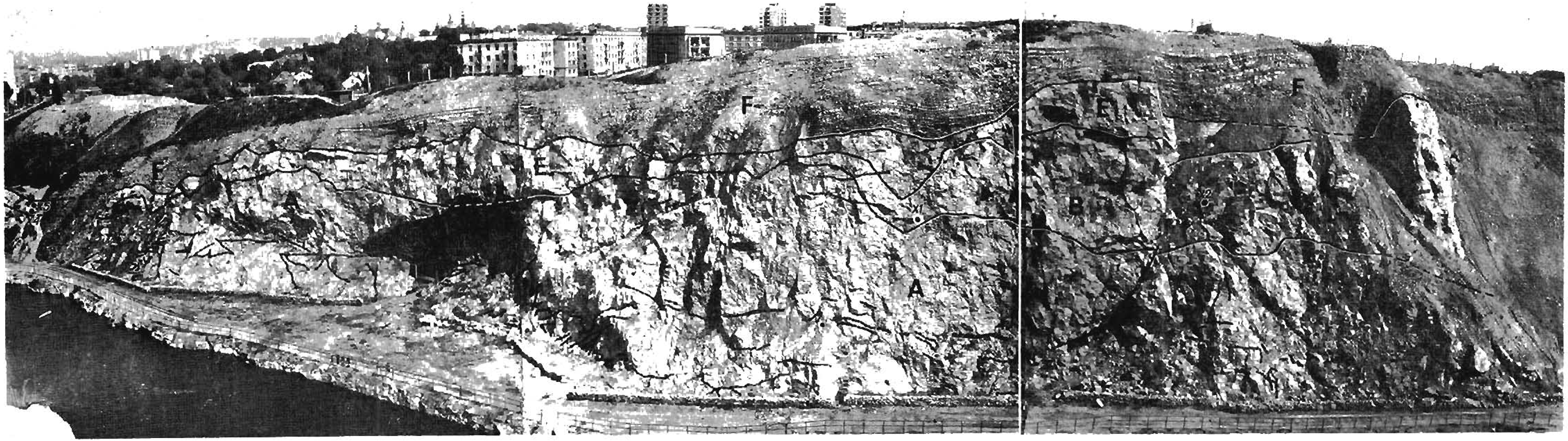
Places of sampling marked X in the Kadzielnia quarry are shown in Fig. 3, whereas marked *XA* and *XB* — in Fig. 4 (cf. also profiles in Fig. 7); sample *D. 8* comes from the profile (cf. Fig. 7), sample *D. 1* from a block lying at the foot of the Dalnia hill; numerical symbols of conodont zones explained in Table 1

As mentioned in the introduction, Czarnocki (1948) distinguished in the Frasnian of Kadzielnia three units corresponding in his opinion to substages and which were later adopted by other authors. Such a division was also presented by Pajchlowa (1962, pp. 86 and 87, also for the profiles presented in Wolska, 1967 and in Różkowska, 1969). Pajchlowa & Stasińska (1965, 1968) described bioherms from the Lower and Middle Frasnian and gave their tentative ecological interpretation.

Now, the quarry on the Kadzielnia hill (Figs 3, 4) is already inactive and its lower parts are flooded. The Middle Frasnian *sensu* Czarnocki is visible only in what is known as "Geologists' Rock". In the eastern wall of the quarry, the only deposits outcropped are the Upper Frasnian, visible at the highermost of the former exploitation levels and the Cheiloceras Famennian overlaying (Figs 3, 4).

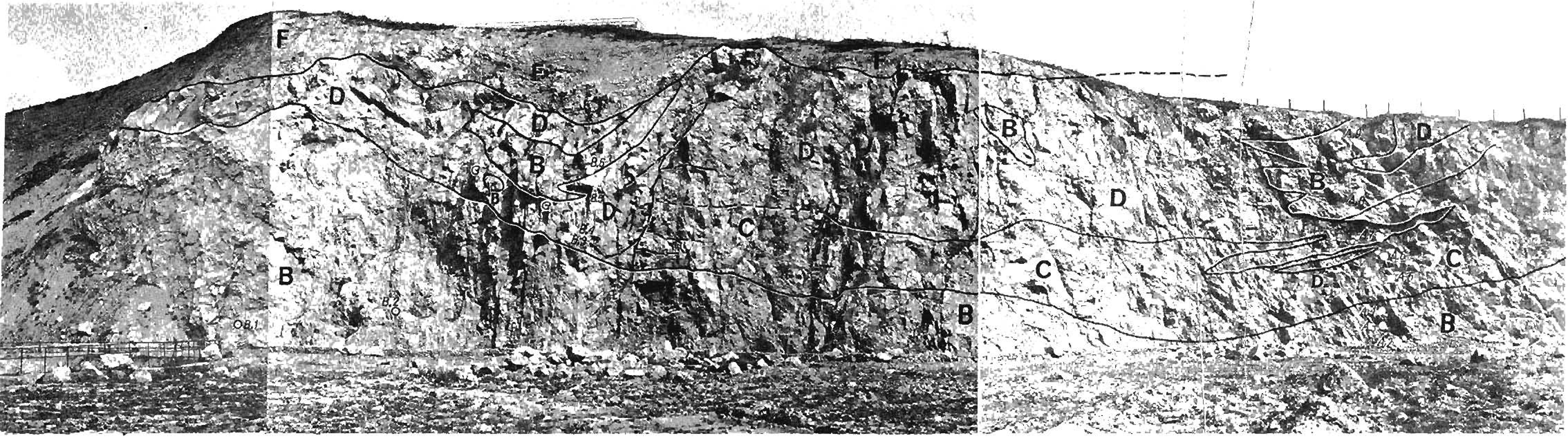
The Frasnian deposits, now accessible for the studies, (Fig. 7), correspond only to the upper substage as it was understood by Czarnocki. An assemblage of conodonts indicative of the Ancyrognathus triangularis Zone (*to Iγ*) has been found (Table 4) in its lowermost part (sample *XA. 2*). The Upper Frasnian *sensu* Czarnocki belongs to this zone and to the Palmatolepis gigas Zone (*to Iγ—δ*). A considerable lateral facial variability is marked in these zones. In the north-western part of the wall (Fig. 3), the Frasnian is developed as nonbedded limestones with lamellar and massive stromatoporoids, massive *Alveolites,* ramose tetracoralls, brachiopods and a detritus of crinoids. Southwards, lower and lower zones are gradually replaced by detrital limestones (calcarenites and calcirudites) among which enclaves of the oolitic limestone are sporadically met with. Finally, in the south-eastern end of the quarry (Fig. 4), detrital deposits completely replace massive stromatoporoid limestones. In this part of the quarry, almost entire assemblage of detrital limestones turns laterally into micritic and striped limestones and micritic limestones with large intraclasts of calcarenites. Micritic limestones contain here and there cephalopods which, however, cannot be exploited. Lenses and interfingerings of detrital limestones occur among micritic limestones. A bed most bounding in them contains conodonts (sample *XB. 5*) which indicate that it belongs to the Lower Palmatolepis gigas Zone (*to Iγ*). The limiting surface between non-bedded stromatoporoid limestones of Kadzielnia and a complex of detrital limestones, as well as the boundary between detrital and micritic limestones are inclined to the east and run obliquely to the surfaces of bedding visible in the Famennian. An interpretation of these differences as a tectonic discordance connected with possible movements on the boundary between the Frasnian and Famennian does not seem to be possible on account of the petrographic character of the lowermost Frasnian and the lack of the products of a possible erosion. Under such circumstances, it should be acknowledged that the differences in dips of the Frasnian and Famennian are caused by the original sedimentary inclination of the Frasnian deposits. They are of the nature of diachronous surfaces. General lithological changes in the Frasnian are, therefore, lateral facial changes.

The Famennian starts (Fig. 7) with thick-bedded micritic limestones containing a rich fauna of cephalopods. These limestones, usually about 2 m thick, belong to the lower part of the Cheiloceras Stage. They rest successively from the west to the east on massive stromatoporoid limestones (the Kadzielnia limestone), on detrital limestones and, finally, on micritic limestones with cephalopods. Their undersurface is uneven. Some of its depressions are filled with abundant cephalopods. Here and there, North-western part of the Kadzielnia quarry



The deposits correspond to the upper part of the Frasnian and the lowermost part of the Famennian. Facial changes in the Frasnian comprise: *A* stromatoporoid-coral limestones (Kadzielnia limestone), *B* detrital limestones; veins of laminated limestone (cf. Fig. 8) are marked by cracked lines. Overlying are: *E* Cheiloceras limestone, *F* marly Famennian.
Numbers of samples the same as in Table 4 and Fig. 7

South-eastern part of the Kadzielnia quarry



Left side of the photograph shows the same fragment as the right side of Fig. 2; Further facial changes and interfingering of various Frasnian deposits are visible. Letteral symbols are explained in Fig 3 except the Manticoceras limestones (*C* intraformational lumpy limestones, *D* micritic limestones). Places of sampling marked *A* correspond to samples designed as *XA* and *B* to samples designed as *XB* in Table 4 (cf. also Fig. 7). Additionally, occurrence sites of the Frasnian goniatites are shown large blocks of the Kadzielnia limestone are embedded in the lower part of the cephalopod limestones. As follows from both Wolska's (1967) studies and the present writer's observations (samples *X. 3, 4*), the sedimentation of the Cheiloceras limestones was started in the Middle or Upper Palmatolepis crepida Zone (*to IIa*). The conodonts from sample *X. 3* concur with *Tornoceras acutum* Frech, which, according to Professor H. Makowski (pers. communication), is the oldest goniatite from the Cheiloceras beds occurring on the Kadzielnia hill. An assemblage of conodonts which is already indicative of the Palmatolepis rhomboidea Zone (*to IIβ*) has been found in the upper part of the Cheiloceras limestone (*X. 5*). The Cheiloceras limestones from Kadzielnia are, therefore, a unit which displays a considerable stratigraphic condensation. As found by Wolska (1967), the shale-marly deposits of the Famennian, overlaying the Cheiloceras limestones, contain conodonts of the Palmatolepis quadrantinodosa Zone (*to IIβ—IIIa*). Wolska's (1967) conodonts were found in the Famennian only. The present writer has succeeded in finding them also in the Frasnian. They were not, however, found in the stromatoporoid limestones (the Kadzielnia limestone), but in detrital and micritic limestones replacing the latter to the east.

The reasons why conodonts of the Palmatolepis triangularis (*to Iδ — to I/II*), as well as the Lower and may be Middle Palmatolepis crepida (*to IIa*) zones do not occur, are not quite clear. Probably, a stratigraphic gap, corresponding to the zones referred to above, appears on the Kadzielnia hill. The supposition that the uppermost part of the Kadzielnia stromatoporoid limestone and its detrital and micritic equivalents might correspond to these zones is much less likely, since the deposits of the older zones of the Frasnian found there reach as high as below the Cheiloceras limestone. If this supposition was correct, these zones should be condensed to a maximum extent, whereas they do not display, in their development, any features characteristic of the deposits of such a type.

Psie Górki

The Upper Devonian rocks are exposed in a few small, abandoned quarries on the Psie Górki hill in the Kielce suburbs. Thick-bedded limestones of the lower members of the Upper Devonian are exposed on the southern slope of the hill and marly-shaly deposits of the Famennian on the northern slope. The occurrence of the Middle Frasnian *sensu* Czarnocki with *Pexiphyllum ultimum* Walther and the Upper Frasnian with *Pseudoacervularia ananas* (Goldfuss) has on the basis of corals been found by Różkowska (1953, p. 5).

The oldest rocks, outcropped in the profile (Fig. 7), belong the some of the zones between the Upper Polygnathus asymmetricus (*to Iβ*) and

Table 5

Distribution and frequency of conodonts at Psie Górki

PSIE GÓRKI /P, PG/ — Zone	5–7					6–7			6–8	8						11	12–14	13–14	14–15		15
Sample	P.1	P.2	P.3	P.4	P.4a	P.5	P.6	P.7	P.8a	P.8c	P.9	P.9a	P.10	P.10a	P.10b	P.10c	P.11	P.12	PG.1	PG.2	PG.3
Polygnathus decorosus	6	2	6		1			6	1	11	3		2			2	2				
Palmatolepis subrecta	3							5	6	12	13	35	2	26	5	1					
Ancyrodella lobata			1	2		3		1		1											
Ancyrodella triangularis						1						1			1						
Nothognathella aff. klapperi						1															
Icriodus symmetricus						3		37													
Ancyrodella gigas						1															
Ancyrodella nodosa						1	3	3		1											
Palmatolepis punctata						3		3													
Palmatolepis proversa						3		4													
Ancyrodella ioides							1	1													
Polygnathus normalis								5	12	1		1	2	6	7		1				
Icriodus alternatus								4	2		4					12	12	6			
Enantiognathus lipperti									1												
Ancyrodella curvata										1	2	5	3	3							
Palmatolepis gigas										3		4	5	2	17						
Ancyrognathus asymmetrica										1											
Palmatolepis unicornis											2	2	1								
Polygnathus brevilaminus														1		1		1			
Nothognathella typicalis															1						
Nothognathella condita																1					
Palmatolepis triangularis																6	3	6			
Palmatolepis delicatula delicatula																1		10			
Palmatolepis delicatula clarki																2		4			
Icriodus cornutus																	1	1			
Palmatolepis subperlobata																		1	1	2	8
Palmatolepis quadrantinodosalobata																		1		2	
Polygnathus aff. angustipennatus																		1			
Palmatolepis tenuipunctata																		2	9	2	8
Palmatolepis perlobata perlobata																			1	2	
Palmatolepis minuta minuta																			3	4	2
Palmatolepis minuta wolskae																			1		
Palmatolepis termini																			4		
Ancyrognathus sinelamina																				1	
Palmatolepis crepida																					7
Palmatolepis glabra glabra																					1

Samples marked *P* come from detrital limestones, whereas marked *PG* — from the marly Famennian; places of sampling in the profile shown in Fig. 7; numerical symbols of conodont zones explained in Table 1

the Lower Palmatolepis gigas Zone (*to Iγ*) inclusively (Table 5). Much the same as higher members of the Manticoceras Stage, these deposits are developed almost solely as calcarenites and calcirudites. Thick-bedded, micritic limestones about 2.5 m thick occur only in the upper part of the Upper Palmatolepis gigas Zone (*to Iδ*). The sedimentation of the detrital limestones of the "Frasnian" type persists on the Psie Górki hill until the Lower or Middle Palmatolepis crepida Zone (*to IIα)* and, therefore, it is included in the Cheiloceras Stage. A boundary between the Manticoceras and Cheiloceras stages or that between the Frasnian and Famennian, running below, are in no way marked in the lithology of the deposits. A boundary between detrital limestones and the shale-marly Famennian is not exposed. Deposits with a typically Famennian sequence (samples *PG. 1—3*), consisting in the alternation of marly limestones with shales, and which are exposed on the northern slope of the hill belong as a whole to the Upper Palmatolepis crepida Zone (*to IIα*). Intercalations of intraformational flat pebble conglomerates and crinoid marls with brachiopod fauna appear in this monotonous complex. Both in its stratigraphic position and the manner of development, this member corresponds to Gürich's (1896, pp. 94—96) *Crinoidenmergel*, found by this author on the Cmentarna hill and considered by Sobolev (1912a, p. 7) as corresponding to the Cheiloceras beds and, in their uppermost part, maybe even to the Clymenia beds.

A few phacopid trilobites, *Phacops granulatus* (Münster), *Dianops typhlops* (Gürich), *Ductina ductifrons* R. & E. Richter, are mentioned from the Famennian of this outcrops by Osmólska (1958, p. 124) who erroneously calls the exposure "Psiarnia" and consequently assigns it, after Gürich, to the Clymenia beds. Really, the outcrop "Psiarnia" was situated (cf. Gürich 1896, Fig. 3) further to the west and now does not exist any more. The outcrop on the Psie Górki hill, corresponds most likely to Gürich's (*op. cit.*, Fig. 3) "Pulverhausberg" on which he stated the presence of the Kadzielnia limestone. Consequently, recognizing the Famennian beds exposed on the Psie Górki hill to be the Clymenia beds is a misunderstanding and *Ductina ductifrons* R. & E. Richter turns out to occur in its proper stratigraphic position.

Wietrznia

Three large quarries on the Wietrznia hill and a quarry at Zagórze are situated close each other and represent the eastern end of the Upper Devonian outcrops in the Kadzielnia chain. Detailed profiles with stratigraphy based on conodonts have been elaborated in two of them, which for the purposes of the present paper are called Wietrznia *I* and Wietrznia *II*. One of them is the furthest to the west, that is, the nearest to Psie Górki, the other, westernmost, is situated north of a road running to Bukówka. A quarry at Międzygórze, also included in the file of the Wietrznia quarries, is situated between them.

Wietrznia I

This is the largest and best-known quarry on the Wietrznia hill exploited until now. Newer works (Czarnocki 1948, Różkowska 1953) devoted to Wietrznia concern precisely this quarry.

Gürich (1896) stated that the limestones from Wietrznia differ from those from Kadzielnia in their distinct stratification. On the basis of fossils, he considered them as a transitional link between the Middle and Upper Devonian. According to Czarnocki (1948, p. 244), the calcareous--marly Frasnian of Wietrznia is, however, a facial equivalent of the Frasnian of Kadzielnia. Czarnocki (*in* Różkowska 1953, p. 1) claimed that the entire profile of Wietrznia belongs to the Frasnian, which, much the same as on the Kadzielnia hill, may, mostly on the basis of brachiopods of the genus *Hypothyridina*, be divided into three parts. The tripartite division of the Frasnian on the Wietrznia hill was strengthened, on the basis of the rugose corals, by Różkowska (1953, Table 1).

Table 6

Distribution and frequency of conodonts in the quarry Wietrznia *I*

WIETRZNIA I /W/ Zone	3–4								5–6	5–7							5–8
Sample	W.7	W.16	W.22	W.28	W.30	W.34	W.40	W.52	W.56	W.58	W.60	W.61	W.69	W.71	W.73	W.86	W.88
Polygnathus decorosus	4	4	5	3	5	12	4	24			6		4		3	7	71
Polygnathus normalis	3				2			1	7	7	1	25			1		6
Ancyrodella rotundiloba rotundiloba	1					4	3	2									
Polygnathus dengleri				1				3									
Spathognathodus sannemanni sannemanni				1													
Polygnathus pennatus				4													
Polygnathus asymmetricus asymmetricus				1		1		10									
Polygnathus asymmetricus ovalis						1	6										
Ancyrodella rotundiloba alata						1		2									
Nothognathella klapperi								3	1								
Spathognathodus gradatus								2									
Ancyrodella sp. A								1									
Polygnathus sp. A								1									
Palmatolepis transitans									4								
Palmatolepis punctata									5					3		7	
Palmatolepis proversa									2	1					1		
Ancyrodella lobata									6		1			3	5	2	1
Ancyrodella curvata									1				1				
Ancyrodella gigas														1		4	
Palmatolepis subrecta																2	23
Polygnathus foliatus																	3

Location of the profile shown in Fig. 1, places of sampling in the profile — in Fig. 7; numerical symbols of conodont zones explained in Table 1

Only few samples from that outcrop turned out to be positive, most of them containing few conodonts (Table 6). Hence, a detailed separation of conodont zones on the Wietrznia hill is impossible. Nevertheless, it turned out that the lower part of the profile (Fig. 7) belonged to the Lower or Middle Polygnathus asymmetricus Zone (*to Iα*). The samples taken from the highermost places belong to some of the zones between the Upper Polygnathus asymmetricus Zone (*to Iβ*) and Lower Palmatolepis gigas Zone (*to Iγ*). The uppermost members of the Frasnian present on the Wietrznia hill are now inaccessible, but the profile does not reach the Famennian (cf. Fig. 7). The following sets of beds may be distinguished on Wietrznia *I:*

A. Thin-bedded, black, bituminous limestones about 25 m thick. They contain many massive and tabular stromatoporoids, rugose corals, *Alveolites*, brachiopods and crinoids. The limestones are fine-grained and at least some of the contained organisms are redeposited.

B. Indistinctly bedded, light-colored calcirudites about 6 m thick, containing many broken and redeposited fossils, including, in addition to those mentioned in set *A*, colonial rugose corals.

C. Thin-bedded, dark-colored, bituminous limestones, abundantly intercalated with marly shales. The limestones are marly and frequently wavy-bedded. Intercalations of calcirudites, consisting of intra- and bioclasts, occur among them. Brachiopods and a detritus of crinoids abundant, solitary rugose corals also happening to occur.

D. Calcarenites and calcirudites with many, redeposited massive and tabular stromatoporoids, massive tabulate corals, solitary rugose corals and brachiopods. The thickness of the set amounts to about 14 m.

E. Alternating detrital (calcarenites, calcirudites), marly and knobby limestones. The detrital limestones contain an abundant, redeposited fauna of massive and tabular stromatoporoids, rugose and tabulate corals and brachiopods. The marly and knobby limestones are devoid of fossils. As compared with previous sets, the knobby limestones are here a new lithological element. An increase in the frequency of changes in the type of deposits is characteristic of this part of the profile. The thickness of the set, accessible to measurements, amounts to 11 m.

Sets *A, B* and *C* belong, as a whole, to the Lower or Middle Polygnathus asymmetricus Zone (*to* $I\alpha$). The upper part of sets *D* and *E* belong to the zones which are contained within the range from the Upper Polygnathus asymmetricus (*to* $I\beta$) to the Lower Palmatolepis gigas Zone (*to* $I\gamma$).

Wietrznia II

An abandoned quarry, in which an Upper Devonian profile is exposed (Fig. 7), divisible into the following sets:

A. Thin-bedded, knobby, marly, 1 m thick limestones, containing an abundant fauna of brachiopods, colonial rugose corals and *Receptaculites*.

B. Detrital limestones (biocalcarenites), containing many brachiopods, detritus of crinoids, colonial rugose and tabulate corals and massive stromatoporoids. An oblique stratification is frequently observed. A bed of a crinoid limestone makes up the top part of the set.

C. Rhythmically stratified, alternating, a few centimeters thick beds of calcarenites and calcilutites with erosional surfaces and a sedimentary boudinage; about 3 m thick.

D. Coarse-bedded micritic limestones with thin intercalations of intraformational breccia. Ramose stromatoporoids are the only fossils contained in pelitic limestones. The thickness of the set amounts to about 4 m.

E. Alternating micritic and marly limestones and marly shales, with the share of the last-named two components increasing topwards. Ostracods and goniatites, the latter visible only in sections, occur in the marly limestones. The thickness of the set is 3 m.

F. Alternating calcarenites and marly shales. Some of the beds of calcarenites display an oblique stratification. Tentaculitoids and *Spathiocaris* occur in marly shales. The thickness of the set amounts to about 2.5 m. The boundary between set *F* and the overlaying set *G* is tectonic in character. The size of the displacement is indeterminable.

G. Knobby limestones devoid of fossils, about 4.5 m in thickness.

H. Alternating, thin-bedded, marly limestones and marly shales, tectonically overthrust on the knobby limestones of set *G* and strongly folded.

Set *A* and the lower part of set *B* are of an indeterminate age and belong to the Lower-Middle Polygnathus asymmetricus zones (*to* $I\alpha$) or to the Schmidtognathus hermanni — Polygnathus cristatus Zone (Table 7). The upper part of the detrital limestones of set *B*, about 10 m in thickness, undoubtedly belongs already to the Lower or Middle Polygnathus asymmetricus Zone (*to* $I\alpha$). A characteristic bed of a crinoid limestone,

Table 7

Distribution and frequency of conodonts in the quarry Wietrznia *II*

WIETRZNIA II /V/ — Zone	2–4			3–4			4	5		5–7	7			7–8	7–11
Sample	V.1	V.5	V.6	V.8	V.12	V.14	V.16	V.17	V.17a	V.18	V.20	V.34	V.41	V.56	V.57
Polygnathus rugosus	1														
Polygnathus decorosus	2	2	1	1	4	2				5	2				
Polygnathus normalis	9	2	4	2				28	14	7	10	101		1	
Polygnathus aff. caelatus		1													
Polygnathus asymmetricus ovalis				1			2	1	1						
Ancyrodella rotundiloba rotundiloba				3		4	12								
Ancyrodella rotundiloba alata							4								
Ancyrodella sinecarina							5								
Ancyrodella gigas							6	1				2	1		
Polygnathus asymmetricus asymmetricus							6	1	3						
Palmatolepis transitans							2		1						
Polygnathus foliatus							3								
Enantiognathus lipperti							3			1		3			
Ioriodus symmetricus							43	4	2						
Ioriodus nodosus s.l.							1	1							
Palmatolepis punctata								3							
Palmatolepis proversa								2							
Palmatolepis subrecta								1		2	64	69	2	6	2
Ancyrodella lobata								7	2			2			
Ancyrodella curvata								1				4			
Ancyrodella sp. B									1						
Ancyrognathus triangularis										2	12	3		1	
Palmatolepis hassi											5				
Palmatolepis unicornis											6	26		1	
Palmatolepis gigas											3	1		22	
Ioriodus alternatus											13	4			
Nothognathella iowanensis											2				
Ancyrodella nodosa												61			
Ancyrodella ioides													1		
Avignathus orthoptera														2	

Location of the profile shown in Fig. 1, places of sampling in the profile — in Fig. 7; numerical symbols of conodont zones explained in Table 1

situated on top of the set *B*, makes up a top bed of the Middle Polygnathus asymmetricus Zone. The entire set *C* and the lower part of micritic limestones of set *D* belong to the Upper Polygnathus asymmetricus Zone (*to Iβ*). The reduced Ancyrognathus triangularis Zone (*to Iγ*) is situated within the upper part of this set. Set *E* belongs already as a whole to the Lower Palmatolepis gigas Zone (*to Iγ*), which also includes the lower part of set *F*. It is not unlikely that its upper part belongs already to the Upper Palmatolepis gigas Zone (*to Iδ*). The age of the knobby limestones of set *G* is indeterminate due to the poverty of conodonts. At any rate, they belong to the Frasnian. Despite the fact that no conodonts have been found in them, the marly deposits of set *H* undoubtedly belong already to the Famennian.

The comparison of the profiles Wietrznia *I* and Wietrznia *II* shows that, despite a superficial similarity in lithological types, occurring in the two profiles, they considerably differ from each other. The difference are so conspicuous that a correlation of these outcrops, situated near each other, based on lithology is impracticable. Especially characteristic is a considerable reduction in the thickness of the middle part of the Frasnian on Wietrznia *II*.

Górno

Deposits of the Upper Frasnian, near its boundary with the Famennian (Czarnocki 1938), are exploited in the Górno quarry. The deposits, closely resemble the Frasnian deposits of Śluchowice (cf. Czarnocki 1948, Szulczewski 1968). These are (Fig. 7) usually fine-bedded, bituminous, knobby limestones, wary-bedded or micritic, with many

Table 8

Distribution and frequency of conodonts at Górno

GÓRNO /G/ — Zone	?	12–?15				
Sample	G.1	G.2	G.3	G.4	G.5	G.7
Polygnathus normalis	7	37	36	9	150	58
Palmatolepis transitans	1	1	1			
Palmatolepis punctata	1	13	4	3		
Palmatolepis subrecta	4	42	16	12	12	74
Ancyrodella nodosa	9	3	2		17	19
Ancyrodella ioides		1				
Polygnathus decorosus		4		15		1
Palmatolepis hassi		4		1	15	8
Palmatolepis gigas		1	3	1	4	2
Palmatolepis linguiformis		7	2			
Icriodus alternatus		7				4
Palmatolepis tenuipunctata		1				
Palmatolepis triangularis		5				
Polygnathus nodocostatus nodocostatus			1			
Palmatolepis proversa			1		4	10
Palmatolepis unicornis				1	1	1
Ancyrodella lobata				1	3	2
Ancyrodella curvata					1	1
Ancyrodella gigas						3

Places of sampling in the profile shown in Fig. 7; numerical symbols of conodont zones explained in Table 1

intercalations of detrital limestones and intraformational deposits of flat pebbles, irregular pebble conglomerates and breccia. Erosional surfaces and graded bedding are common. Conodonts have been found only in redeposited detrital limestones. In all samples, conodonts are of the nature of mixed assemblages (Table 8) varying in age and containing many species which, under the conditions of a normal succession of species, never concur. The youngest species found allow one to consider the entire profile as not older as the Upper Palmatolepis triangularis Zone (*to I/II*).

Kowala

At the eastern end of the Gałęzice syncline, the Upper Devonian deposits are exposed in a few outcrops. A small section of the Frasnian profile is outcropped along the roadcut between the cement plant and the Kowala quarry. Frasnian deposits are also exposed along the railroad cut of Kielce — Busko railway (Fig. 5). Deposits of the same age are exposed in the Kowala quarry, where the lower part of the Famennian is also accessible. Detailed observations are, however, dificult in the quarry because of the exploitation, whereas in the railroad cut somewhat weathered surfaces of the limestone make this outcrop a very grateful object of studies of the Frasnian of the Holy Cross Mts.

In the environs of Kowala, no Famennian beds are exposed higher than the Lower or Middle Palmatolepis crepida Zone (*to IIa*). The presence of the uppermost Famennian, passing into the Lower Carboniferous, was, however, found by Czarnocki (1933) in the trenches. Conodonts which were indicative of the presence of the Middle Spathognathodus costatus (= S. bischoffi) Zone (*to V/VI? — VI*) were described from these deposits by Wolska (1967, p. 372). A rich fauna of corals was described from this place by Różkowska (1969, pp. 20 and 21). Part of the profile from which the material was obtained both by Wolska and Różkowska makes up the highermost section of the Upper Devonian beginning with the Frasnian outcropped in the railroad cut and Kowala quarry. The middle part of the profile, contained between the deposits visible in the quarry and those studied by Wolska and Różkowska, does not outcrop anywhere.

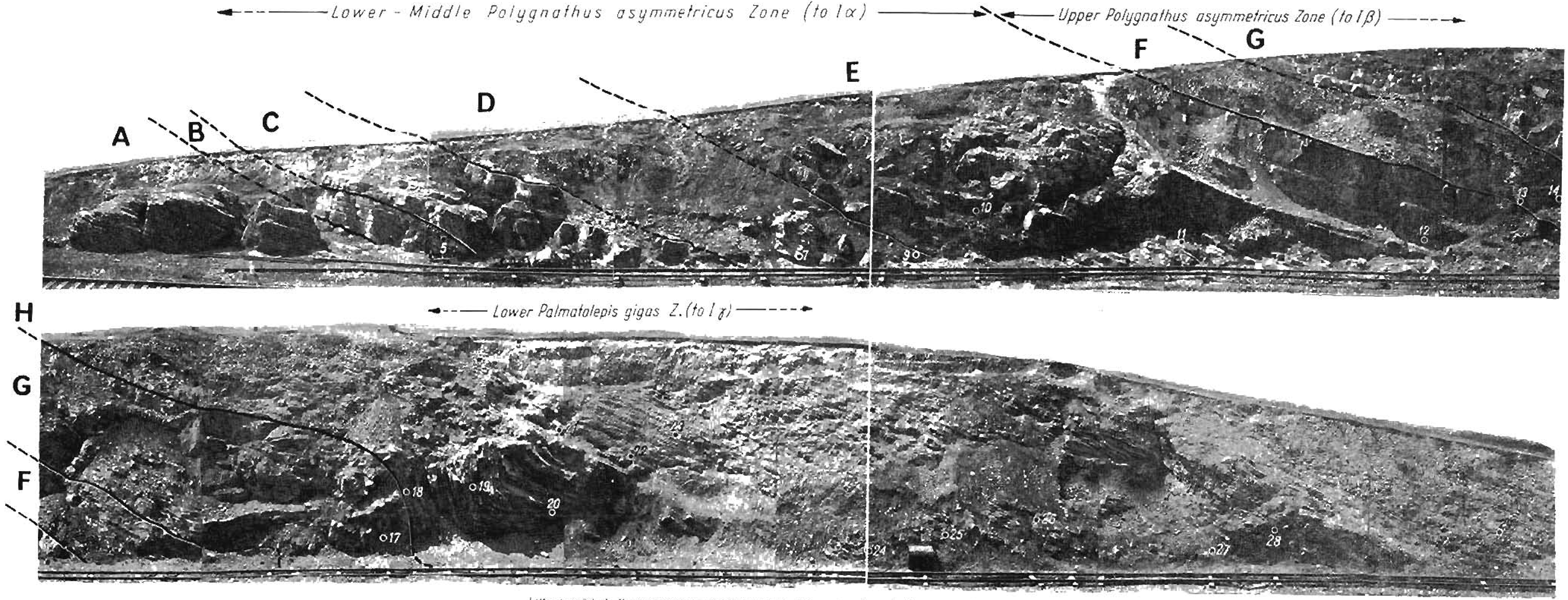
Railroad cut

The railroad cut was dug in 1951. The Devonian deposits it exposes (Fig. 5) have not so far been elaborated satisfactorily in their paleontological and stratigraphic aspects. A geological section was here made by Czermiński (1960, Tables 87 and 88), who believed part of the profile to be the Givetian and part the Frasnian. The boundary between these stages was located by him in the place in which thin bedded limestones overlay coarse-bedded ones. The entire profile, exposed in the cut was, however, stated by Szulczewski (1968, Text-fig. 7) to be the Upper Devonian. The present studies on conodonts have revealed that the entire Devonian exposed in the railroad cut belongs to the Manticoceras Stage. The boundary between the Givetian and the Frasnian suggested by Czermiński runs in fact within the highermost part of the Middle Polygnathus asymmetricus Zone (*to Iα*). The following sets of deposits, marked by letters *A* through *H*, have been distinguished in the profile (cf. Szulczewski 1968, Fig. 7):

A. Biostromal limestones with many massive and tabular stromatoporoids and tabulate corals (*Alveolites mailleuxi* Salée, *Thamnopora boloniensis* Gosselet) accompanied by less numerous rugose corals, gastropods, brachiopods, and a crinoid detritus. Light-colored flints occur here and there. The limestones are slightly knobby and display a distinct, but irregular stratification, wavy a little. In the highermost part of the complex, rugose corals are also visible (Pl. 21, Fig. 2).

B. Well-bedded micritic limestones with numerous tabulate, and solitary rugose corals.

Western side of the railroad cut at Kowala



Letteral symbols $A-H$ correspond to the sets discussed in the text; numbers of samples the same as in Table 9 and Fig 7

C. Biohermal limestones with numerous massive and tabular stromatoporoids, tabulate (*Alveolites mailleuxi* Salée, *Thamnopora boloniensis* Gosselet) and rugose corals. Of brachiopods, *Fitzroyella alata* Biernat, *Spinatrypa* cf. *tubaecostata* (Paeck.) and *Devonoproductus* sp. were mentioned (Biernat 1969). Gastropods and a detritus of crinoids are also present.

D. Coarse-bedded micritic limestones with brachiopods (not described thus far).

E. Micritic and detrital limestones with a poor fauna of massive stromatoporoids, rugose corals, *Thamnopora* sp., brachiopods and plant detritus. At least part of all stromatoporoids and corals are redeposited.

F. Alternating, thin-bedded, marly limestones and shales with numerous tentaculitoids and few brachiopods.

G. Bedded calcarenites and flat pebble conglomerates (Fig. 10). The latter contain redeposited stromatoporoids and rugose and tabulate corals. Tentaculitoids occur in thin marly intercalations.

H. Thin-bedded, alternating marly limestones and shales, containing many intercalations of graded detrital limestones (Pl. 33, Fig. 2). Marly limestones and shales contain few fossils such as, *Amphipora* sp., tentaculitoids, brachiopods, *Spathiocaris* and undeterminable goniatites, while a redeposited detritus of massive and ramose stromatoporoids, corals, crinoids and brachiopods abundantly occurs in graded detrital limestones. The amount of detrital intercalations decreases topwards.

No conodonts have been found in sets *A—C*, except of *Polygnathus decorosus* Stauffer, but other fossils indicate that they are as a whole Frasnian. The first conodonts, useful for detailed stratigraphy (Table 9 and Fig. 7), were found in set *D* (sample *KW. 7*). Sets *D* and *E* belong to the Middle and maybe also, in their lower part, to the Lower Polygnathus asymmetricus Zone (*to Ia*). The Upper Polygnathus asymmetricus Zone (*to* $I\beta$) begins into the highermost part of set *E*. The age of subsequent sets cannot be determined accurately, but set *G* does not reach higher than the Lower Palmatolepis gigas Zone (*to* $I\gamma$). This zone certainly includes the middle part of set *H* (samples *KW. 22—26*). The highermost part of set *H* is contained within limits of the Lower Palmatolepis gigas Zone (*to* $I\gamma$) and the Lower Palmatolepis triangularis Zone (*to* $I\delta$).

Kowala quarry

The lower part of the profile exposed in the quarry corresponds to the beds outcropped in the nearby railroad cut. The sequence of deposits is here similar, but such detailed observations as those in the cut are impossible because of the effects of exploitation. A series of alternating, monotonous, marly limestones and shales, devoid of intercalations of detrital limestones, is exposed (Pl. 33, Fig. 1) above the deposits corresponding to set *H* from the cut. These deposits do not contain fossils and the conodonts met with in them are also extremely rare. Fortunately, a sample (*T. 16*) has been obtained which revealed that the highermost beds outcropped in the quarry belong to the Lower or Middle Palmatolepis crepida Zone (*to IIa*). The boundary between the Mantico-

Table 9

Distribution and frequency of conodonts at Kowala

KOWALA /KW, T/ Zone	1–4	3–4					4	5		5–7		6–7			7			7–9			7–10		14
Sample	KW.5	KW.7	KW.8	KW.9	KW.10	KW.11	KW.12	KW.13	KW.14	KW.17	KW.18	KW.19	KW.20	KW.21	KW.23	KW.24	KW.26	KW.28	KW.29	KW.30	KW.31	KW.32	T.16
Polygnathus decorosus	1			2	12		3	17	2	6	2	21						1	1				
Polygnathus asymmetricus ovalis		1		1	3		1	1	2														
Polygnathus asymmetricus asymmetricus			5	6	6		3	1	6														
Ancyrodella rotundiloba rotundiloba			2		1		2																
Icriodus symmetricus			1	1	16	1	4	5	4		5			3									
Palmatolepis transitans			2																				
Enantiognathus lipperti					1						1												
Ancyrodella gigas							1						2										
Palmatolepis subrecta								5			1	8	10	7	1	3	3	1	2	26	2	1	
Palmatolepis punctata									2		2	1		4			1						
Polygnathus foliatus										1		9											
Ancyrodella lobata										2		5											
Ancyrognathus triangularis												1											
Ancyrodella nodosa														1									
Palmatolepis hassi														1		2	1						
Palmatolepis unicornis														1		2	1						
Icriodus nodosus s.l.														4									
Palmatolepis gigas															1				1	8	1	2	
Polygnathus normalis																1		2					
Icriodus alternatus																		3					
Ancyrodella curvata																			3	1		3	
Palmatolepis termini																							1
Palmatolepis tenuipunctata																							2
Palmatolepis subperlobata																							1
Palmatolepis minuta wolskae																							1
Palmatolepis quadrantinodosalobata																							1

Samples marked *KW* come from the railroad cut, whereas sample *T* comes from the uppermost layers outcropped in the Kowala quarry. Places of sampling in the profile shown in Fig. 7; numerical symbols of conodont zones explained in Table 1

ceras and Cheiloceras stages is here rather undetectable and it cannot be indicated on the basis of any fossils. It is also in no way expressed in the monotonous profile.

Gałęzice

The Upper Devonian of the western part of the Gałęzice syncline was discovered by Czarnocki (1928) in the environs of Gałęzice. According to this author (1928, 1948), very strongly condensed Famennian deposits, including the stages Prolobites (*to III*) through Wocklumeria (*to VI*), directly overlay the Upper Givetian ones. The entire thickness of the Famennian does not here exceed 3—4 m. The Famennian occurs in two separate lenses, on the Besówka and Ostrówka hills. A profile of the Famennian on the Besówka hill was made by Pajchlowa (*in* Wolska 1967, Fig. 3A) and on the Ostrówka hill by Osmólska (1962). An abundant fauna of corals, brachiopods, pelecypods, gastropods, ostracods, trilobites, cephalopods and fishes was described only in part (Osmólska 1958, 1962; Różkowska 1969). Unfortunately, a luxuriant and rich fauna of cephalopods has not so far been described and only part of it was listed (Czarnocki 1928, p. 59; Makowski *in* Różkowska 1969). The conodont stratigraphy of the Famennian of both Besówka and Ostrówka was elaborated by Wolska (1967, pp. 369 and 370) whose conclusions are in conformity with those presented by Czarnocki. The profile (Fig. 7) begin with the Palmatolepis quadrantinodosa (*to IIβ — IIIα*) and reach the Spathognathodus costatus (= S. bischoffi) Zone (*to V/VI? — VI*). Despite a considerable stratigraphic condensation both cephalopods and conodonts display a normal succession of species and, except for one conodont sample, are not mixed.

Despite a small tectonic displacement on the boundary between the Givetian and Famennian, it does not seem to having exerted a significant influence on the stratigraphic sequence of the Devonian deposits occurring in this locality. Besówka is situated less than 2 km from Ostrówka. It does not seem likely that a fault over such a distance might have precisely met the same, thin conodont zone within strongly condensed profile, on the other hand squeezing out the entire Frasnian. Much more likely seems to be a lack of the Manticoceras and Cheiloceras stages resulting from the sedimentary reason. A strongly decreased rate of sedimentation of the Famennian, recorded in the locality, strikingly contrasting with a rapid sedimentation which produced very thick deposits in the entire area of the other parts of the Holy Cross Mts, might be an evidence of the sedimentary gap and not tectonic cause of the lack of the Frasnian. Of interest and maybe also of importance is the fact that only in the places of the occurrence of the condensed Famennian it is overlain, higher up in the profile, with the Lower Carboniferous (Visean) developed in the limestone facies, whereas it was the Culm that deposited in the entire area of all other parts of the Holy Cross Mts. The reasons of the lack of the Frasnian and the presence of the condensed Famennian and Visean Carboniferous limestone should be ascribed to the subsidence which is insignificant as compared with the adjoining areas. During that period, the region of Gałęzice was a persistent rise.

Characteristics of zones

Conodonts from the profiles outcropping in the western part of the Holy Cross Mts establish the presence of eleven Upper Devonian zones described by Ziegler (1962b) from the Rhine Slate Mts and being of the universal nature on a world scale. These zones range from the Middle Polygnathus asymmetricus Zone (*to Iα*) to the Palmatolepis rhomboidea Zone (*to IIβ*) and represent the almost entire Manticoceras Stage and most of the Cheiloceras Stage. In the part of the profile under study, only the Upper Palmatolepis triangularis Zone (*to I/II*) and Middle Palmatolepis crepida Zone (*to IIα*) have not been separated in any of the profiles, because of the methodological difficulties indicated above. As previously shown by Wolska (1967), the conodont zones overlaying the Palmatolepis rhomboidea Zone (*to IIβ*) and corresponding to the cephalopod Platyclymenia, Clymenia and Wocklumeria stages may be also distinguished in the Holy Cross Mts.

Detailed data concerning the occurrence of definite conodont species in particular samples and dating them on the basis of assemblages of conodonts, are shown in Tables 2—9. Only part of all samples may be dated so precisely as to one conodont zone. Bases for dating them, equivalent to those for the distinction of particular conodont zones, are given below. In regard to the rest of the samples, an alternative age, determined with an accuracy to two or more conodont zones, is given in the tables. A principle of dating these samples is identical with that used for the samples whose age is exactly determined, but the ranges of species occurring in these samples considerably overlap each other and the time of coexistence of species exceeds one zone.

The Schmidtognathus hermanni — Polygnathus cristatus Zone and the Lower Polygnathus asymmetricus Zone (*to Iα*) have not been distinguished in the profiles under study, although the possibility of their presence cannot be precluded. The lowermost Frasnian and the uppermost Givetian are as a rule developed in the stromatoporoid-coral facies, particularly poor in conodonts, this fact making the studies difficult or even impossible. Samples from the deposits lowermost stratigraphically coming from Wietrznia II (*V. 1, 5, 6*) and Kowala (*KW. 5*) and containing only the species of *Polygnathus* with a relatively wide range may represent some of the zones named above, but also they may be younger.

In the profiles under study, the Lower Polygnathus asymmetricus Zone (*to Iα*) is difficult to separate from the Middle Polygnathus asymmetricus Zone (*to Iα*) due to the lack, in the material studied, of *Polygnathus varcus* Stauffer which becomes extinct at the end of the Lower Polygnathus asymmetricus Zone. With the used method of distinguishing conodont zones and the lack of this species, the distinction of the Lower Polygnathus asymmetricus Zone is impossible. Both Lower and Middle Polygnathus asymmetricus zones (*to Iα*) occur unseparated from each other at Czarnów (*C. 9, 10*), Śluchowice (*S. 3—6*), Wietrznia I (*W. 8—14*) and Kowala (*KW. 7—11*). The Middle Polygnathus asymmetricus Zone (*to Iα*) is the oldest conodont zone of the Manticoceras Stage which may be distinguished unequivocally. It has been distinguished at Wietrznia II (*V. 16*) and Kowala (*KW. 12*), where the subspecies of *Ancyrodella rotundiloba* (Bryant) are accompanied by *A. gigas* Youngquist. *Palmatolepis punctata* (Hinde) whose appearance in the definition of this zone determines its lower boundary (Ziegler 1962b, p. 19) has been found in the two profiles somewhat higher up, that is, in the Upper Polygnathus asymmetricus Zone (*to Iβ*).

The Upper Polygnathus asymmetricus Zone (*to Iβ*) can be easily distinguished at Wietrznia II (*V. 17, 17a*), where *Polygnathus asymmetricus asymmetricus* Bischoff & Ziegler and *P. asymmetricus ovalis* Ziegler & Klapper concur with *Ancyrodella curvata* Branson & Mehl and *Palma-*

tolepis subrecta Miller & Youngquist. This zone may be also distinguished at Kowala (*KW. 13, 14*), where of the species named above only *Ancyrodella curvata* Branson & Mehl is however lacking.

With the procedure adopted, the Ancyrognathus triangularis Zone (*to Iγ*) may be distinguished only in the case of the concurrence of *Palmatolepis transitans* Müller with any of the species which appears for the first time in this zone. Except for *P. transitans* Müller, none species is extinct with the end of the Ancyrognathus triangularis Zone. The A. triangularis Zone has been distinguished at Kadzielnia (*XA. 2*) and Śluchowice (*S. 17, 20*) on the basis of the concurrence of *Palmatolepis transitans* Müller and *Ancyrodella nodosa* Ulrich & Bassler.

The Lower Palmatolepis gigas Zone (*to Iγ*) may be easily distinguished on the basis of the concurrence of *Palmatolepis gigas* Miller & Youngquist with any of the species which do not reach higher than this zone, i.e. *Palmatolepis punctata* (Hinde), P. *proversa* Ziegler, *P. foliacea* Youngquist and *Ancyrodella ioides* Ziegler. However, only the two last-named species, rarer than the former ones, persist as far as the top of the zone under study, whereas the two first-named species become extinct in its lower part. This is the reason why the Lower Palmatolepis gigas Zone, distinguished at Śluchowice (*S. 21—34*) and Kowala (*KW. 23—26*) is, strictly speaking, only a lower part of this zone. On the other hand, this reservation does not concern the zone under study, distinguished at Kostomłoty (*KT. 7*) and Wietrznia II (*V. 20—41*), where it has been determined on the basis of the concurrence of *Ancyrodella ioides* Ziegler and *Palmatolepis gigas* Miller & Youngquist, as well as at Kadzielnia (*XB. 4, 5*), where *Palmatolepis foliacea* Youngquist occurs in addition to the two last-named species.

An upper part, containing *Palmatolepis linguiformis* Müller, may be distinguished after Glenister & Klapper (1966) within limits of the Upper Palmatolepis gigas Zone (*to Iδ*). According to Ziegler (1962b, p. 23), the lower boundary of the Upper Palmatolepis gigas Zone is determined by the extinction of *Palmatolepis foliacea* Youngquist and the appearance of *Ancyrognathus asymmetrica* (Ulrich & Bassler). The presence of the lower part of the Upper Palmatolepis gigas Zone has been determined at Kostomłoty (*Y. 5*) on the basis of *Ancyrognathus asymmetrica* (Ulrich & Bassler) and accompanying species which do not pass any more to the upper part of this zone, that is, *Ancyrodella gigas* Youngquist, *A. lobata* Branson & Mehl and *Ancyrognathus triangularis* Youngquist. The lower part of the zone under study has also been distinguished at Psie Górki (*P. 8c—10b*), where the two last-named species concur with *Ancyrognathus asymmetrica* (Ulrich & Bassler). The upper part of the Palmatolepis gigas Zone may be distinguished only in the case in which the presence of *Palmatolepis linguiformis* Müller is found. It has been precisely on this basis that it was separated at Kostomłoty (*Y. 18*), where, among other species, *Palmatolepis hassi* Müller & Müller and *Ancyrognathus princeps* (Miller & Youngquist) concur with *Palmatolepis linguiformis* Müller.

The Lower Palmatolepis triangularis Zone (*to Iδ*) is determined at Kostomłoty (*Y. 23, 27*) by *Palmatolepis gigas* Miller & Youngquist and *Ancyrodella curvata* (Branson & Mehl), becoming extinct together with the end of this zone, and already accompanied by new species *Palmatolepis triangularis* Sannemann and *P. subperlobata* Branson & Mehl.

The Middle Palmatolepis triangularis Zone (*to Iδ?*) has been stated at Psie Górki (*P. 10c*), where *Palmatolepis triangularis* Sannemann, *P. delicatula delicatula* Branson & Mehl and *P. delicatula clarki* Ziegler have been found in addition to *Palmatolepis subrecta* Miller & Youngquist reaching as far as this zone.

The Upper Palmatolepis triangularis Zone (*to I/II*) cannot be, as mentioned above, distinguished since none of the species becomes extinct with its upper boundary. For, it turned out that *Palmatolepis delicatula delicatula* Branson & Mehl, whose extinction was supposed, according to Ziegler (1962b, p. 26), to determine the upper boundary of this zone the same as the appearance of *P. tenuipunctata* Sannemann, persisted as far as the Lower Palmatolepis crepida Zone (cf. Glenister & Klapper 1966, p. 808). Such a high occurrence of *P. delicatula delicatula* Branson & Mehl has also been found at Śluchowice and Psie Górki (*S. 41; P. 12*).

The Lower Palmatolepis crepida Zone (*to IIa*) has been found at Śluchowice (*S. 41*) on the basis of the concurrence of *Palmatolepis delicatula delicatula* Branson & Mehl, *P. delicatula clarki* Ziegler and *P. quadrantinodosalobata* Sannemann. Since the only two specimens of *P. quadrantinodosalobata* Sannemann, found there, are nontypical as having a slightly developed inner lobe, this is probably a lower part of this zone. Among other material, they are accompanied by specimens of *Palmatolepis* sp. and *P. perlobata perlobata* Ulrich & Bassler with a strongly elongated inner lobe, and similar in outline to the specimens illustrated by Ziegler (1962b, Text-fig. 6a—c).

The Middle Palmatolepis crepida Zone (*to IIa*) has not been distinguished anywhere since it is difficult to separate it from two adjoining zones. This results from the fact that *Palmatolepis triangularis* Sannemann is the only species which becomes extinct in this zone, but its frequency is already very low there. The presence of *Palmatolepis termini* at Kadzielnia (*X. 3, 4*), Psie Górki (*PG. 1, 2*) and Kowala (*KW. T. 16*) with a simultaneous lack of *P. glabra* Ulrich & Bassler does not allow to decide whether we have here to do with the Middle Palmatolepis crepida or a lower part of the Upper Palmatolepis crepida Zone.

The Upper Palmatolepis crepida Zone (*to IIa*) has been found at Psie Górki (*PG. 3*), where *P. glabra glabra* Ulrich & Bassler, whose appearance marks the beginning of this zone, occurs along with *Palmatolepis* *crepida* Sannemann, *P. tenuipunctata* Sannemann and *P. subperlobata* Sannemann.

The Palmatolepis rhomboidea Zone (*to IIβ*) is determined at Kadzielnia (*X. 5*) by the presence of the name-giver of this zone.

Stratigraphy and correlation

The conodont zonation, found in the Upper Devonian of the western part of the Holy Cross Mts (Table 2—9), has been accepted as a basis for the correlation of profiles (Fig. 7). It is more accurate than the correlation adopted so far and enables correcting certain inaccuracies discovered in the last-named. The sequence of conodont zones, universal in a world scale, allows one at the same time a more exact presentation of the boundaries between the Upper Devonian stages.

The Upper Devonian stages and their boundaries

The Frasnian and Famennian stages have for a long time been used in the principal division of the Upper Devonian in the Holy Cross Mts. Originally, these stages were distinguished in the Ardennes. A different stratigraphic division is employed in the Rhine Slate Mts, where several cephalopod *Stufen* (cf. Table 1) are distinguished. The equivalents of these *Stufen,* from Cheiloceras *Stufe* to Wocklumeria *Stufe,* were distinguished in the Holy Cross Mts as cephalopod zones within the Famennian. Thereby, Manticoceras *Stufe* was understood, according to a generally accepted view, as an equivalent of the Frasnian. In presently accepted from, conodont zones are accurately determined in the Rhine Slate Mts and well correlated with cephalopods biostratigraphic units, whereas an accurate correlation of a detailed stratigraphic division of the Ardennian stages with conodont zones difficult for facial reasons, has not so far been elaborated. Nevertheless, Bouckaert's & Ziegler's (1965) description of conodonts from the Famennian of the Ardennes allowed one to find that the lowermost part of the Famennian, that is, the *assize de Senzeille* corresponds to the Middle Palmatolepis triangularis Zone (*to Iδ?*) and, therefore, enters the Manticoceras *Stufe.* Thus, a stratigraphic schema, based on conodont zonation, may be accurately correlated primarily with a division, based on cephalopods, but the Frasnian and Famenmain stages may be accurately correlated also on the basis of conodonts. After the introduction of a detailed stratigraphic division, based on conodonts, the acceptance, in the Holy Cross Mts, of a stratigraphic division used in the Rhine Slate Mts is undoubtedly more justified, although the Frasnian and Famennian stages will probably be continuously distinguished, since they may be determined by appropriate conodont horizons corresponding to them. The boundary between the Frasnian and Famennian in the Holy Cross Mts cannot be determined as accurately as in the Rhine Slate Mts. Nevertheless, the boundary between the Frasnian and the Famennian runs differently than that accepted thus far. The position of this boundary does not coincide with any permanent lithological boundary. Lithological changes that take place near the Frasnian/Famennian boundary are heterochronous. In particular, this boundary does not run in the bottom of marl-shaly deposits appearing above limestones. The sedimentation of limestones and marly shales, characteristic of the Famennian, begins as a rule above the boundary under study, although the moment of its beginning is not the same for all localities. On the Psie Górki hill, the Frasnian/Famennian boundary runs still within the coarse-bedded detrital limestones, typically "Frasnian" in their development, at least 3 m below the bottom of marl-shaly deposits. On the Kadzielnia hill, a stratigraphic gap occurs at the Frasnian/Famennian boundary, at least in some places, or the boundary may run below the Cheiloceras limestone in the lowermost part of the limestones which as a whole are considered as the Frasnian. At Śluchowice, a flat pebble conglomerate, probably corresponding to a few conodont horizons, appears on the Frasnian/Famennian boundary, while the marl-shaly sedimentation begins only in higher horizons of the Cheiloceras Stage. Likewise, the bottom of the Cheiloceras Stage, equivalent to the bottom of the Lower Palmatolepis crepida Zone and running above the Frasnian/Famennian boundary, is not marked as a definite permanent lithological boundary. At Kowala, both boundaries also run within a monotonous marl-shaly complex. A difference between the trace of the Frasnian/Famennian boundary, as marked on the maps used so far, and its real trace is, however, relatively insignificant (usually, of the order of a few meters) and, in practice, it is of no major importance to the mapping.

The lower boundary of the Upper Devonian, tantamount to the Givetian/Frasnian boundary, cannot be so far accurately determined in the Holy Cross Mts. To be sure, as indicated by Glenister & Klapper (1966, p. 783), due to the scarcity of cephalopods in the Ardennes, it is impossible to show that the boundary between the Givetian and the Frasnian, distinguished in this area, is exactly tantamount to the boundary between the Maenioceras terebratum and the Pharsiceras lunulicosta zones, to which appropriate conodont zones (cf. Table 1) are subordinated and which were distinguished in the Rhine Slate Mts. The Schmidtognathus hermanni — Polygnathus cristatus Zone, occurring in the gap between the last *Maenioceras* and the first *Pharsiceras,* found it the Rhine Slate Mts, has not so far been distinguished anywhere in the Holy Cross Mts. The Givetian/Frasnian boundary probably runs in stromatoporoid limestones, in which conodonts are among the rarities.

According to a practice based on the succession of cephalopods and conodonts (cf. Ziegler 1962b, Klapper 1966), the Upper Devonian — Carboniferous boundary has been adopted as an equivalent of the boundary between the Wocklumeria and Gattendorfia zones.

Detailed correlation

The correlation of the Frasnian, conducted on the basis of conodont zonation (Fig. 7), is far from perfect since not all of the single horizons could be separated in each profile, which was caused by a low frequency of conodonts in many a sample. The correlation of the profiles, based on lithology, is impossible in practice with an accuracy larger than to a stage and it is even within this range that the correlation is not quite accurate. In the case of the Frasnian, the difficulties are caused by a rapidly advancing lateral variability and, in the case of the Famennian — by a monotony of the development of the entire profile in most of the outcrops. The conodont zonation, found in outcrops, enables a biostratigraphic correlation of the outcrops (Fig. 7), which is more accurate than that accepted so far, to which it introduces considerable corrections.

As it has already been mentioned in the introductory chapters, the tripartite division of the Frasnian in the Łysogóry region, introduced by Czarnocki (1950), has been called in question by Pajchlowa (1957) who found that only the uppermost of the three members, that is, the Kostomłoty Beds were undoubtedly Frasnian. The statement of Kościelniakowska (1967), who maintained that the entire Frasnian of the Łysogóry region occurring at Kostomłoty, Trzcianka and Wzdół belonged to the Zone *to* $I\beta/\gamma$, seemed to be ungrounded (Szulczewski 1968). The present paper describes three outcrops, mentioned by Czarnocki (1950) as representing the Kostomłoty Beds, that is, those at Kostomłoty, Śluchowice and Górno. Trzcianka is situated outside the area covered by studies and, in addition, the Frasnian in this locality is not exposed anywhere. Now, it turned out that at Kostomłoty, the Frasnian includes the horizons from the Lower Palmatolepis gigas Zone (*to* $I\gamma$) up to the boundary with the Famennian. Lower members of the Frasnian at Kostomłoty are not exposed at all.

On the other hand, a more complete profile of the Frasnian in the Łysogóry facies is outcropped at Śluchowice, where a manner of developing the Frasnian, corresponding to the Kostomłoty Beds, appears in the Upper Polygnathus asymmetricus Zone (*to* $I\beta$) and persists up to the end of the Frasnian. Lower members of the Frasnian, belonging to the Lower and Middle Polygnathus asymmetricus Zone (*to* $I\alpha$), are developed in the facies of coarse-bedded, detrital limestones with an abundant sedentary benthic fauna and whose manner of development corresponds to that of the Kielce region. Thus, the Kostomłoty Beds, occurring at Kostomłoty itself, correspond only to the upper part of the Śluchowice profile which is similar to them facially. The development of the Frasnian is not, however, identical at Kostomłoty, Śluchowice and Górno. A characteristic member of limestones with flints, present at Kostomłoty and Trzcianka, does not occur at all at Górno and Śluchowice, despite a continuity in the last-named profile. The considerations, presented above, result in the following conclusions:

1. The development of the Frasnian, characteristic of the northern area of the Holy Cross Mts appears on the boundary between the Middle and Upper Polygnathus asymmetricus Zone (*to Iα/β*) and persists at least up to the Upper Palmatolepis triangularis Zone (*to I/II*).
2. The most complete Frasnian profile occurs in this facies at Śluchowice.
3. At Kostomłoty, only the upper part of this profile is exposed.
4. Considerable differences in types of deposits are observed between the Frasnian profile at Kostomłoty and that in other localities of the northern area.

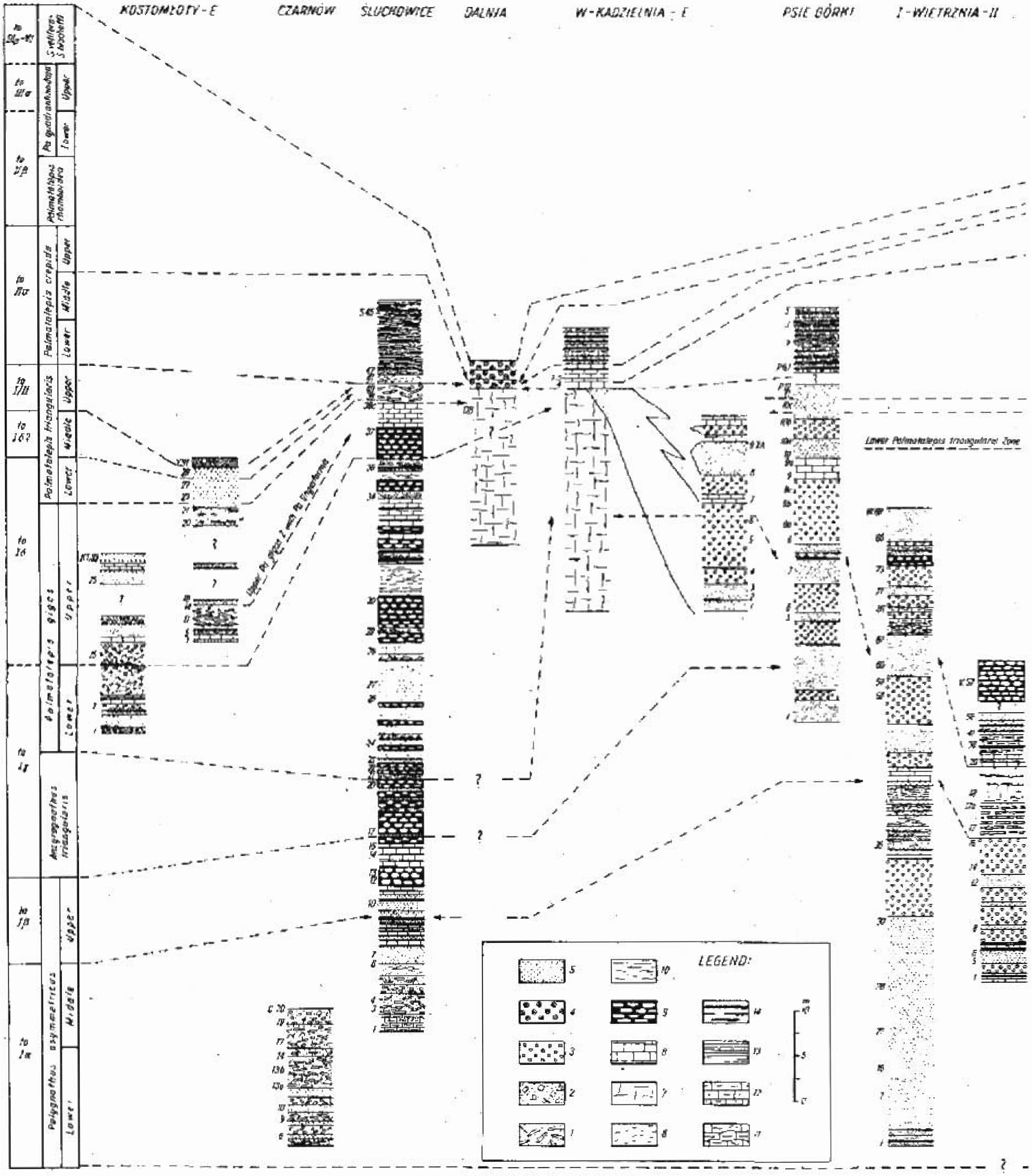
On account of the incompleteness of the profile and non-representative character of the deposits in the typical place, it seems advisable to give up the term Kostomłoty Beds, which is not unequivocal. This term was lithoprotostratigraphic in character and now, after introducing the biochronostratigraphic division, it has lost its topicality. The Pokrzywianka Beds and Nieczulice Beds, which have been distinguished in the eastern part of the Holy Cross Mts, do not occur at all in the western part of the area.

The lower part of the Frasnian in the Łysogóry region, belonging to the Lower and Middle Polygnathus asymmetricus Zone (*to Iα*), is developed in the manner characteristic rather of southern region.

The triplicity of the Frasnian in the area of Kielce is not marked in the form of a different lithology of the deposits succeeding each other. Czarnocki (1948) emphasized a presence of the lateral facial changes within the Kielce region, but the triplicity of the Frasnian, indicated by this author, is not marked even in the entire Kadzielnia quarry, since the abruptness of the lateral facial changes causes, a quite different succession of deposits in various parts of this quarry. The biostratigraphic triplicity of the Frasnian, shown in stratigraphy based on corals, may be replaced by a more accurate stratigraphy based on conodonts, whereas all conodont zones are equivalent to each other and not subordinated to the tripartite division.

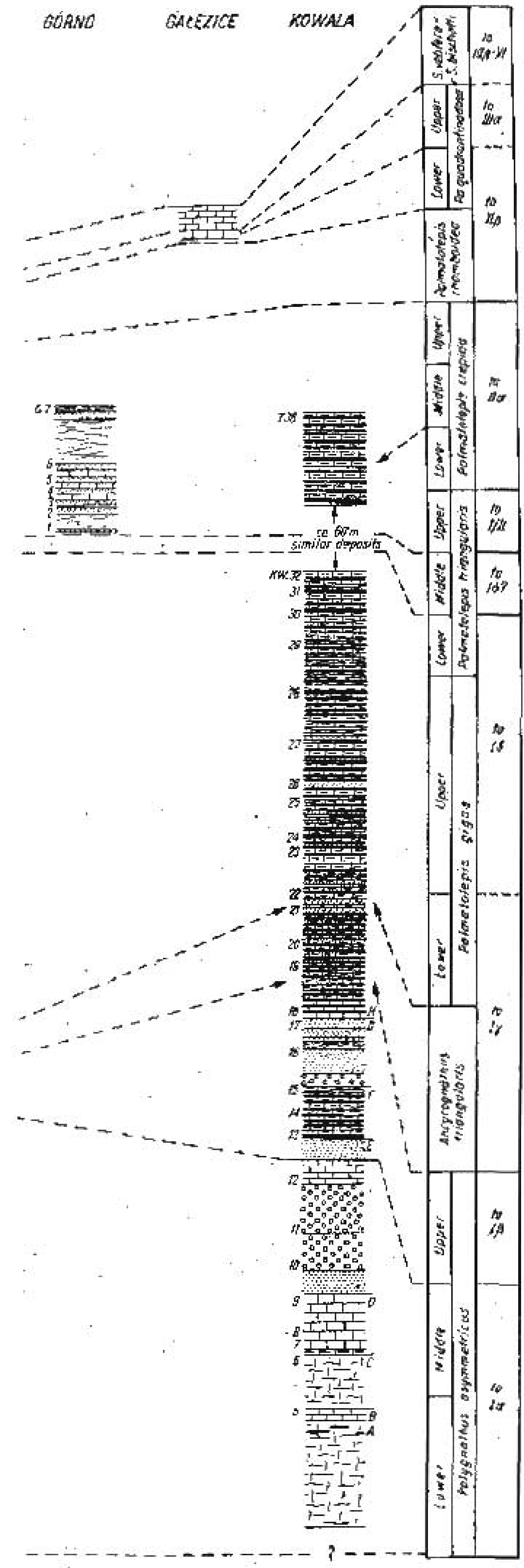
The thickest Frasnian deposits in the Kielce area are now outcropped in the quarries of Wietrznia (*I, II*), where the lowermost part of the Frasnian is exposed, corresponding to the Middle and probably also Lower Polygnathus asymmetricus Zone (*to Iα*). These profiles do not, on the other hand, include the uppermost part of the Frasnian and they probably terminate below the Upper Palmatolepis gigas Zone (*to Iδ*). The Frasnian, now exposed at Kadzielnia and Psie Górki, begins with horizons higher

Correlation of the Upper Devonian profiles in the western part of the Holy Cross Mts base



1 flat pebble intraformational conglomerates, 2 irregular pebble intraformational breccias, 3 calcirudites, 4 oolitic limestones, 5 othe
7 unbedded or weakly bedded stromatoporoid-coral limestones, 8 well bedded micritic limestones, 9 knobby limestones, 10 wavy bedded m
limestones, 12 regularly bedded marly limestones, 13 marly shales, 14 flints

on conodonts



alcarenites, 6 brachiopod limestones,
itic limestones, 11 wavy bedded marly

than those at Wietrznia, since the oldest deposits exposed at Kadzielnia belong to the Ancyrognathus asymmetricus Zone (*to Iγ*) and those exposed at Psie Górki — to zones which are not lower than the Upper Polygnathus asymmetricus Zone (*to Iβ*). On the other hand, these profiles include a transition from the Frasnian to the Famennian. A detailed correlation of the outcrops named above is shown in Fig. 7. It should be stressed, that no index lithological horizons have been found which might facilitate the correlation of the profiles.

A separate position is taken by the Frasnian exposed in a railroad cut at Kowala which is situated a considerable distance to the south of the outcrops named above (cf. Fig. 1). Its particular members may be fairly accurately correlated, although not it all cases with an accuracy to one conodont zone, with the Frasnian outcrops of the Kadzielnia range, as well as with the Frasnian profiles from the Łysogóry region.

The full picture of the Frasnian, based on all available outcrops in both regions under study, allows one to conclude that the Frasnian of the Łysogóry area corresponds stratigraphically to almost entire Kielce Frasnian as in both regions the same zones occur now. The lowermost Frasnian of the Łysogóry region is analogous facially to the Frasnian of the Kielce region. A different development of the Frasnian in this region, corresponding to the former Kostomłoty Beds, appears with the Upper Polygnathus asymmetricus Zone (*to Iβ*). In this development, the Frasnian more or less corresponds stratigraphically to the entire profile of the Frasnian occurring at Psie Górki.

FACIAL DEVELOPMENT

In the older Upper Devonian, in its part stretching a little over the Manticoceras Stage, the facial pattern is rather stable. The areal pattern of the facies varies to some extent, although the main facies maintain the same for all the distinguished biostratigraphical units. These main facies are: Stromatoporoid-Coral Facies, Detrital Facies, Manticoceras Limestones, Transitional Facies, and Basin Facies.

In the younger Upper Devonian a rapid change of the facial types takes a place and four different facies occur. These are: Cheiloceras Limestone, Marly Facies, Multifossiliferous Facies, Oolitic Facies. The last two are remarkable restricted.

Stromatoporoid-Coral Facies

Distribution. The limestones of this facies, known as the Kadzielnia limestones are exposed on the Kadzielnia (Fig. 3) and Dalnia hills. Likewise, the Karczówka hill is formed by them. The Frasnian in the

Bolechowice-Panek quarry and sets *A—C* in a railroad cut at Kowala (Fig. 5) are also developed in this facies.

General description. The occurrence of stromatoporoids and corals as a rock-forming component significant quantitatively, at least some of these fossils being preserved in growth position, is a common character of all limestones assigned to this facies. A deposit formed by precipitation, is a component of the limestones equalling in importance the skeletons. These limestones are either massive (non-bedded), or weakly stratified and thick-bedded. They are biolithites of the nature of either biostromes or bioherms.

Petrology and fossils. The limestones of this facies are marked by a wide range of paleontological and paleoecological problems, which have to be based on detailed paleontological studies of various groups of fossils, in particular stromatoporoids and corals. Partial paleontological studies, undertaken by Pajchlowa & Stasińska (1965, 1968) turned out to be unsufficient. Since detailed studies of this type could not be effective, the remarks given below are rather general in character.

A decided majority of limestones, belonging to this facies, are micritic limestones with a small amount of pellets and bioclasts. Sparry calcite forms local nests which fill open spaces. Bioclasts are formed of broken stromatoporoids and crinoids. Foraminifers and calcispheres are also present. Skeletons, with the predominance of those of stromatoporoids and corals, are a component of these limestones equalling in amount the micritic matrix. Considerable part of all sessile benthic coelenterates occur in growth position (Pl. 21, Fig. 2). This concerns *i.a.* massive (Pl. 21, Fig. 1) and tabular stromatoporoids (Pl. 22; Pl. 23, Fig. 1). An encrustation of some organisms by some others is observed, but it is insignificant quantitatively. Ramose stromatoporoids and corals, which never occur in growth position, are frequently broken. In some of the outcrops (*e.g.* Kowala), the stromatoporoid-coral limestones are knobby. The assemblage of organisms, occurring in various beds and various outcrops, is not uniform. A zonation of fossils is marked in some of the profiles. It has been found in the lower part of the Frasnian at Kadzielnia (Pajchlowa & Stasińska 1965) and Kowala (sets *A—C*).

At Bolechowice, the lowermost part of the profile is made up of the limestones which contain primarily very numerous *Amphipora*. In some beds they are accompanied by massive stromatoporoids, *Thamnopora*, solitary rugose corals, rare brachiopods, gastropods and pelecypods. Massive stromatoporoids are predominent in the upper part of the profile, but at first they are accompanied by still numerous *Amphipora*. In this part of the profile, very numerous are *Megalodon* and, less so, *Loxonema*. Corals are also present (Różkowska 1953).

An assemblage of fossils, occurring in sets *A—C* at Kowala, has previously (Szulczewski 1968, Fig. 7) been described, the same as the Lower Frasnian on the Kadzielnia hill (Pajchlowa & Stasińska 1965). Massive and tabular stromatoporoids, accompanied by corals, in particular *Alveolites*, are predominant in both localities. Ramose stromatoporoids either do not occur at all in these beds, or play an only subordinate role.

On the other hand, massive stromatoporoids, accompanied by tabular ones, predominante on the Dalnia hill (cf. Fig. 6). They are accompanied by *Thamnopora*, ramose tetracorals and numerous large gastropods *Pleurotomaria*.

Several interesting data have been supplied by the upper part of the stromatoporoid-coral limestone, outcropped on the Kadzielnia hill and assigned to the Ancyrognathus triangularis Zone (*to Iγ*) and probably belonging also to higher ones. These limestones contain very thin, numerous tabular stromatoporoids which usually reach a bare few *mm* in thickness (Pl. 22; Pl. 23, Fig. 1). They are accompanied by much rarer corals, brachiopods and small gastropods. Very frequently thin layers or umbrella-like lenses of mosaic sparry calcite occur below the plate-like stromatoporoids. Apart from stromatoporoids, bands of sparry calcite, similar to frequently described "Stromatactis" structures, are also common in this locality. Moreover, the Kadzielnia limestone is here and there separated by a dense network of fissures (Fig. 3) filled with a pink or, sometimes, multicoloured micritic limestone, which is usually laminated (Fig. 8). Some of the veins run parallel to the stratification, but most of them are irregular. Some of them reach a thickness of 1 m. Blocks of the Kadzielnia limestone are sporadically met with in the veins. Thin layers of a gray detrital limestone, resembling the limestones of the detrital facies, happen to occur between the laminae of micritic limestone filling the fissures. A graded calcareous deposit of very fine size (calcilutite-micrite) is frequently met with in some of the veins. Layers of fibrous calcite (Fig. 8) may occur in the top of particular graded beds.

Fossils occur very rarely in veins, but thin layers filled with small gastropods (Pl. 31, Fig. 2) have, however, been found in a few places. Veins, in filled with laminated limestone, are much less frequent in detrital facies and sometimes they even run across Cheiloceras limestone.

Interpretation. An interpretation of environment in which stromatoporoid-coral limestones were formed is usually based mostly on an assemblage of organisms they contain. However, considerable controversies are recorded in the interpretation of the environments with which various forms of stromatoporoids and corals were associated.

Massive stromatoporoids are usually considered as an index of shallow, turbulent waters (Lecompte 1959; Jux 1960; Klovan 1964, p. 35;

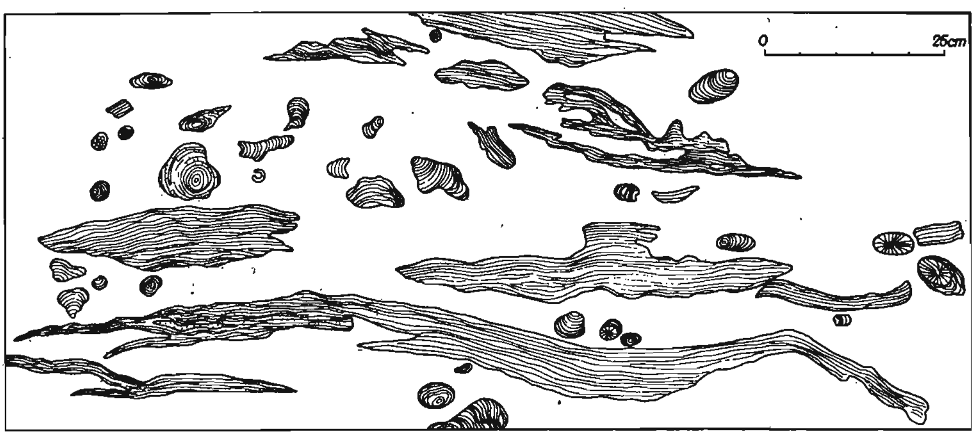


Fig. 6

Distribution of fossils in the Frasnian stromatoporoid-coral limestone at Dalnia

Large, tabular stromatoporoids preserved in growth position; small stromatoporoids partly overturned and broken

Fig. 8

Infilling of a vein in the stromatoporoid-coral limestone from Kadzielnia; rhythms composed of graded laminated limestone and sparry-calcite layer repeat one by one; nat. size

Murray 1966, p. 16; Laevit 1968, p. 324). The facts that massive stromatoporoids are frequently overturned and abraded and that the skeletal grains with sparry calcite cement predominate in associated matrix, are usually cited as arguments. Likewise, the most frequent occurrence of massive stromatoporoids along basinward margins of the structures considered as reefs, indicates that such was their preferred habitat. It has, however, been found by Krebs (1968a, p. 304) that massive stromatoporoids in "block-reefs" in the Rhine Slate Mts grew below wave base.

Tabular stromatoporoids grew, according to a general opinion, more abundantly in quiet water, but in the lower part of the photic zone (Lecompte 1959, p. 19; Klovan 1964, p. 38; Murray 1966, p. 17; Laevit 1968, p. 324). Different conclusions were, however, drawn by Perkins (1963, pp. 1, 341) who maintains that a flat habitat of the stromatoporoids under study can be an adaptation to a very turbulent water. According to this author, this is primarily indicated by their common occurrence in growth position and by the predominance of micrite, usually with no sparry calcite in the associated matrix.

Dendroid stromatoporoids, in particular *Amphipora* seem to have been adapted to a wide variety of habitats, but they especially preferred sheltered water of the back-reef (Klovan 1964, p. 39; Murray 1966, p. 199).

Laevit (1968, p. 326) believes that *Amphipora* grew in abundancy only in quiet, sheltered waters.

Alveolites are considered by Klovan (1964, p. 39) as tolerant of a wide variety of environmental conditions.

Thamnopora lived, according to Klovan (1964, p. 39) and Laevit (1968, p. 327), under moderate turbulent conditions. Murray (1966, p. 19) believes, however, that it preferred quieter and either deeper or more sheltered waters.

The analysis of the stromatoporoid-coral limestones in the area under study suggests certain remarks concerning the ecology of the organisms referred to above. Massive stromatoporoids very frequently occur in these limestones in life position (cf. Pl. 21, Fig. 1), micrite being the predominant component of the matrix. On the other hand, broken and overturned massive stromatoporoids are met with in abundance in the facies of detrital limestones. They occur commonly both with the tabular and dendroid stromatoporoids. They are frequently and abundantly accompanied by other benthonic organisms such as, solitary and colonial tetracorals, brachiopods, gastropods and crinoids. The conclusion may, therefore, be drawn that stromatoporoids lived in a zone of intensive turbulence and abrasion, but also occurred in an environment in which turbulence, if any at all, did not cause the abrasion of the bottom.

The occurrence of tabular stromatoporoids seems to be controlled by a limited water turbulence rather than by bathymetry. On the Kadzielnia hill, tabular, plate-like stromatoporoids (Pl. 22; Pl. 23, Fig. 1) occur in the peripheral zone of the stromatoporoid-coral limestones, that is, on their boundary with very shallow-water detrital limestones. It seems likely that they were protected from intensive turbulence by the zone of detrital deposits.

Dendroid stromatoporoids, as the only type of stromatoporoids, occur in the micritic limestones of the basin facies at Kowala or Śluchowice. Their bathymetric range was undoubtedly more extensive than that of other forms of stromatoporoids, they lived at larger depths than the remaining ones and reached below the wave-base. They may, however, concur as well with massive stromatoporoids (locality Bolechowice).

On the basis of fundamental petrographic characters of the deposit, of the manner of occurrence of fossils, in particular sessile benthic coelenterates and, finally, of the assemblage of fossils, we may conclude that although at least part of the stromatoporoid limestones was formed above the wave-base, none of them were formed in the surf zone. *Amphipora* limestones, forming the lower part of the profile at Bolechowice, correspond to the deepest sedimentary environment. All the remaining localities probably correspond to waters with a moderate turbulence, which might be a function of both bathymetry and the distribution of water dynamics caused by the configuration of the bottom.

The upper part of the stromatoporoid-coral limestones from Kadzielnia was probably formed under the extreme shallow-water conditions, but at the same time it was screened from turbulent open sea waters by an adjoining zone of sedimentation of detrital limestones and maybe also even by small, destructed marginal reefs. The *Stromatactis*-like structures are frequently considered as an evidence of the existence of a littoral environment (Wolf 1965). The commonly occurring cavity-filling sparry calcite closely resembles the early void-filling calcite in the Devonian fore-reef limestones, described by Krebs (1969) who proved that the voids, which did not display solution phenomena, occurred in a shallow, subtidal environment. The umbrella-like structures, which consisted in the occurrence of calcite lenses or veins below plate-like stromatoporoids, were formed here probably not by washingout a fine sediment from under the organism (cf. Krebs 1969) but by the filling with calcite of the voids formed by loosening the deposit, caused by its compaction, from the lower surface of the organisms. The *Stromatactis*-like structures, frequently considered as an evidence of a littoral environment (Wolf 1969), might have a smilar genesis and need not necessarily indicate a tidal zone. The veins of laminated limestone, common on the Kadzielnia hill, closely resemble fissures filled with calcareous sediment which are observd in many formations (cf. *e.g.* Fabricius 1962, Houša 1965, Wendt 1969). They are, however, most similar to the voids and their fillings, described by Krebs (1966) from the Iberger Limestone. Krebs discusses the hypotheses of their formation and is inclined to explain it by the results of tectonic movements or earthquakes. The last-named interpretation seems to be also most probable in explaining the formation of fissures in the Kadzielnia limestone. Much the same as in the Iberger Limestone, these voids were filled subaqueously still in the course of the Frasnian sedimentation. In addition to other arguments, given by Krebs (1966), this is confirmed by the presence of many small gastropods in some of the beds.

Detrital Facies

Distribution. The detrital facies occurs at Czarnów, in the lowermost part of the Frasnian exposed at Śluchowice and on the Kadzielnia hill, where they replace eastwards the limestones of the stromatoporoid-coral limestone. The entire profile of the early Upper Devonian outcropped at Psie Górki below the marly Famennian is also developed in this facies.

General description. The limestones of this facies are light-coloured, as a rule indistinctly stratified and coarse-bedded. Detailed field observations of the structural and textural features of the rocks are frequently difficult and they may be conducted only on clean and slightly weathered surfaces. No diagonal stratification has anywhere been found in these rocks. In the area of the facies under study, detrital limestones occur in thick complexes, reaching several scores of meters. Intercalations of other rocks occur in them rather exceptionally. Limestones of this facies may, however, interfinger the deposits of adjoining facies.

Petrology and fossils. The detrital limestones are considerably differentiated in their allochem composition and grain-size. In analyzing thin sections, one may distinguish among them several petrographical varieties, but, due to an indistinct stratification and considerable variability, the determination of the boundaries of occurrence of particular types in outcrops is in practice impossible. The following varieties occur among detrital limestones.

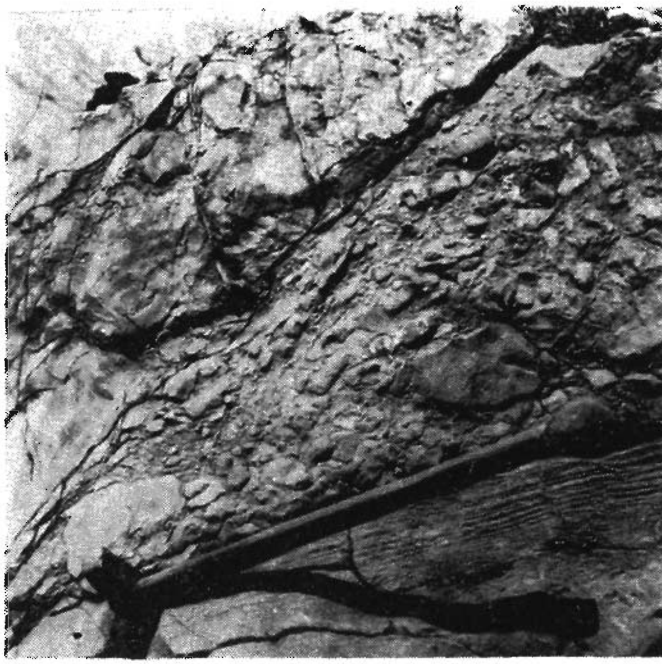


Fig. 9
Redeposited calcirudite containing large fragments of sessile benthic coelenterates; railroad cut at Kowala, set *E* (Frasnian)

1. *Biosparudites*

Gray, coarse-grained, skeletal limestones composed of large bioclasts (Pl. 24, Figs 1, 2; Pl. 25, Fig. 1; Pl. 27, Fig. 1). Massive stromatoporoids, frequently mostly allochems, occur as a rule among fragmented fossils. Dendroid stromatoporoids also are met with. Fragmentary tabulate and rugose corals are rare. Echinoderm debris, brachiopod shells and tests of ostracods, foraminifers and calcispheres are common. In addition to allochthonous and fragmented fossils, there also occur stromatoporoids, a few *cm* and larger in size, whose either auto- or allochthonous origin is difficult to prove. Intraclasts of micritic limestones and structureless pellets occur in subordinate amount. These limestones are unsorted: bioclasts varying from arenite to rudite fraction. Allochems are present in sparite matrix. A considerable recrystallizations is observable.

2. *Biointrasparenites*

A gray calcarenite (Pl. 30, Figs 3, 4), containing many fragments of crinoids, brachiopods, ostracods, foraminifers and calcispheres. Stromatoporoid and coral debris not very abundant. Many intraclasts of micritic or biomicritic limestones occur in addition to bioclasts; pellets few. Here and there, micrite matrix is visible, but sparite matrix predominates. A drusy calcite matrix, visible here and there, allows one to conclude that the amount of micrite was considerably devreased by recrystallization. Abundant algae *Chabakovia* (cf. Klovan 1964; Taf. 5, Figs 1—6; Krebs 1966, p. 22) do not display any traces of redeposition and seem to be autochthonous in the deposit. Blue-green algae *Girvanella* rare.

3. *Biopelsparenites*

This type of calcarenite contains fossils similar to those in the calcarenite described above. Algae *Chabakovia* are also frequent in it. In addition to bioclasts and small fossils, there occur numerous structureless pellets, whereas intraclasts are rare. Matrix is mostly sparite, although micrite also occurs in places.

4. *Oointrasparites*

A gray calcarenite (Pl. 29, Fig. 2), consisting of ooids and intraclasts accompanied by smaller amounts of lumps, pellets and bioclasts. Poorly sorted ooids are large, to 2 mm in diameter. Sometimes, superficial ooids predominate. Their nuclei are mostly formed by intraclasts. Ooids are irregular in shape, subcircular or suboval. Broken, regenerated and composed ooids are present. There also occur lumps compose of ooids. Intraclasts mostly consist of biomicrite and reach a size of 3 mm. Bioclasts are few and represent fragmentary skeletons of stromatoporoids or tests of brachiopods. Interstices between allochems are filled with pure, mosaic calcite. As in the two varieties of calcarenites described above, the algae *Chabakovia* are also frequently met with. No distinct oolite beds have been found. It is very likely that oointrasparite forms only isolated enclaves among other varieties of detrital limestones, but this could not be found for certain.

Interpretation. All types of detrital limestones are clearly of a very shallow-water origin. The presence of bioclasts and intraclasts as the main allochem components indicates that they were formed near or within the zone of intesive abrasion which affected both the organisms and the inorganic sediment. The dimensions of broken fossils give evidence for the intensity of a mechanical action of waving. Occurrence of algae confirms the conclusions on the shallow-water character of the zone in which detrital limestones of all types described were formed. Finally, the occurrence of ooids gives evidence that intertidal conditions were predominating during the formation of oointrasparites. Oosparites, very similar to those presented above, were described by Krebs (1968b) from the back-reef limestones of the Rhine Slate Mts. The intertidal origin

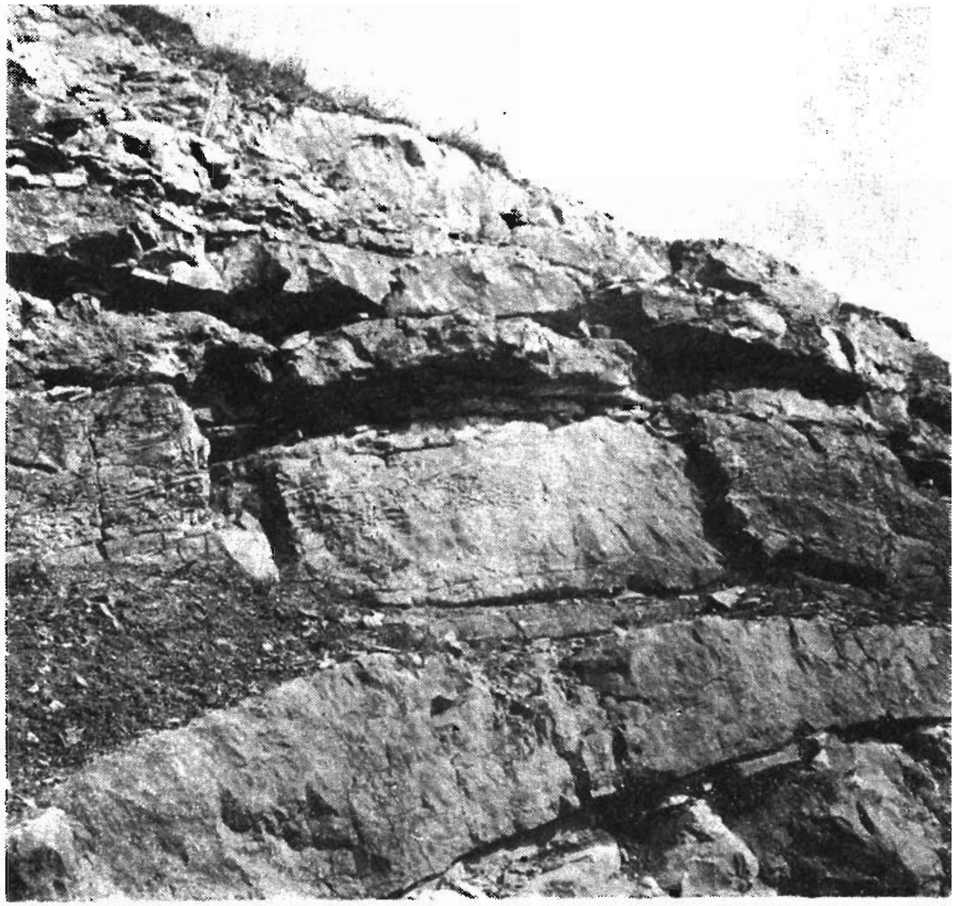


Fig. 10

Layers of flat pebble intraformational conglomerates; railroad cut at Kowala, set *G* (Frasnian)

was ascribed to them by this author. In contradistinction to those deposits, the oointrasparites described in the present paper contain, although small amounts, of fragmentary marine fossils. It has been suggested by Łabęcki & Radwański (1967) and Krebs (1968b) that superficial and broken ooids indicated a hypersaline seawater. Among detrital limestones, ooids do not play a quantitatively major role, but the abundance of pellets is an evidence that not only abraded and redeposited particles were significant to the sedimentation of detrital limestones. Also a considerable part of all fossils which here played an essential rock-forming role (brachiopods, ostracods, foraminifers, calcispheres, algae and maybe also some of the stromatoporoids and corals) lived in the zone of the formation of detrital limestones.

The environment of detrital deposits was, therefore, a shallow-water but generally subtidal. The strongly turbulent water caused abrasion and transported fragments of organisms from the adjoining zone abundantly settled by stromatoporoids. In the waters with a normal salinity, there lived brachiopods, echinoderms, ostracods, foraminifers and algae, characteristic of this environment and making up a considerable part of the sediment. Here and there, the depositional surface might rise up to the sea level and form local shoals reaching the intertidal zone and on which oolitic deposits were accumulated. A higher salinity might occur in those places.

Transitional Facies

Distribution. In this facies the Frasnian is developed at Wietrznia *I* and Wietrznia *II*.

General description. This facies includes two types of deposits overlapping each other. On the one hand, these are detrital limestones, identical with or related to the deposits of the Detrital Facies and, on the other, various, mostly micritic and marly limestones. The deposits of both these types differ from each other not only in lithology, but also in an assemblage of fossils they contain. The deposits of this facies are well-bedded and, on the whole, fossil-rich. Detrital limestones are as a rule light-coloured, while marly and micritic limestones of various types are usually dark-coloured and bituminous. The transitional character of this facies consists in an alternate, a few times repeated occurrence of a few meter thick complexes, alternately displaying characters of each of the facies mentioned above, whereas in the Basin Facies intercalations of detrital limestones have a thickness which only exceptionally exceeds a few scores of *cm* and usually does not exceed even a dozen or so *cm* and are mostly of the nature of turbidity intercalations.

Petrology and fossils. Of the petrographical types, mentioned and described in the chapter, devoted to the deposits of the detrital limestone facies, the following ones occur in the facies under study:

1. Biosparudites (Pl. 25, Fig. 2),
2. Biointrasparenites,
3. Biopelsparenites.

Oolitic limestones have not been found in this facies. The deposits of the three types mentioned above occur in some of the assemblages alternately but without sharp boundaries and forming an internal stratification. Diagonal stratification occur. Taphonomic characters of organisms give ample evidence of redeposition, manifested in the state of preservation of fossils, their spatial orientation and mechanical selection subordinated to the stratification of the deposit in which they are contained. Many fossils are broken, which is particulary clearly visible in the case of corals and stromatoporoids (Pl. 25, Fig. 2). Many brachiopods are preserved only as isolated valves. Fossils as a rule are embedded at random in the deposits, discordant to the growth position. This is particularly well-visible in massive and tabular stromatoporoids and tabulate corals. In the case of diagonal stratification, fossils of various taxonomic groups are concentrated in diagonally developed thin layers of rudite. All fossils known from similar deposits of the detrital limestone facies are met with. A considerable part of crinoids and brachiopods is, however, characteristic of the transitional facies. Despite being particularly susceptible to abrasion, crinoids are frequently preserved as a few-columnal fragments with an intact ornamentation. A stromatoporoid 2 m long and about 70 cm high occurs in detrital limestones, which here and there display a diagonal stratification. Algae of the genus *Chabakovia* have not been found in the facies under study.

The deposits characteristic of the basin facies are here represented by the following petrographical types:

1. Amphipora-micrites,
2. Micritic limestones,
3. Knobby limestones,
4. Graded detrital limestones,
5. Irregularly pebble intraformational breccia,
6. Marly shales.

The types of deposits mentioned above completely correspond, both lithologically and in the fossils they contain, to characteristics in the next chapter which is devoted to the deposits of the basin facies. Tentaculitoids, ostracods, cephalopods and *Spathiocaris* occur in places in marly deposits.

In addition to all the types of deposits mentioned above and which are characteristic of particular facies between which the facies under study occurs, certain singular types of deposits are also recorded, such as:

1. *Crinoid limestones* (Pl. 31, Figs 3, 4). A gray biorudite with a micritic and, in places, purely sparite matrix. It consists of many large elements of crinoids reaching 0.7 cm in size. Mostly, they are not abraded or display only slight traces of abrasion. In addition to them, the deposit also contains few tests of brachiopods. Insignificant amounts of pellets may also occur. This type of deposit occurs at Wietrznia *II*.

2. *Crinoid-brachiopod limestones.* A biorudite with a micritic and strongly marly cement, frequently recrystallized into sparite. These limestones are usually black and bituminous. They contain an abundant detritus of crinoids and brachiopods, which display slight traces of abrasion. Intraclasts of micritic limestones may concur with them in considerably varying proportions, sometimes even making up a component equalling quantitatively. In exceptional cases, the dimensions of intraclasts may reach a dozen or so cm. Pellets also occur. Some of the beds display a graded stratification. The deposits of this type occur at Wietrznia *I*.

3. *Rhythmically bedded calcarenite-calcilutites* (Pl. 30, Fig. 2). Rhythmically bedded, alternating thin layers of calcarenite and calcilutite whose thickness varies within limits of 1.5 and 4.5 cm. Lighter, gray layers are composed of a fine calcarenite in which only the remains of echinoderms and calcispheres may be identified. Darker layers are marly and calcilutite deposits. Erosional surfaces are observed in the bottom of calcarenite layers. A discontinuity of calcarenite layers, interrupted many times as a result of the sedimentary boudinage, is a common phenomenon. The deposits of this type occur at Wietrznia *II*.

Interpretation. The deposits of the facies under study take a position transitional between a detrital limestone facies and a basin facies in which the detrital limestones occur only subordinately as thin intercalations mostly of the turbidites. The range of the two facies was not, however, maintained within identical limits throughout the Frasnian but was subject to periodical changes which caused the interfingering of both facies. The facies under study is precisely of a transitional character, and it was affected either by the facies of detrital limestones or by the basin facies. However, this zone is probably marked also by specific characters of sedimentation. Detrital limestones, deposited in this zone, display very distinct features of redeposition, among them, a diagonal stratification. Of rock-forming organisms, a considerable importance is here acquired in particular by crinoids and brachiopods. Their common occurrence which, in the case of crinoids, exceeds their frequency observed in the facies of detrital limestones, their state of preservation and their rock-building role in some layers give evidence that this facies was the most favourable for their life requirements. In the Devonian, crinoids are most frequent in the reef or fore-reef facies (Klovan 1964, Murray 1966, Laevit 1968) and only Krebs (1966, 1968b) found them in the back-reef facies. Their presence may be considered as an evidence of a normal sea salinity. In regard to the mobility of waters in which they occurred, a considerable divergence of opinions is noted, for instance, Klovan (1964) believes that they lived a in deep, quiet-water environment, while Laevit (1968) is of the opinion that shallow, slightly agitated waters were their habitat. The low index of crinoid limestones shows that still and relatively deep waters were the most favourable habitat for the crinoids. Their presence in redeposited sediments and even in shallow-water stromatoporoid-coral limestones indicates, however, that their degree of their tolerance to environment was rather high.

Basin Facies

Distribution. The upper part of the Frasnian at Śluchowice, the Upper Devonian outcropped at Górno and part of Frasnian in the railroad cut at Kowala (sets *F* and *H*) are assigned to this facies.

General description. Deposits assigned to this facies are thin-bedded and display a multiple, monotonous alternation of a few lithological types repeatedly occurring. The alternating deposits belong to two different groups. One of them is made up of more or less marly limestones and marly shales the other being composed of detrital limestones. The deposits of each of these groups contain a different assemblage of fossils. Two subfacies may be distinguished within limits of the basin facies. One of them, corresponding to the deposits outcropped at Śluchowice and Górno, is marked by a greater variety of petrographical types, among which intraformational conglomerates are important ones. The deposits of the other subfacies are less differentiated and display a multiple alternation of three petrographical components, that is, marly limestones, marly shales and detrital limestones.

Petrology and fossils. The first group of deposits is formed by micritic, more or less marly limestones and marly shales. The following types of deposits may here be distinguished:

1. *Amphipora-micrites*

Gray, thin- or medium-bedded micritic limestones poor in fossils. Insignificant amounts of pellets may here occur. Only *Amphipora* occur in these limestones. They are scarce in the deposits, but sometimes they occur abundantly on the surface of the beds.

2. *Micritic limestones*

Light-gray, thin- or medium-bedded limestones, consisting almost entirely of micrite, which is frequently recrystallized in part. Usually, they do not contain fossils, but sometimes numerous tentaculitoids (Pl. 27, Fig. 2) or ammonoids (Pl. 31, Fig. 1) are met with in them. In some other cases, they contain (Wietrznia III) ostracods and cephalopods, the latter occurring only sporadically and in indeterminable numbers. At Kowala, also occurs a bank of micritic limestones containing many small gastropods.

3. *Knobby limestones*

Gray, thin- or coarse-bedded, marly limestones, knobby in shape. Knobs of micritic limestones, a few *mm* to a few *cm* in size, are embedded in a strongly marly matrix. They are lenticular to irregular in shape and do not contain fossils.

4. *Marly shales*

Thin beds of marly shales display a tabular stratification. Sometimes, they contain abundant tentaculitoids or *Spathiocaris* and, rarely, a plant detritus.

The second group includes detrital limestones of the following types:

1. *Graded detrital limestones*

They form a few to 75 cm thick beds. Intraclasts and bioclasts and, less numerous, pellets are the main allochems in them. Thin, a few *cm* thick beds vary from calcarenite in the lower to calcilutite in the upper part. In thicker beds, the graded bedding includes rains from rudite to lutite size (cf. Szulczewski 1968, Pl. 6, Fig. 3). Beds usually begin with intrabiosparudite (Pl. 26, Figs 1, 2) or intrabiosparenite. The dimensions of the largest allochems decrease topwards and within matrix the amount of micrite increases as compared to sparite. In the uppermost part of graded beds, this is usually biomicrite. Brachiopods and crinoids are predominant fossils forming bioclasts. Fragmentary stromatoporoids, primarily ramose but also massive, are also numerous, as well as foraminifers and ostracods. Rare corals are met with only in the coarse rudite fraction. A fine organic detritus is usually unrecognizable in biomicrite forming the upper part of graded beds, in which, however, few intact ostracod tests occur. Intraclasts are sometimes of the nature of micritic limestone only, but in other beds they are differentiated and may be micrite, biomicrite or biomicarenite. Bottom surfaces of graded beds are usually very distinct, frequently erosional and clearly stand out against the background of underlaying beds (cf. Szulczewski 1968; Pl. 5, Figs 1, 2; Pl. 6, Figs 1, 2). On the other hand, the transition to an underlaying bed is mostly gradual. Graded beds usually terminate in marly shale which frequently turns into biomiclutite. A diagonal stratification is sometimes marked in the uppermost part of the banks (cf. Szulczewski 1968; Pl. 5, Fig. 2).

2. *Irregularly pebble intraformational breccia*

Petrographically, these are, strictly speaking, intrabiosparudites or intrabiomicrudites (Pl. 28, Figs 1—3). The intraclasts occurring in them are, however, of a considerable size which may reach a few or even a dozen or so *cm*. Sometimes, they are only micritic, but frequently biomicrite or biomicarenite intraclasts also occur together with them. Intraclasts are frequently irregular in outline. Thin sections and polished surfaces reveal that many of them have canals which are round in transverse section and filled with sparry calcite (Pl. 28, Fig. 3). These canals, reaching the margins of intraclasts, resemble in shape the holes of boring organisms. Such an origin of the canals seems, however, improbable. Maybe, they were caused rather by the escape of gases from the sediment. Intraclasts are embedded in a usually sparite and less frequently micritic matrix, containing fine intraclasts and bioclasts primarily of crinoids and brachiopods or, sometimes, of ramose stromatoporoids, as well as fossils mentioned above as characteristic also of the graded detrital limestones. Bottom surfaces are usually erosional and there mostly occurs a coincidence of the lithology of most of the intraclasts with the petrographical character of the eroded underlying bed (Pl. 28, Fig. 3, Szulczewski 1968, Pl. 4, Fig. 2; Pl. 5, Fig. 3). The cases are also known (Pl. 28, Fig. 1, Szulczewski 1968, Pl. 4, Fig. 1), in which the lithology of a direct substratum differs from the character of intraclasts.

3. *Intrabiosparenites*

Limestones of this type usually form a few *cm* thick beds which sporadically may even reach more than two meters. They do not display a graded bedding, but sometimes are diagonally bedded. In regard to the composition, they do not, however, depart from the limestones of the same fraction within the range of the graded detrital limestones described above. It is also in these limestones that bioclasts of crinoids and brachiopods are the most frequent among the organic detritus (Pl. 30, Fig. 1). In some beds, conodonts are so numerous that they may be distinguished in microscopis sections. Pyrite occurs commonly and makes up an essential component of a residuum left over after the dissolution of limestones.

Interpretation. A general description of the limestones of this facies and interpretation of sedimentary phenomena characteristic of this facies have been given before (Szulczewski 1968) with the main emphasis put on the mechanism of the sedimentation of redeposited beds.

Marly and micritic deposits of the first group make up autochthonous deposits of the basin facies. They are marked by a low content of allochems and by a considerable part of the clay component. Of the benthonic organisms, these deposits contain at most *Amphipora* and few brachiopods (mostly lingulids). More frequent are the nectonic, planktonic and pseudoplanktonic organisms, such as, tentaculitoids, ostracods, *Spathiocaris* and rare cephalopods.

On the other hand, detrital limestones of the second group display structural and faunal characters of the redeposition. As proved previously (Szulczewski 1968), the deposits, now described as flat pebble intraformational conglomerates, irregularly pebble intraformational breccia, graded detrital limestones and intrabiosparenites, are closely related to each other genetically. Transitions are observed between intraformational deposits of both types, as well as between irregularly pebble breccia and graded detrital limestones. Allochems, forming all types of detrital limestones, come partly from shallow-water areas, situated outside the basin facies and abundantly settled benthonic organisms and partly from intraformational and subaqueous reworking of basinal sediments. At the same time, the same factors were responsible for the transportation of the detritus of shallow-water organisms and for the subaqueous erosion within the basin facies. Subaqueous slumping and turbidity currents were primarily these factors. Flat pebble intraformational conglomerates and previously described (Szulczewski 1968) slump sheets were formed by the former, while the latter were responsible for the deposition of graded detrital limestones. The reality of such a genesis of them is confirmed by textural characters of the deposits, by a strange character of fragmentary organisms they contain whose assemblage decidelly differs from that characteristic of the autochthonous deposits of the basin facies and, finally, by the paleogeographical situation of the facies. Probably, part of intrabiosparenites was deposited by bottom currents. This is particularly true of thicker and diagonally stratified beds. Such deposits occur, however, in inferior amounts. It is likely that some of the intrasparenites were deposited by turbidity currents. Irregularly pebble conglomerates resemble certain types of deformations resulting from a reverse density stratification in sediments (cf. Anketell & al. 1970, Fig. 17). This is, however, a superficial similarity which is confirmed if only by the diversity of intraclasts met with in a bed and the occurrence of breccia above the deposit lithologically strange to the intraclasts it contains, that is, above shales. Lumpy limestones, formed by disruption followed by dessication, very similar to both types of intraformational deposits described above, were described by Matter (1967, Fig. 5). Intraclasts, illustrated by Matter, have similar canals as those formed as a result of the activity of boring organisms. Not discussing the genesis of lumpy limestones, presented by Matter, the conclusion should be drawn that the intraformational deposits, described in the present paper, have not anything in common with the dessication in the tidal zone.

The detrital limestones of the basin facies under study closely resemble in character Meischner's (1964) allodapic limestones. The deposits of this facies are of the general nature of turbidite formations. Two type of sequence may, however, be here distinguished. One of them is observed at Śluchowice and Górno and the other in the railroad cut at Kowala. At Górno and Śluchowice, the profile contains deposits more differentiated than those at Kowala. In regard to both auto- and allochthonous deposits, these are deposits of all types here mentioned and described. A great amount of repeatedly occurring intraformational deposits is a specific character of the facies at Śluchowice. At the same time, the deposits of this facies are bituminous, darker and richer in pyrite than the deposits of the basin facies at Kowala. The basin facies at Śluchowice and Górno was probably a stagnantwater environment, only periodically reached by current started by subaqueous gravitational mass movements. It is not unlikely that the escape of gases, probably manifested by the canals which resemble the cavities of boring organisms, was the factor which facilitated the disintegration of the deposits by periodically occurring currents and, consequently, contributed to the formation of intraformational breccia.

The deposits of the basin facies at Kowala are marked by an exceptional monotony, consisting in a multiple alternation of marly limestones, marly shales and graded detrital limestones. These deposits are lightcoloured and do not display bituminous characters. These beds do not contain beds of detrital limestone thicker than 75 cm. No intraformational deposits of any type are met with here, except for intraclasts which are components of graded beds. Sporadic cephalopods, lacking at Śluchowice and Górno, here are met with in marly limestones. The comparison of the characters of basinal sedimentation at Śluchowice and Górno on the one hand and at Kowala on the other enables the conclusion that in a zone corresponding to Kowala the influence of an adjoining facies of detrital limestones was smaller which might be caused by a longer distance from it. In this locality, the basin was open and well aerated. It was not reached by slumps from the area of Detrital Facies, but was reached only by turbidity currents which usually transported small amounts of relatively fine material.

Manticoceras Limestones

Distribution. Limestones of this facies are known only from the eastern part of the Kadzielnia quarry where they occur in the upper part of the Frasnian.

General description. These are limestones with a very limited occurrence, interfingered with adjoining detrital limestones (Fig. 4). They are non- or thick-bedded, light-coloured, gray or creamy.

Petrology and fossils. The following two types of deposit predominate in this facies:

1. Micritic limestones

These are micritic limestones containing small amounts of fragmentary crinoids, detritus of cephalopods, rare ostracods and calcispheres. In some of the beds (comp. Fig. 4), there occur considerable accumulations of goniatites. Fossils are only slightly damaged so that, *e.g.* most of the crinoid ossicles are almost intact.

2. Intraformational lumpy limestones

These are intramicritic limestones (Pl. 23, Fig. 2) locally containing considerable admixtures of an organic detritus and small fossils such as those contained in the micritic limestone described above. Numerous biomicrite or pelmicrite intraclasts, reaching a few *cm* in length, are embedded in the matrix. Their boundaries with the micrite matrix are sharply outlined in some places and hardly traceable in some others.

Interpretation. Micritic limestones are deposits formed in an environment with a low energy index, which is indicated by an only slight abrasion of the skeletons of organisms they contain. Intraformational lumpy limestones were probably formed in a similar environment, to which lumps or intraclasts of a fine-grained deposit, coming from a nearby detrital facies, were, however, supplied. It is likely that they were formed as a result of the redeposition caused by waving or periodical stroms. Thus, fragments of poorly consolidated material from the adjoining detrital facies were redeposited to a calm sedimentation zone of micritic limestones. A direct neighbourhood and interfingering of Manticoceras limestones with detrital limestones (cf. Fig. 4) indicates that the zone of sedimentation of cephalopod limestones could not be very deep. The paleogeographical position of this facies, known from one outcrop only, is not quite clear, since despite the proximity of the zone of sedimentation of detrital limestones, no rich organic life is recorded in this facies.

Cheiloceras Limestone

Distribution. At present, this facies is exposed only on the Kadzielnia hill (Figs 3—4), but its actual range was more extensive. The Cheiloceras limestone was once outcropped further to the east on the Cmentarna hill (Sobolev 1912b, pp. 5—6) and to the west where it was known to Gürich (1896, p. 88) and Sobolev (1912b, p. 38) from the eastern slopes of the Karczówka hill. The last, westernmost occurrence of the limestone is recorded between Karczówka and Dalnia, where it, however, does not occur *in situ*.

General description. This facies has a relatively small range and its deposits are of an insignificant thickness of the order of a few meters.

These are thick-bedded micritic limestones with locally occurring large assemblage of cephalopods. It seems that there exists a transition from limestones containing Manticoceras to those containing Cheiloceras. At any rate, no distinct boundary between such limestones can be perceived on the Kadzielnia hill. The boundary of this member with the stromatoporoid-coral and detrital limestones is, however, sharp and uneven.

Petrology and fossils. The Cheiloceras limestone is micritic, locally containing small amounts of an organic detritus, which is mostly indistinguishable. The rock is gray or pink. Blocks of the stromatoporoid-coral limestone (the Kadzielnia limestone) are locally met with at the base of the Cheiloceras Limestone. Fossils are unevenly distributed in the rock, locally forming great accumulations. They mostly occur at the base of this unit or in pockets at the top of the Kadzielnia limestone. These are primarily cephalopods, both goniatites and abundantly occurring nautiloids. Few solitary corals of the species *Petraiella centralis* Różkowska (cf. Różkowska 1969, p. 112) and ossicles of crinoids.

Interpretation. The limestones containing *Cheiloceras* were formed in an environment of a low energy and settled by a very poor benthic fauna. Among the fossils, decidedly predominant are nectonic organisms. This is, therefore, a typically pelagic deposit. The occurrence of considerable accumulations of cephalopods is probably connected with a considerable drop in the rate of sedimentation of the limestones with *Cheiloceras,* which was expressed in a certain stratigraphic condensation. It is not unlikely that the accumulations of cephalopods in the Kadzielnia-limestone pockets were formed during a periodical non-deposition of the sediments which might probably take place prior to the deposition of the limestones with *Cheiloceras.*

Marly Facies

Distribution. This facies predominates in the Famennian of the Holy Cross Mts. Susceptible to weathering and rarely exploited at quarries, the deposits of this facies are exposed in only few outcrops. They are exposed in the quarries of Śluchowice, Kadzielnia, Psie Górki, Wietrznia *II* and Kowala.

General description. The deposits of this facies are developed as thick, thin-bedded, many times alternating marly limestones and marly shales (Pl. 31, Fig. 1; Pl. 32, Fig. 1). They may be either regularly stratified, or their stratification may be deformed (Pl. 34, Fig. 1) as a result of load casting, as well as sedimentary and tectonic boudinage. Deposits of this facies are usually very poor in, or even completely devoid of fossils. In their lowermost part fossils, may, however, occur in abundance.

Petrology and fossils. Although marly limestones and shales decidedly predominate, other lithological types may also occur subordinately.

1. Marly limestones

Strongly marly, micritic limestones, gray or yellowish in color, mostly devoid of fossils. They form either regular beds, or boudins or flow rolls separated from each other by shales and concordant to the stratification. Although they are on the whole devoid of fossils, relatively numerous ones are contained in the deposits of this facies outcropped on the Kadzielnia hill (cf. Różkowska 1969, p. 17), where a rugose-coral fauna occurs consisting mostly of solitary and, less frequently, budding forms. Of trilobites, almost exclusively occurring are blind phacopids (Osmólska 1958). In some places, there also occur cephalopods, both goniatites and nautiloids. Brachiopods, mostly lingulids are also present (Biernat 1970), the same as pelecypods *Posidonia.*

2. Marly shales

Gray, crumbling marly shales, containing similar fossils as those in marly limestones which intercalate them. Corals, cephalopods, brachiopods and bivalves are more frequent in shales than in limestones (cf. Różkowska 1969).

3. Crinoid marls

This term comes still from Gürich (1896). These are in fact marly biomicrudites forming thin banks. They contain a crinoid detritus and many brachiopods, among others, of the genus *Cyrtospirifer.* Fragmentary fossils are only slightly abraded. In some beds, the crinoid detritus is as abundant that the rock makes up a true crinoid limestone.

4. Flat pebble intraformational conglomerates

The deposits of this type resemble flat pebble conglomerates described from the Frasnian, to which they are similar only in the flat shape of intraclasts they contain and in their large dimensions reaching here a dozen or so *cm.* However, the Famennian flat pebble conglomerates always form thin beds and their matrix is micritic, or at least containing some detritus of crinoids. Intraclasts are lighter--coloured and less marly than the matrix, but they also are fragments of micritic limestones.

Interpretation. Despite a little-differentiated sedimentation of the facies under study, the deposits which represent it slightly differ from each other in various outcrops in both their litho- and biofacial characters. At Kowala, this facies is a direct continuation of the Basin Facies of the early Upper Devonian, from which it differs only in the lack of turbidites. In this locality, only the two first, regularly stratified types of sediment, that is, marly limestones and shales intercalate with each other in the profile. No fossils are recorded. On the Kadzielnia hill, the lithological sequence is the same and only the stratification happens to be frequently deformed. In the last-named locality, limestones and shales contain, however, a relatively abundant and variable fauna. All the fossils, previously mentioned in the descriptions of lithological types, are present in this locality. At Śluchowice, few intercalations of intraformational pebble conglomerates appear among limestones and marly shales, but the deposits exposed there do not contain fossils. Finally, the marly Famennian of Psie Górki is most differentiated lithologically. There occur all the lithological types mentioned above. The crinoid marls and flat pebble conglomerates do not make up more than 5 per cent of the entire volume of the deposits. Lingulids, trilobites, brachiopods and crinoids are the only fossils that occur at Psie Górki.

All the deposits of the Marly Facies were formed in an open sea, under the conditions of normal salinity and a well-aerated water. Probably, not all deposits of this facies were formed at identical depths. Despite a very similar lithological development, they considerably differ from each other in the amount and differentiation of their fossils. The marly Famennian of Kadzielnia, relatively rich in benthic organisms, probably corresponds to not a deep environment. Since flora had to be a fundamental food for the abundant autochthonous fauna, the sedimentation of these deposits probably took place in the photic zone. However, the water-sediment interface had to be always below the effective wave--base. This is confirmed by the presence of frequently occurring moults of trilobites (collected by J. Głazek and A. Radwański), a considerable amount of corals preserved in growth position (Różkowska 1969), a lack of any effects of turbulence in the deposits which are considerably monotonous. Although the occurrence of ripple-marks on the surface of shales was mentioned by Różkowska (1969, p. 17), they do not in fact seem to be structures of precisely such an origin. Lingulids were also supposed by Różkowska (1969) to give evidence of the shallow-water character of the basin. It seems, however, paradoxical that the blind phacopid trilobites concur with them, their blindness being a result of adaptation to the considerable depth of the basin (cf. R. & E. Richter 1926, Osmólska 1962, Goldring 1965). Fairly common conclusions on a considerable shallow--water character of Paleozoic basins and even statements of their intertidal zones, based on the presence of lingulids, seem to be rather risky. It agrees with the opinion expressed by Paine (1970) that the optimum environment of all living lingulid species is not the intertidal, and a similar tendency is likely to characterize fossil species. All records of living lingulids from silt and clay sediments began at a depth of 10 m or greater. The muddy bottom is rather a character of the environment decisive as to the occurrence of both lingulids and blind phacopid trilobites (cf. Osmólska 1962).

The marly Famennian deposits at Psie Górki, called by Gürich (1896) as *Crinoidenmergel,* were probably formed in a similar environment. In the last-named locality, there are no corals, which are present at Kadzielnia, but there occur crinoids. The recognition of the causes of this difference does not seem to be possible with a sufficient degree of certainty. The flat pebble conglomerates were most likely to be formed as a result of subaqueous slump processes. Nearby, elevated blocks or zones in which purely calcareous sedimentation still predominated were probably the source of deposit producing intraclasts in intraformational conglomerates. During the sedimentation of marly deposits at Psie Górki, as well as at Śluchowice, such a zone might be, for instance, the area of Kadzielnia.

On the other hand, the profile at Kowala corresponds to the deepest part of the Marly Facies located below the photic zone, that is, in a part of basin in which the organisms had not sufficient living conditions.

Multifossiliferous Facies

Distribution. The deposits of this facies occur only in limited area of the western part of the Holy Cross Mts in the environs of Gałęzice.

General description. The deposits of this facies are marked by a great stratigraphic condensation and calcareous sedimentation. They contain very numerous fossils, among them, abundant cephalopods.

Petrology and fossils. A profile and lithological types of deposits, occurring in the Famennian of Gałęzice were given by Różkowska (1969). According to this author, there occur regularly bedded organodetritic limestones, knoll limestones, marly limestones, marls and shales. Professor M. Różkowska has permitted the present writer to make thin sections of the deposits, whose profiles she prepared during the excavation work. An analysis of these thin sections allows the writer to maintain that the limestones contained in all the ten beds, distinguished by Różkowska (1969), are biomicritic ones (Pl. 32, Figs 1, 2). True enough, they considerably differ from each other in the degree of recrystallization of the micritic matrix, which in some of the beds is almost indistinguishable at all and in some others considerably changes the original character of the deposit. There is a very extensive range of bioclasts, contained in limestones coming from various beds. Fragments have been found of numerous crinoids, cephalopods, trilobites and pelecypods, along with commonly occurring ostracod tests. Bioclasts of various groups of organisms predominate in various beds. These may be trilobites (bed *4 in* Różkowska 1969), crinoids (beds *7, 8* and *10*) or gastropods (bed *2*). In most of the beds, the assemblages of fossils are strongly differentiated. Although organic detritus is a considerable component of the limestones, abundant well preserved specimens of bigger fossils (cephalopods, gastropods *Loxonema*) do occur. Most crinoid ossicles have preserved their original shape. In addition to bioclasts and small fossils, few pellets appear in some of the beds (beds *1, 9* and *10*). The occurrence of glauconite has been found in beds *2, 6, 8* and *10*. It occurs only as an impregnatory material of crinoid ossicles.

Interpretation. An extreme stratigraphic condensation found in the Famennian of this facies (Czarnocki 1928, Wolska 1967) is a result of a slow sedimentation. The low rate of sedimentation is undoubtedly reflected in a mass occurrence of fossils, for instance, conodonts which here occur in an abundance never met with anywhere else. This also concerns other groups of fossils. The presence of glauconite is another consequence of the slow sedimentation. A concurrence of benthic organisms (corals, gastropods, trilobites, etc.) with nectonic ones indicates that this was a zone of an open although not very deep sea. The deposit-water interface was situated below the wave-base as revealed by a mostly micritic matrix and only minor destruction of the bioclasts. Deposits are also poorly sorted. Despite a great stratigraphic condensation, fossils and deposits display a normal succession without a strong mechanical reworking, which could otherwise disturb or even destroy such a succession. The zone of depositing the sediments under study was raised above an extensive bottom of the area of the contemporaneous marly sedimentation, which, in addition to abundant fossils, is indicated by the lack of marly intercalations in a considerable part of the profile.

The shallowed zone of the calcareous sedimentation under study was not supported by any land as indicated by the lack of a terrigenic material in the deposits. This was, therefore, a zone of a submarine rise shallower than the areas surrounding it. It corresponds to the site of deposition of the cephalopod limestones, determined in German literature as *Schwellen* (Schmidt 1925, Rabien 1956; cf. also Goldring 1965).

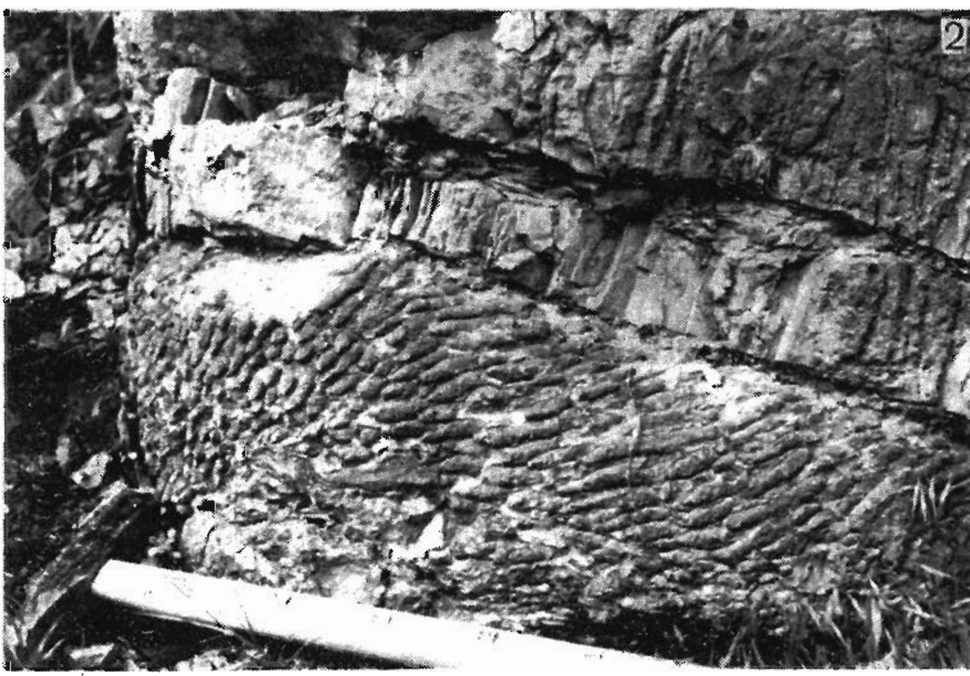
Oolitic Facies

Distribution. The deposits of this facies are known only from one outcrop (Dalnia) and have not so far been recognized in the Devonian of the Holy Cross Mts.

General description. Thick-bedded oolitic limestones of this facies are marked by a considerable stratigraphic condensation with a small thickness (about 3 m).

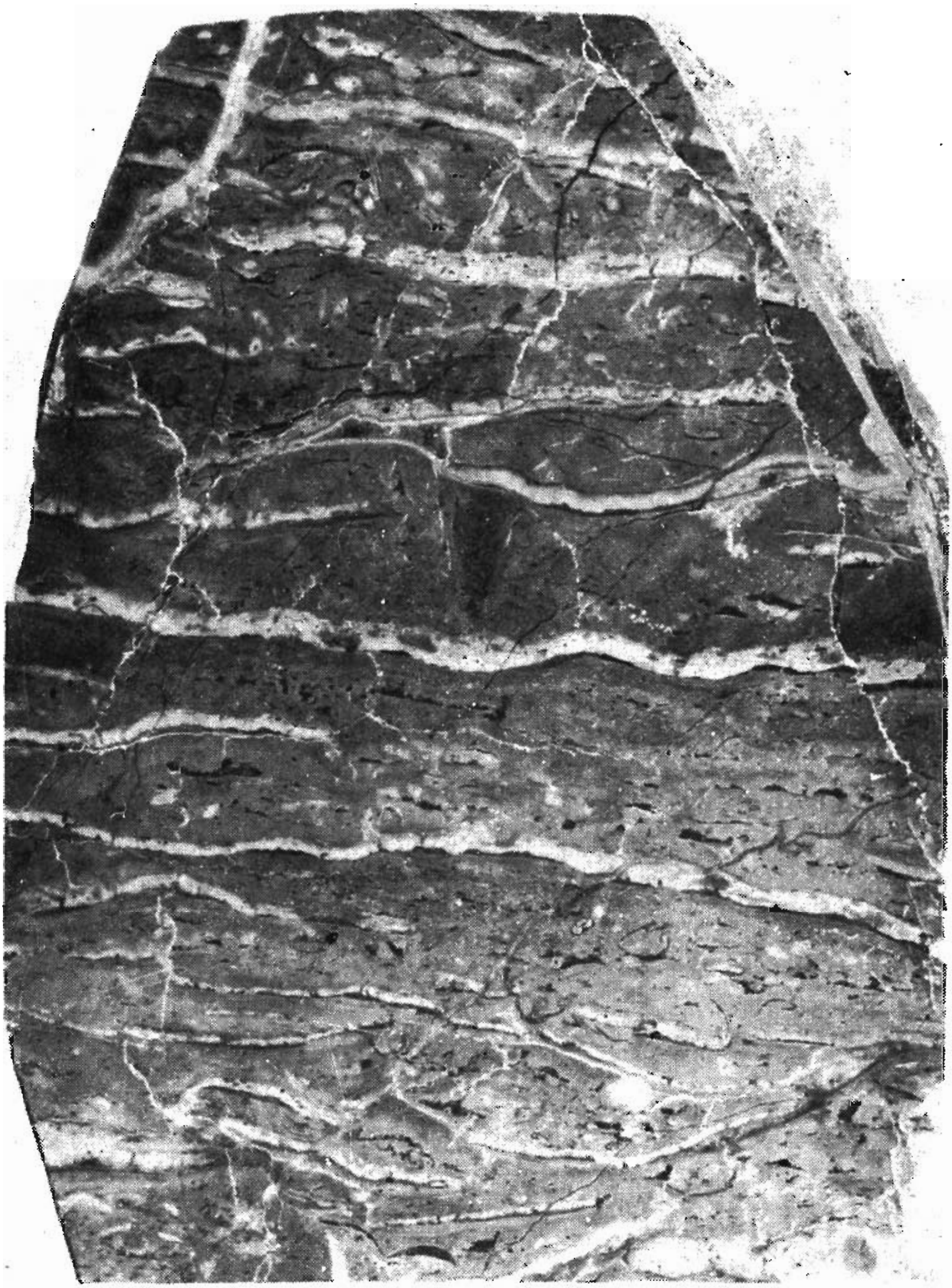
Petrology and fossils. Gray oosparite (Pl. 29, Fig. 1), with ooids having several coatings. There also occur few broken ooids, as well as broken and regenerated ones. The deposit is well-sorted, and the ooids do not exceed 0.7 mm in size. They are locally accompanied by few lumps. Lack of fossils.

Interpretation. Limestones of the Oolitic Facies were formed under the conditions of a high energy of water, which is indicated by the presence of broken ooids and a proper selection of the deposit. The lack of fossils may indicate a raised degree of salinity. The stability of the development of this member, with a considerable stratigraphic condensation, indicate a prolonged stabilization of the sedimentatary conditions. The sedimentation of oolitic limestones took place in a shallow sub- or intertidal zone. This zone was an extreme shoal in a relatively deep Famennian sea which was considerably uniform facially.

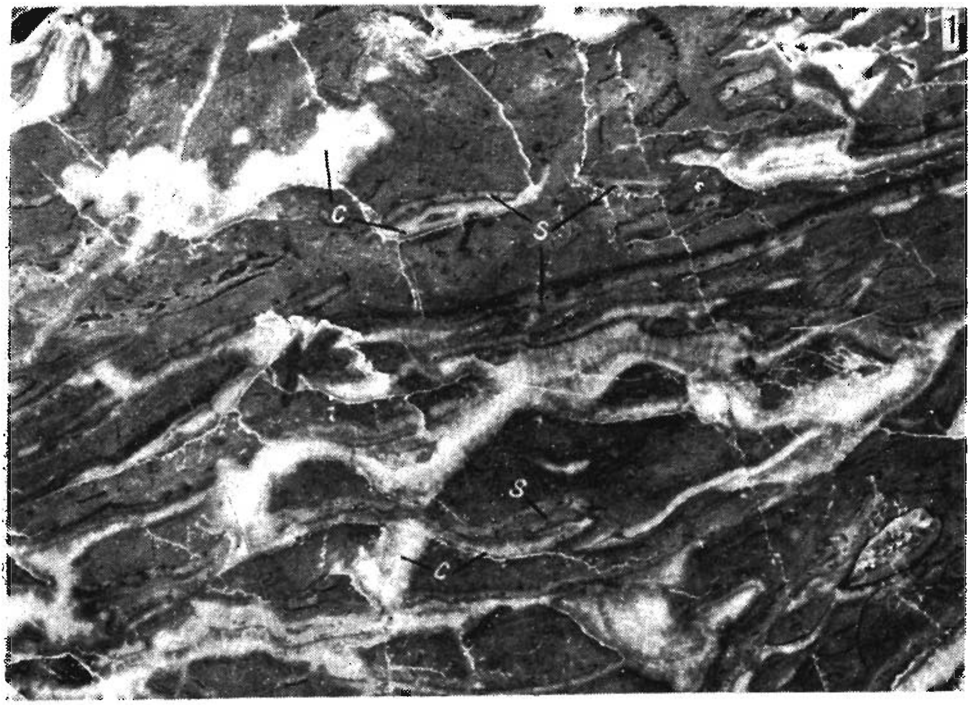


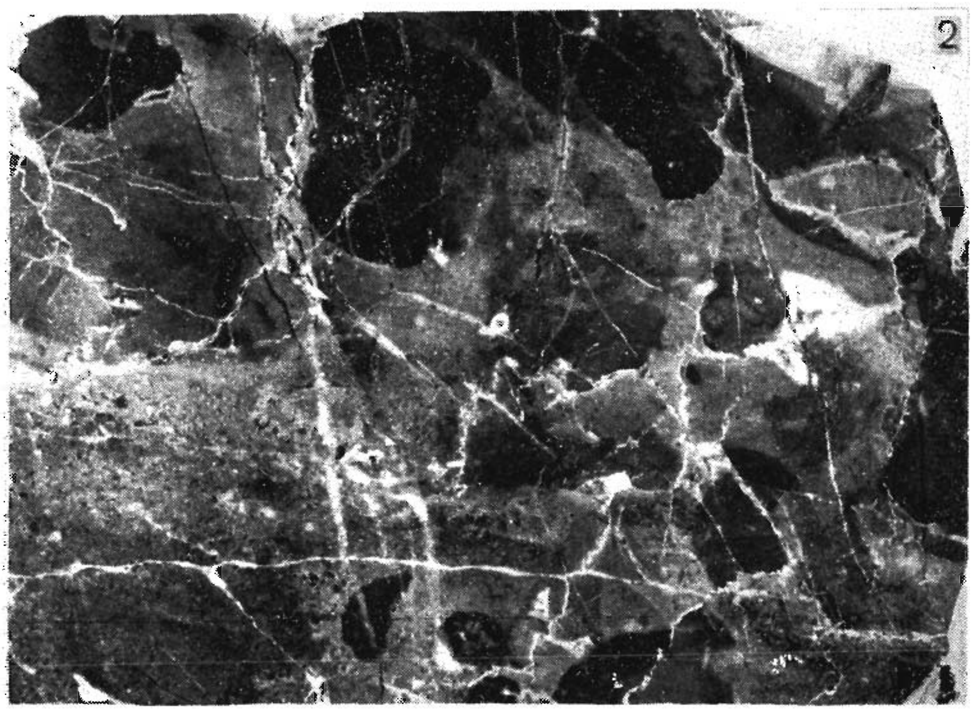
1 — Massive stromatoporoid in growth position; Kowala (railroad cut), set *A* (Frasnian).

2 — Faceloid colony of rugose coral *Disphyllum* in growth position; Kowala (railroad cut), boundary of sets *A* and *B* (Frasnian).



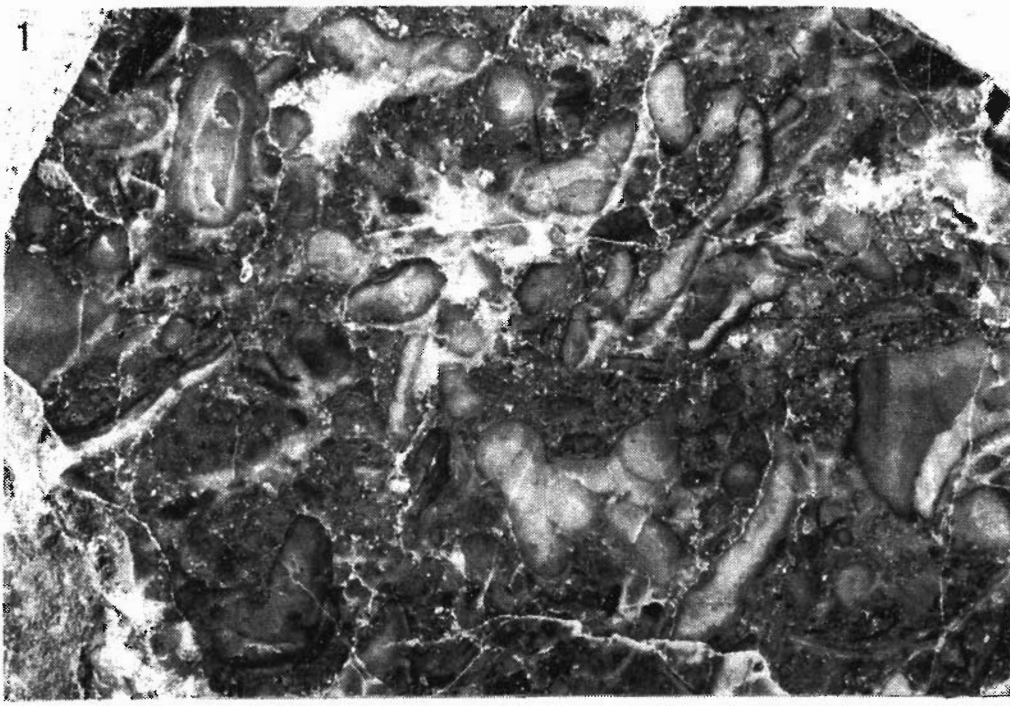
Sediment binding thin, tabular stromatoporoids preserved in growth position; Kadzielnia quarry (stromatoporoid-coral, i.e. the Kadzielnia limestone), Frasnian; nat size

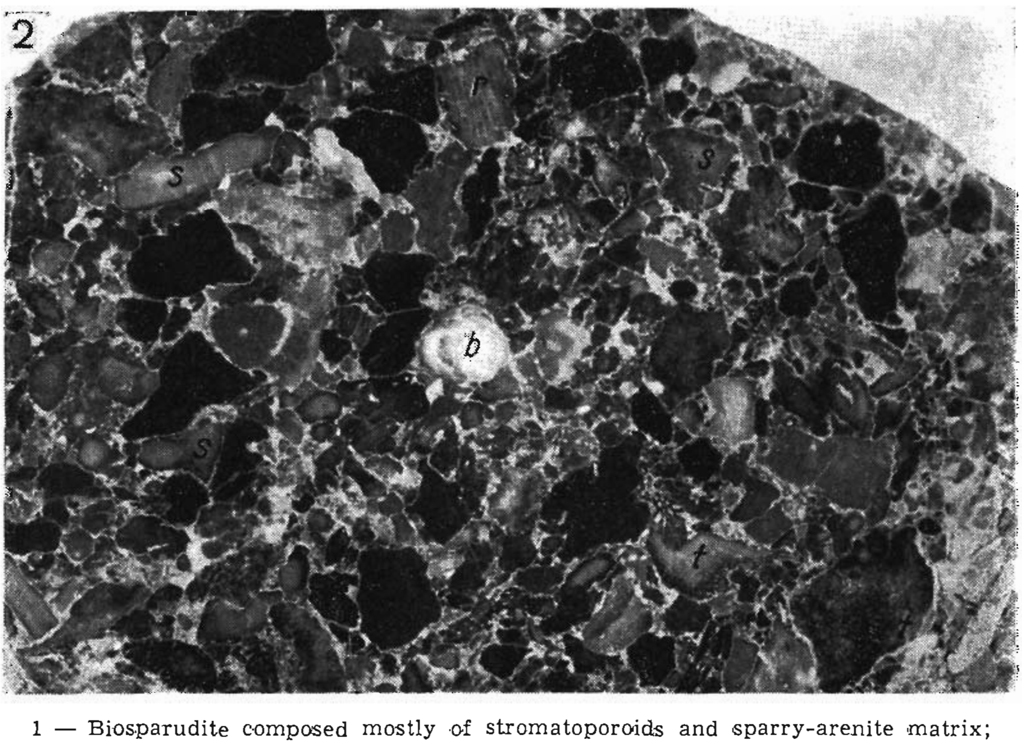




1 — Structure of the Kadzielnia limestone; *s* tabular stromatoporoids, *c* sparry calcite; Kadzielnia quarry, Frasnian; nat. size.

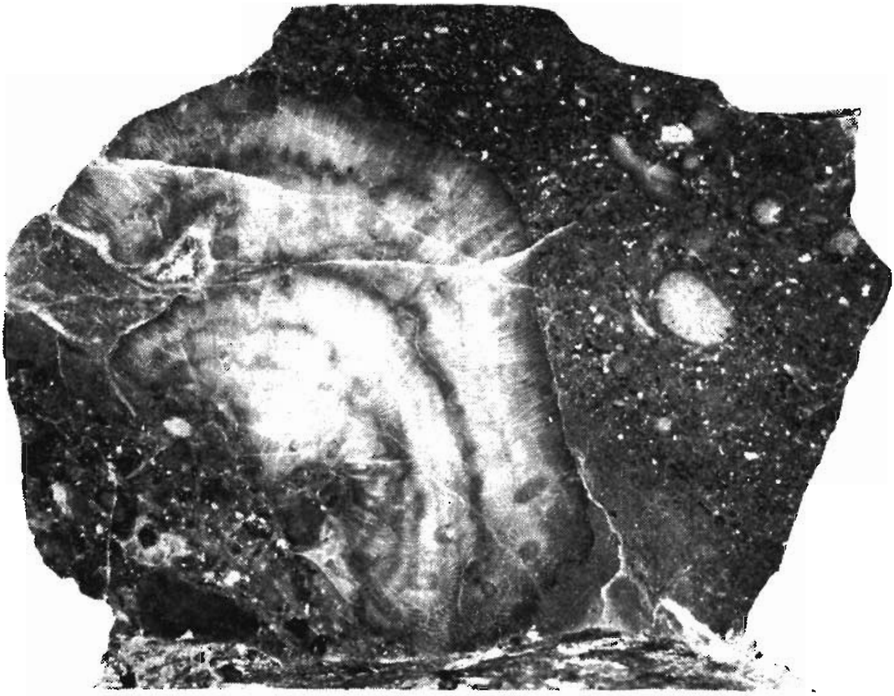
2 — Intraformational lumpy limestone; Kadzielnia quarry (Manticoceras limestones); nat. size.



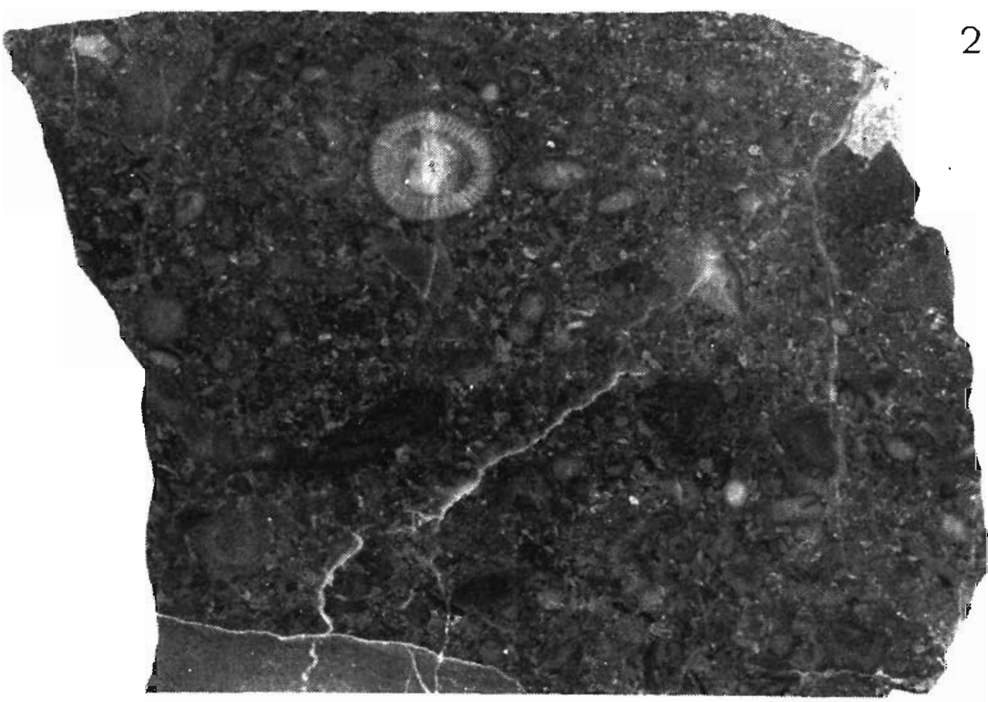


1 — Biosparudite composed mostly of stromatoporoids and sparry-arenite matrix; Kadzielnia quarry (detrital limestones), Frasnian; nat. size.

2 — Biointrasparudite composed of stromatoporoids (*s*), tabulate (*t*) and rugose corals (*r*), brachiopods (*b*) and dark intraclasts; Czarnów, Frasnian; nat. size.



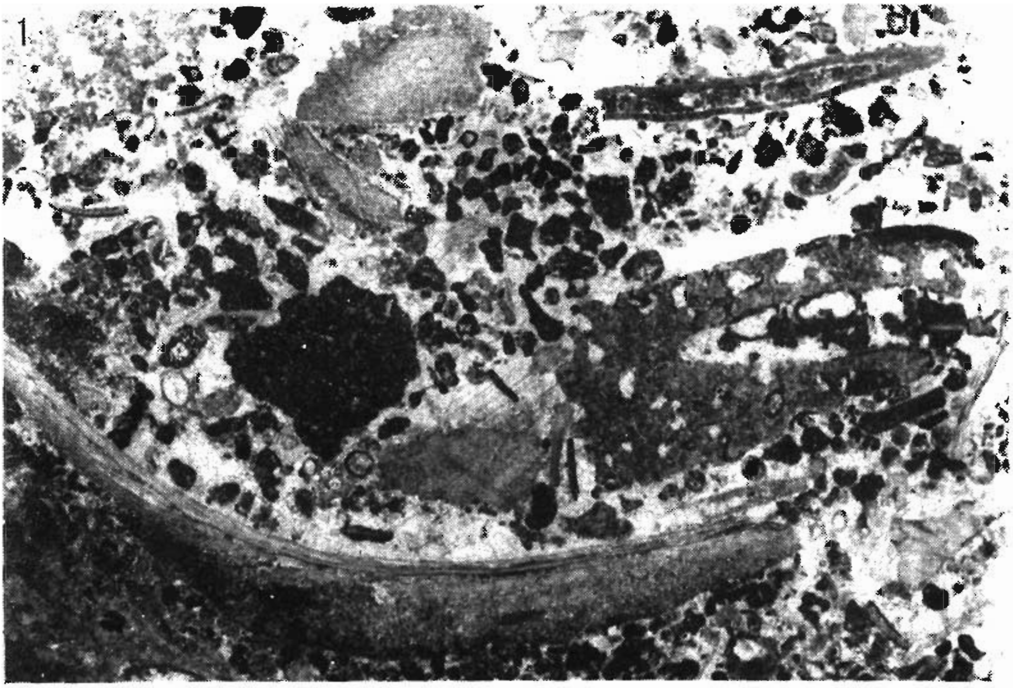
1

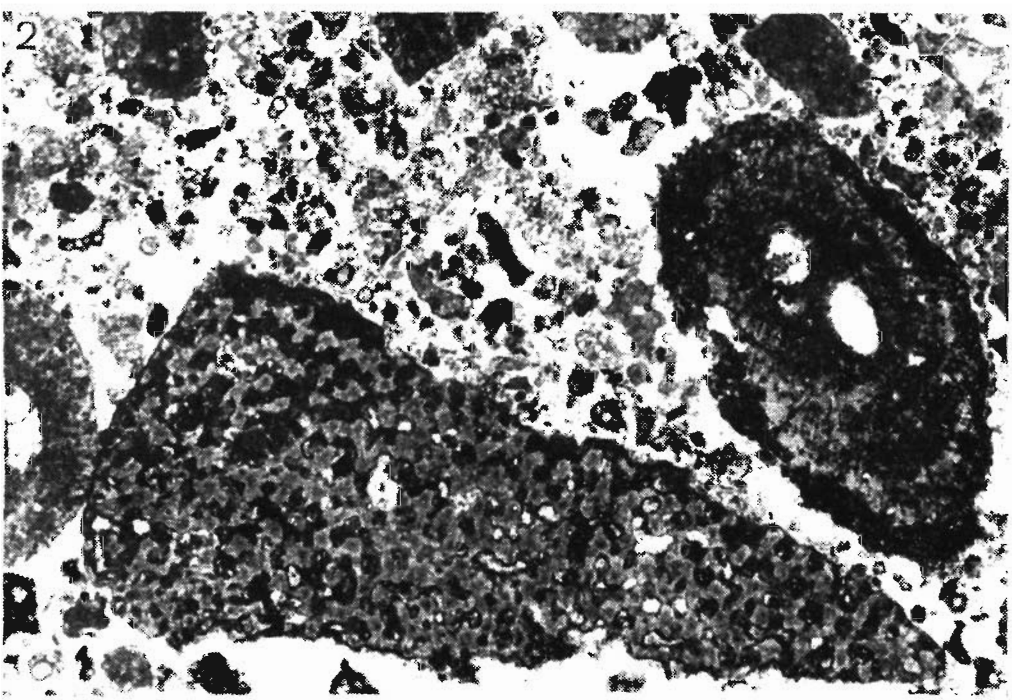


2

1 — Cerioidal rugose coral embedded in biosparite; true position of the specimen is unknown — grading in biosparite suggests the coral to be upside down; Psie Górki, Frasnian; nat. size.

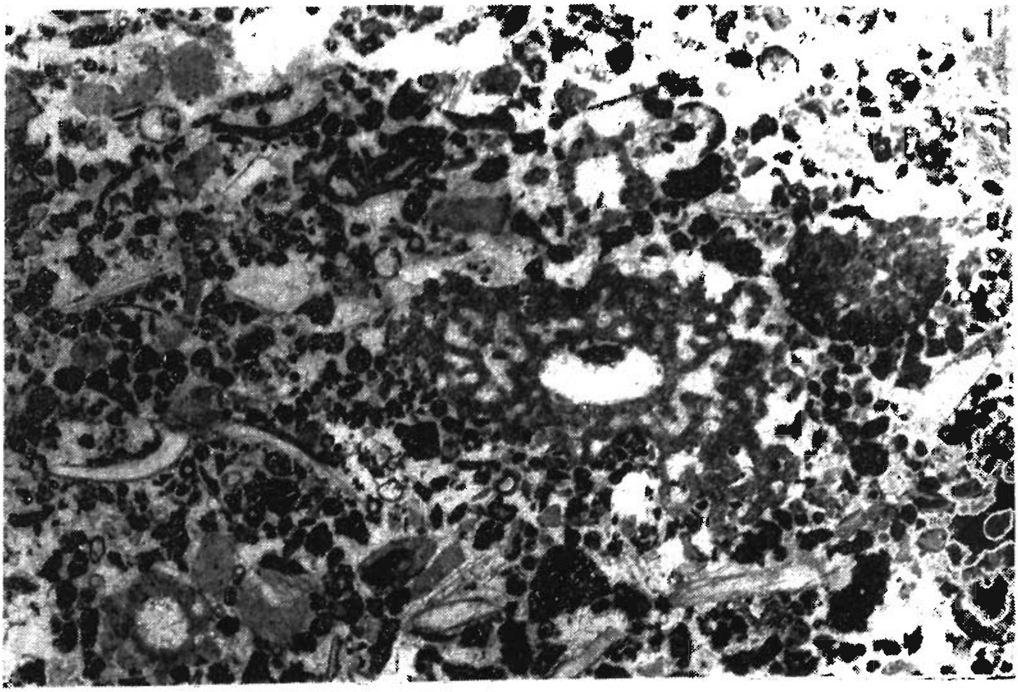
2 -- Biosparudite composed mostly of stromatoporoid fragments; solitary rugose corals also occur; Wietrznia I, Frasnian; nat. size.

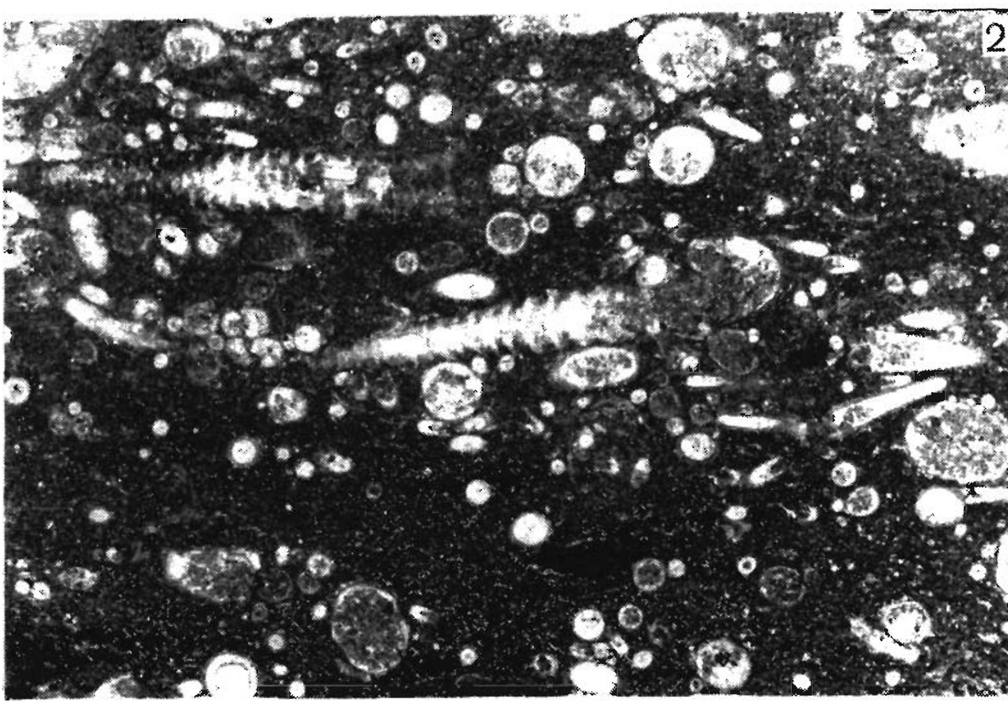




1 — Biointrasparudite composed mostly of stromatoporoid, brachiopod and crinoid debris; Śluchowice, Frasnian; × 12.

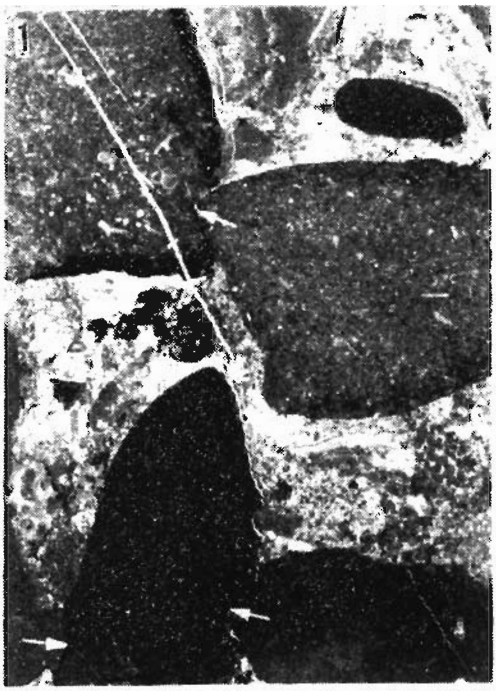
2 — Biointrasparudite from the basal part of a turbidite layer; stromatoporoid fragments embedded in arenite matrix; Kowala (railroad cut), set *H* (Frasnian); × 12.

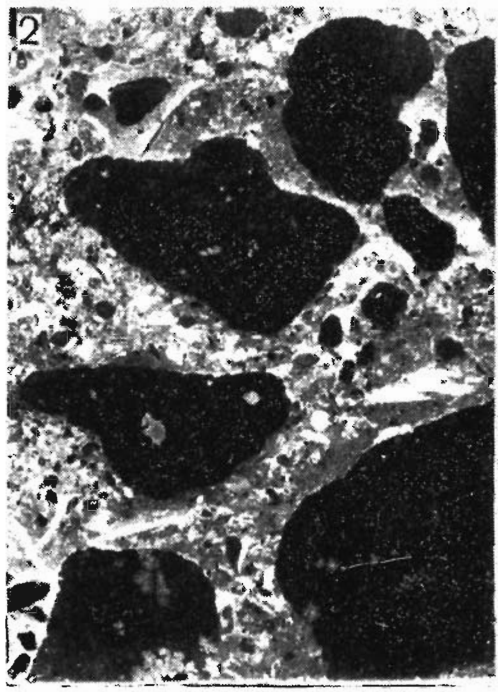


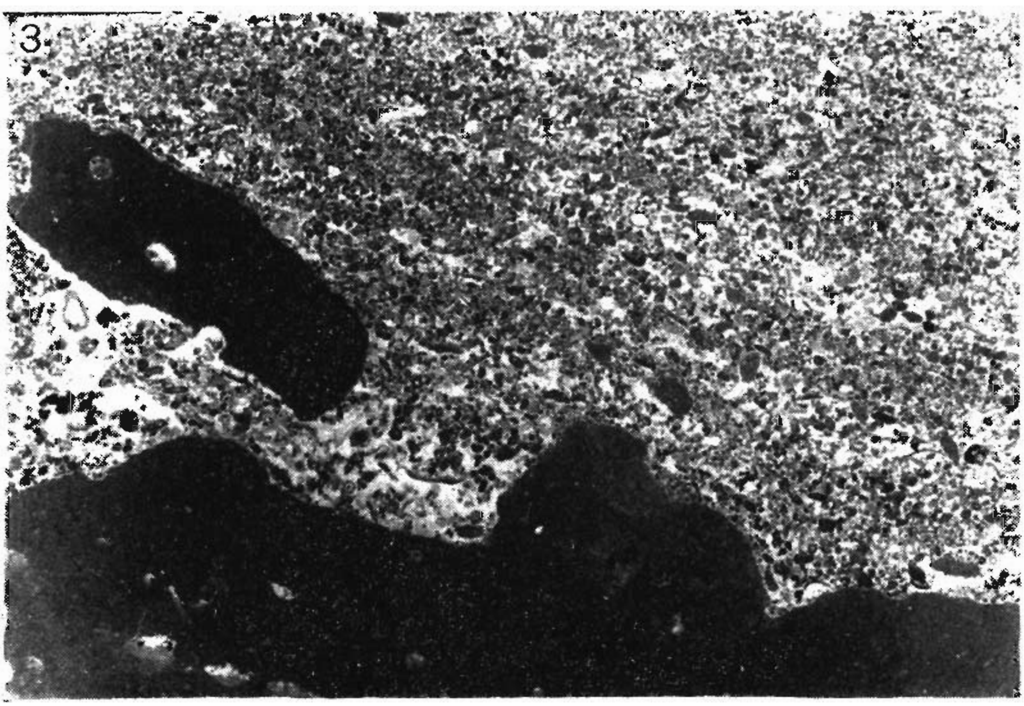


1 — Biointrasparudite composed of *Amphipora*, brachiopod and crinoid fragments, calcispheres and intraclasts; Psie Górki, Frasnian; × 12.

2 — Tentaculitoid biomicrite; Kowala (railroad cut), set *F* (Frasnian); × 12.



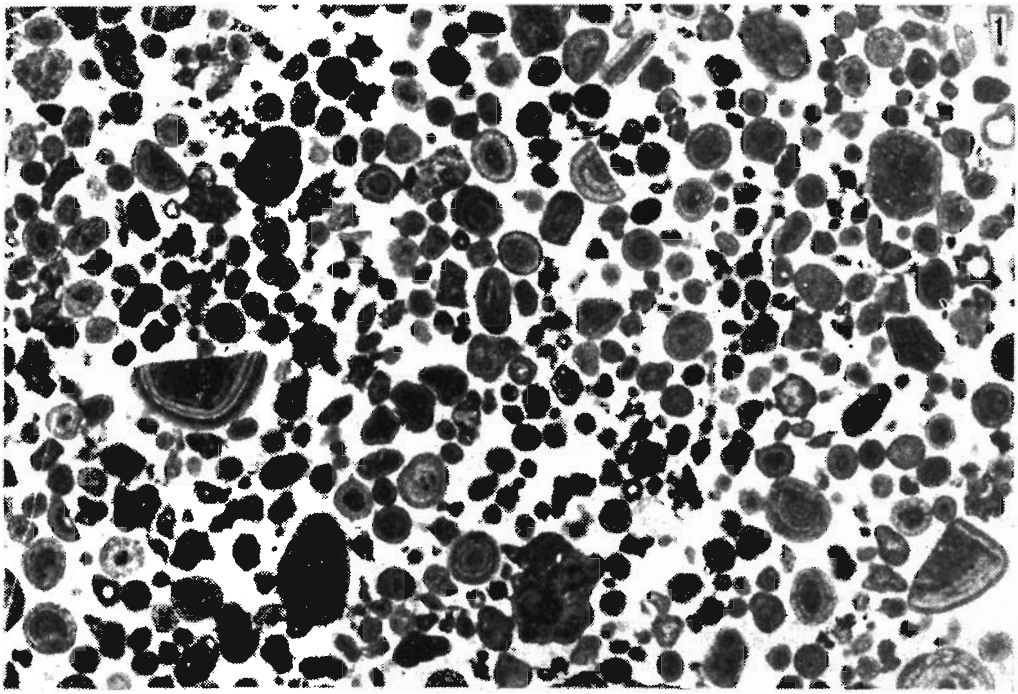


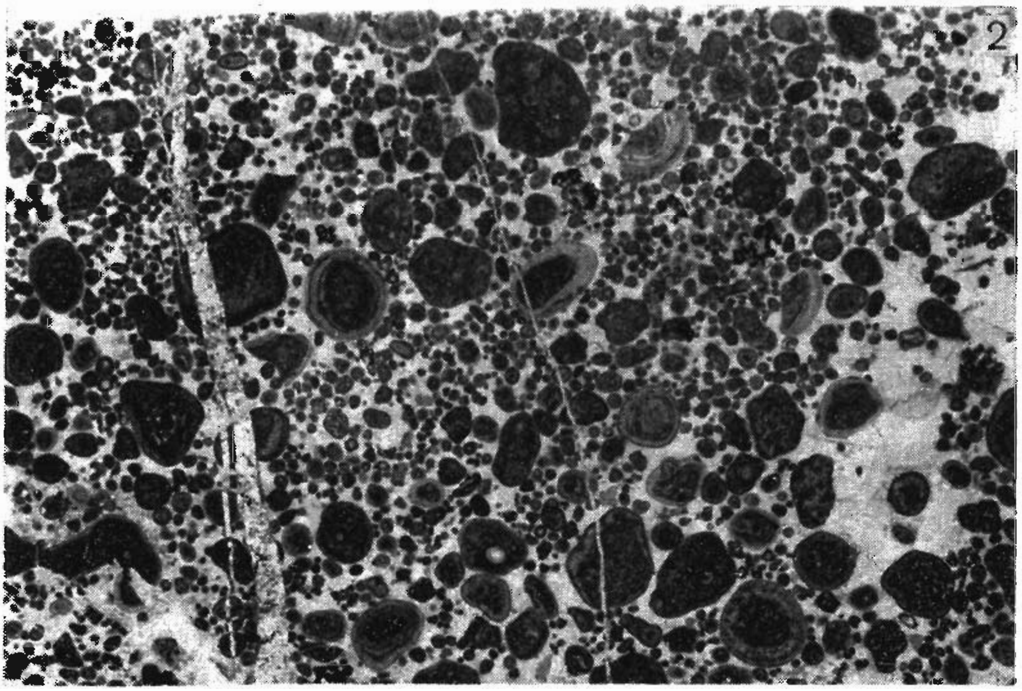


1 — Intraformational irregular-pebble conglomerate with intraclasts of two petrological types (micritic and biomicritic limestones) embedded in fine-grained matrix; arrows point to the pits; Śluchowice, Frasnian; × 7.

2 — Intraformational irregular-pebble conglomerate with intraclasts of micritic limestone embedded in micritic-arenite matrix; Śluchowice, Frasnian; × 7.

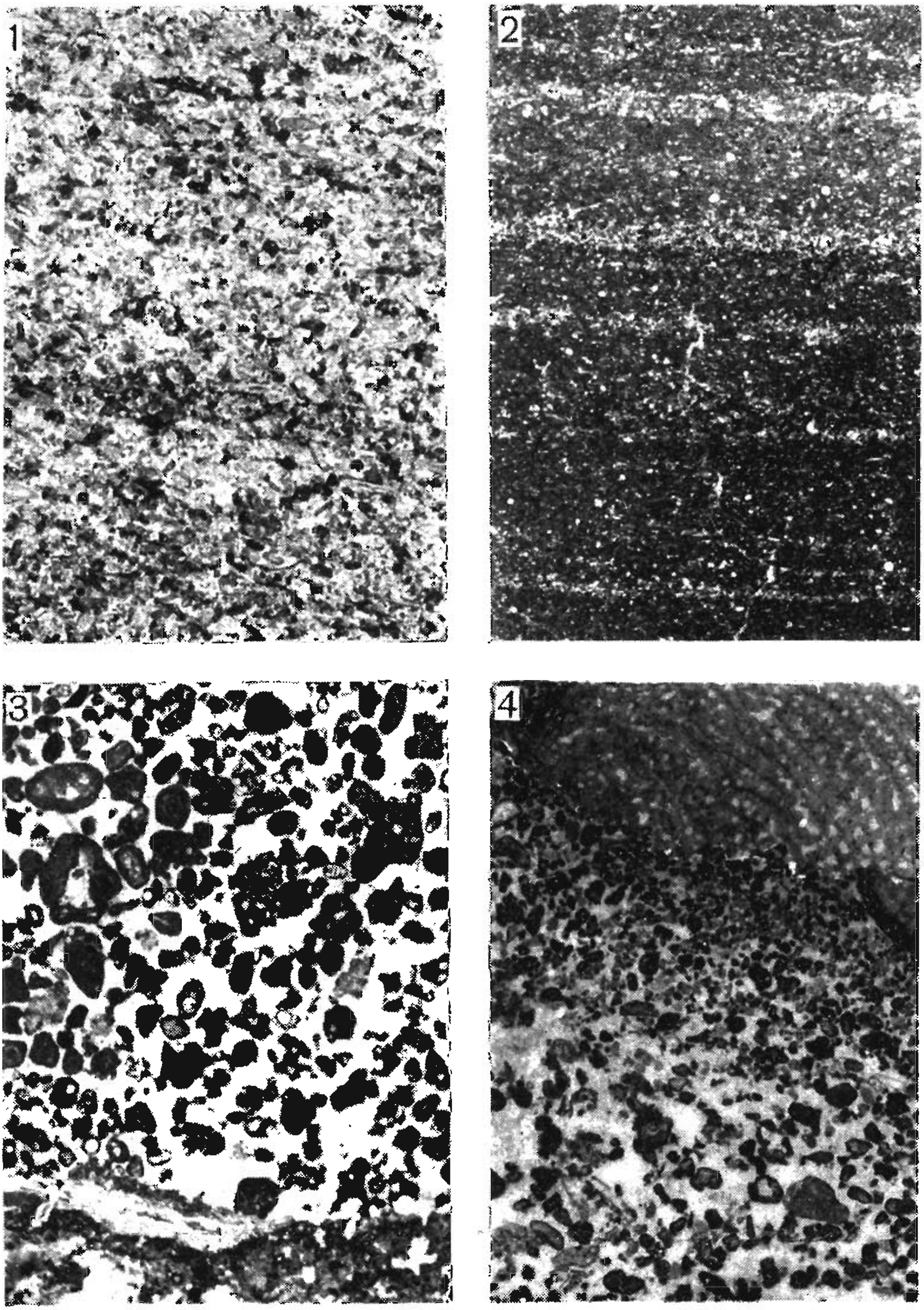
3 — Intrabiosparenite containing large intraclasts of micritic limestone; undersurface erosional; intraclasts lithologically identic with underlying micritic limestone; Śluchowice, Frasnian; × 7.





1 — Well sorted oointrasparite, in places with broken or regenerated ooids and lumps; Dalnia, Famennian; × 7.

2 — Poorly sorted oointrasparite with abundant superficial ooids, and common broken ooids and lumps; Kadzielnia quarry (detrital limestones), Frasnian; × 7.

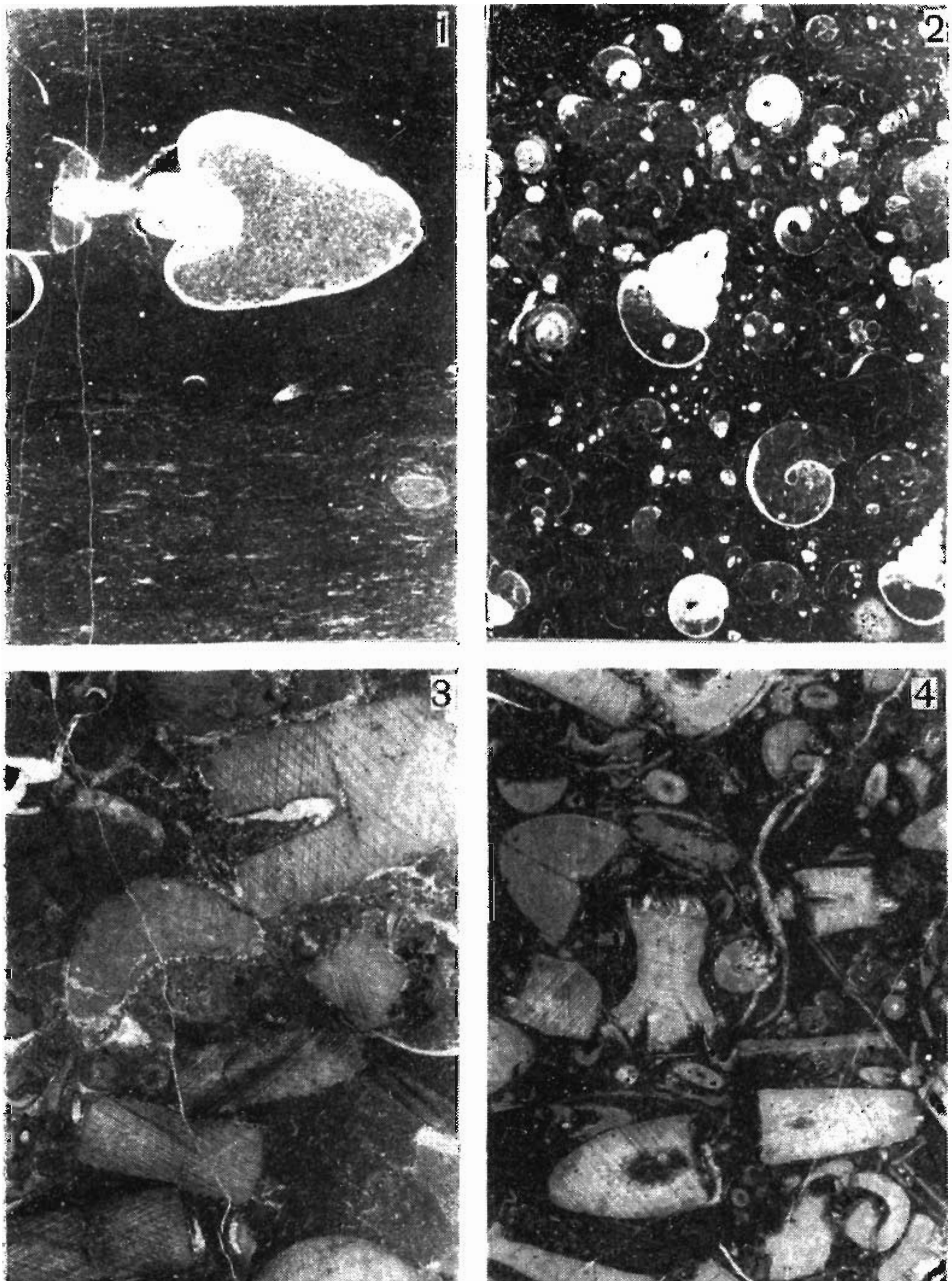


1 — Intrabiosparenite composed of small intraclasts and bioclasts, abundant crinoid and brachiopod debris; Śluchowice, Frasnian; × 12.

2 — Laminated calcilutite from rhythmically bedded calcarenite-calcilutite member; Wietrznia *II*, Frasnian; × 12.

3 — Large rugose coral embedded in sparry arenite matrix; Kadzielnia quarry (detrital limestones), Frasnian; × 12.

4 — Massive stromatoporoid embedded in sparry arenite matrix; Kadzielnia quarry (detrital limestones), Frasnian; × 7.

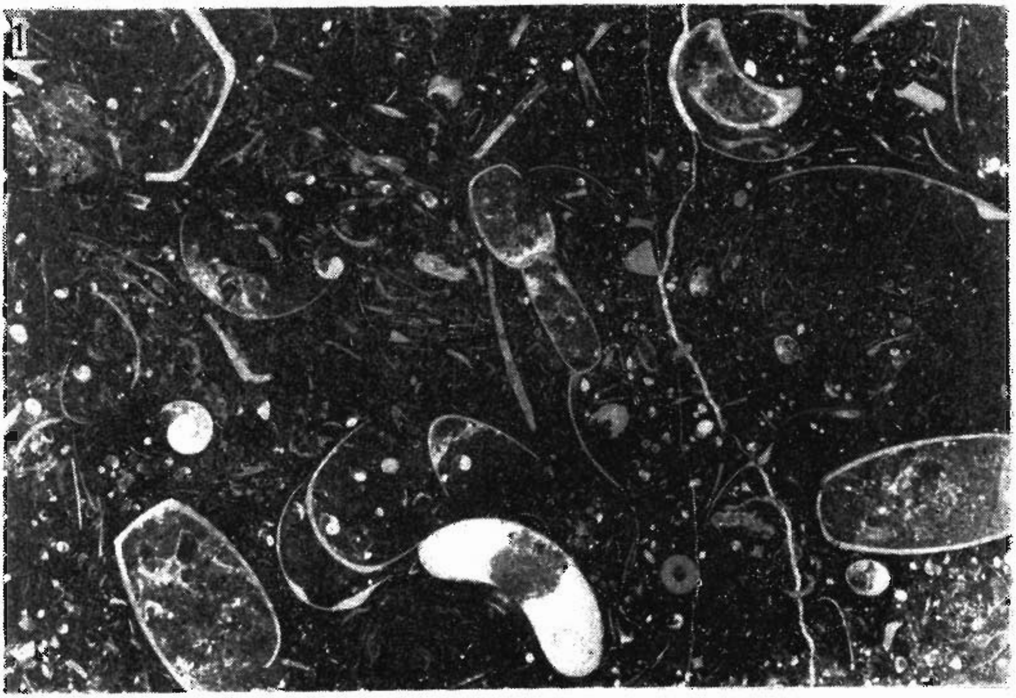


1 — Goniatite shell in marly micritic limestone; Kowala (railroad cut), set *H* (Frasnian); × 2.

2 — Micritic limestone containing numerous small gastropods, the deposit being a fill-in of the veins cutting the Kadzielnia limestone; Kadzielnia quarry (stromatoporoid-coral limestones), Frasnian; × 7.

3 — Crinoid limestone with micritic matrix; the ossicles not being crushed; Wietrznia *II*, Frasnian; × 7.

4 — Crinoid limestone with micritic matrix; the ossicles being slightly crushed; Wietrznia *II*, Frasnian; × 5.



1 — Biomicrite composed mostly of crushed ammonoid shells; crinoid detritus being subordinate; Gałęzice (Besówka hill, bed 7), Famennian; × 5.

2 — Biomicrite composed of crushed fragments of cephalopod and gastropod shells, and crinoid ossicles; Gałęzice (Besówka hill, bed 7), Famennian; × 5.

1 — Rhythmically alternating, fine-bedded micritic marly limestones and marly shales; Kowala (quarry), Famennian.

2 — Turbidites (marked *t*) in a set of rhythmically bedded, marly limestones and marly shales; arrow shows a disruption of the turbidite layer in result of sedimentary boudinage; Kowala (railroad cut), set *H* (Frasnian).

1

2

1 — Rhythmically bedded, marly limestones and marly shales; Psie Górki, Famennian.

2 — Rhythmically bedded, micritic marly limestones and marly shales; disturbances in bedding (flow roll) visible; Psie Górki, Famennian.

REEF CONCEPT

The interpretation of the facies distribution and their pattern in the Early Upper Devonian of the Holy Cross Mts (corresponding approximately to the Frasnian), conducted on the basis of a reef model, is not a novelty. Both in the Holy Cross Mts and elsewhere, the term "reef" was frequently used in excess. The Devonian reefs of the Holy Cross Mts have already been supposed by Siemiradzki (1887, 1888), who argued that their past existence was prowed by conglomerates which were formed of them by their destruction. Later on, these conglomerates turned out, however, to be of Zechstein origin. The Upper Devonian limestones of the Kadzielnia type are generally treated as reef limestones, a much too simplified reasoning being here applied that each limestone, containing numerous corals and stromatoporoids, has to be a reef limestone. In order to recognize whether or not a given formation is of the nature of a reef, it is necessary to adopt a modern definition of a reef and to confront the characters of the sedimentation of the deposits under study with a model of reef sedimentation.

A definition of a reef first formulated by Lowenstam (1950) and accepted by Nelson & al. (1962) is in a general use. According to it, a reef is an accumulated calcareous deposit, formed by organisms possessing the ecological potential to erect a rigid, wave-resistant, topographic structure. Accepting such a definition, we should answer the following questions:

1. Were part of the Upper Devonian limestones, in particular the stromatoporoid-coral limestones of the "Kadzielnia limestone" type, a rigid structure during the sedimentation?
2. Was this structure a positive topographic relief above the effective wave-base?
3. Was it wave-resistant?
4. Were organisms, in particular stromatoporoids and corals responsible for the erection of a possible structure having the characters discussed?

Since any unilateral approach to this problem would be rather risky, such considerations should include structural, lithological and paleontological premises.

In the early Upper Devonian (the Manticoceras Stage and the lowermost part of the Cheiloceras Stage), there occurs considerable facial differentiation presented above. If we assume that the reef hypothesis is the most appropriate for interpreting the sedimentation of the deposits under study, the facies distinguished should make up a reef complex (Henson 1950). Furthermore, an influence of a reef, which controls and modifies adjoining environments and the sedimentation taking place in them, should be marked in various zones of a fossil reef complex. Part of a reef, affecting the sedimentation in adjoining environments and being formed by frame-building organisms is termed as a *reef core* (*e.g.* Nelson & al. 1962), *reef wall* (Henson 1950), *reef proper* (Dunbar & Rodgers 1957), or an *organic reef* (Klovan 1964). In the Upper Devonian, the reef core would have to be composed, either completely or partly, of massive stromatoporoid-coral limestones of the Kadzielnia type. A structure formed of them should have been marked by characters determined by the definition of a reef. Most of the characters of a reef sedimentation should, however, be looked for outside the reef core, that is, in all other zones of the reef complex on which the influence of this sedimentation is exerted.

May we conclude, therefore, that the limestones of the Kadzielnia type were a rigid structure? An extensive network of veins of a laminated limenstones, cutting the Kadzielnia limestone (Figs 3 and 8), provides evidence that the lithification of the Kadzielnia limestone was very rapid. Wide fissures, locally stretching for tens of meters, intersected an already completely consolidated limestone. Filling these fissures with an almost contemporary deposit took place under subaqueous conditions. Moreover, sharp-edged blocks of the Kadzielnia limestones, rare to be sure, are wedged in the fissures. Thus, there is ample evidence that massive limestones of the Kadzielnia type were subject to a rapid consolidation and, in the early Upper Devonian, formed a rigid structure.

The answers to the remaining more important questions connected with the evaluation of the reef character of the Kadzielnia limestones are, however, not to obvious. An answer to the question whether there was a positive topographic structure of the sea bottom formed of the Kadzielnia limestones may be found in an indirect way only. The assemblage of organisms chateristic of particular facies, the same as the spatial distribution of the facies and the direction of supplying the calcareous detrital material to these facies indicate that the massive limestones of the Kadzielnia type correspond to the shallowest facies of the early Upper Devonian occurring in the Holy Cross Mts. For, it was in the direction from these facies that the transportation of the detrital material took place through the zone of the sedimentation of detrital limestones to the deepest parts of the basin. The actual, deepest bathymetric position of the basin facies quite obviously results from the poverty in fossils, from their characters, from the part of marly deposits in the sedimentation and, finally, from the presence of allochthonous detrital intercalations, redeposition of which manifestly results in turn from the strange character of the organic detritus and from structural characters of the deposits. On the other hand, the deposits of the type of basin facies interfingered with detrital deposits which were formed in a zone with a generally high energy index decisive as to the disintegration, which produced bio- and intraclasts and as to the formation of accretionary-

-type allochems. Detrital deposits abound in corals, including colonial ones, and in massive stromatoporoids considerable part of which are redeposited. The zone of detrital limestones separates basin facies from the Kadzielnia limestones, from which the conclusion may be drawn that the last-named limestones were formed in the shallowest of all the zones mentioned above, the more so as they contain numerous massive and tabular stromatoporoids and corals. In the early Upper Devonian of the Holy Cross Mts, there did, therefore, exist a positive topographic structure whose core was made up of the limestones of the Kadzielnia type. However, how high was it and did it reach the zone of waving? We may state that evidence is available for a considerably shallow-water character of the detrital limestones. This evidence consists in the presence of the algae (*Girvanella* and *Chabakovia*) and ooids. The presence of algae indicates that detrital limestones, or at least part of them, were formed in a photic zone, while the presence of ooids, which as a mater of fact are not very frequent, enables the conclusion that some of the detrital limestones were probably formed in tidal oolite shoals. If, therefore, the deposition of detrital limestones, or at least of part of them, took place under such shallow-water conditions, the limestones of the Kadzielnia type had to be formed under extremely shallow-water conditions. As a matter of fact, it is even difficult to imagine a sedimentary environment decidedly shallower than the zone of sedimentation of detrital limestones adjoining the Kadzielnia limestones, whereas they actually border on each other along an easily distinguishable boundary. It seems likely that, since, in view of a small depth, there is simply no space for detrital limestones, bathymetry could not be a factor causing a radical difference between the two facies. The Kadzielnia limestones are in principle a deposit with a low energy index (cf. Plumley & al. 1962), because they do not contain a detrital material which would be significant quantitatively. Clearly, then, the facies of the Kadzielnia limestones and the facies of detrital limestones are very similar to each other bathymetrically and have an extremely shallow-water character, differing primarily in their energy index. The conclusion may be drawn that the zone of the Kadzielnia limestones was formed as if in the shadow of the zone of the formation of detrital limestones and was protected by the latter. A true reef breccia, consisting of the fragments of the stromatoporoid-coral limestone and of the bioclasts of corals and stromatoporoids, occurs in the Upper Devonian beginning with the Lower or Middle Polygnathus asymmetricus Zone (*to Ia*). The breccia gives evidence that the calcareous deposits, formed to a considerable extent of corals and stromatoporoids, were accumulated by accretion in the surf zone and were abraded. The presence of the deposits of this type indicates that in the Upper Devonian, there existed stromatoporoid-coral, wave-resistant structures of the type of the Kadzielnia limestone or similar to it. However, only some, probably seaward, parts of this structure were exposed to abrasion.

Finally, there still remains the question to be answered: whether corals and stromatoporoids could be responsible for building the reef structure and whether they made up the framework of such a structure. According to Cloud (1952), the role of analogous organisms in Recent reefs consist in holding the reef together, and the frame they build is a trap for clastic or chemically precipitated sediments. The role of corals, and the more so of stromatoporoids in the formation of limestones of the Kadzielnia type is somewhat different than that of the typical reef-binding organisms in Recent reefs or in typical fossil ones (*e.g.* Newell 1955). First of all, these organisms' rock-forming role is subordinate or, at most, equalling the role of a sediment precipitated chemically. The cases of some organisms being encrusted by some other ones are very rare and do not play a significant role in constructing a compact framework. The sedimentation of these limestones took place in a sufficiently undisturbed manner enabling the preservation of massive and tabular stromatoporoids in growth position and occurrence of the accompanying sediment in such a state as if immediately precipitated. On the other hand, massive and especially tabular stromatoporoids performed a function of mud-trapping and mud-binding organisms (Pl. 22). The umbrella-like structures, resulting from the occurrence of sparry calcite lenses under the convexitis of tabular stromatoporoids which covered the bottom, seem to indicate that stromatoporoids contributed to the rigidity of the structure prior to the consolidation and compaction of the chemical sediment, which caused the formation of the structures in question.

In some respects, the Upper Devonian reefs from the Holy Cross Mts are, however, different than the Recent, especially, Pacific reefs. These differences resolve themselves into the following items:

1. Stromatoporoids-coral biolithites are not, for the following reasons, a complete equivalent of the reef-core in the Recent reef complexes:

a) The frame of a biolithite, performing a mud-binding function, was formed by stromatoporoids not everywhere and, in addition, only to a limited extent.

b) The chemical precipitation of micritic calcium carbonate played a role in the accretion of biolothites at least equal to that of the development of sessile benthic coelenterates.

c) The occurrence of a considerable amount of stromatoporoids and corals in growth position and an insignificant amount of allochemical components in the matrix of a biolithite indicate that the latter were not formed in the surf-zone but in an environment having a lower energy index.

2. In regard to the position they occupy, the stromatoporoid-coral biolithites, make up, at least in part, an equivalent of the Recent backreef lagoonal sediments, from which they differ, however, in the type of deposits and a general assemblage of dwellers.

3. The boundary between the biolithite and the detrital facies during the sedimentation was not of the nature of a stair in the morphology of the bottom and

a considerable part of the deposit was formed at small depths, which even partly corresponded to the tidal zone.

4. In the sedimentation of detrital limestones, the accretion-type particles played a role corresponding to that of skeletal grains.

Some of the characters mentioned above, which differ the facies under study from the Recent reefs, may suggest certain analogies to the Recent Bahaman carbonate sediments. Detrital limestones actually display a partial petrological similarity to the deposits which occur at present on the Great Bahama Bank. This analogy consists in a significant part of the accretion-type particles (ooids, lumps, pellets). However, a considerable and, frequently, even predominating part of skeletal grains and, among them, fragmented skeletons of organisms, which play the role of sediment-binders in adjoining biolithites in the Upper Devonian limestones, differs them from the Recent sediments of the Bahamas. Except for a narrow *coralgal facies,* skeletal grains do not make up there more than, on the average, a dozen or so per cent (Purdy 1963). Organisms which form a barrier rim, that is, corals and algae amount in the *coralgal facies* do not more than a few per cent and in the *pellet-mud* and *mud facies* they are lacking at all. A considerable share of skeletal grains, mostly of sessile benthic coelenterates, sometimes forming a true reef--breccia, differs, therefore, the Devonian detrital limestones from the Recent Bahama deposits. The transportation of bioclasts from the zone settled by stromatoporoids and corals to the zone of detrital deposits and, further on, to the basin facies is at odds with the manner of sedimentation on the Bahama Bank where in principle a short-distance transportation of skeletal material predominates (Ginsburg 1956, Purdy 1963). In addition, the following two fundamental differences occur between the Upper Devonian formation and the Bahama-type facies complexes:

1. On the Andros Platform, the facies with predominat allochems are decidedly superior quantitatively (Imbrie & Purdy 1962, Purdy 1963), while in the formation under study a facies similar to them is limited to a narrow strip only.

2. An extensive stromatoporoid-coral biolithite facies, occupying the inner part of the Devonian structure under study, has not any counterpart in the Bahamas, where shelf lagoon sediments make up allochemical deposits caused mostly by the precipitation of calcium carbonate upon banks.

Examples of fossil formations considered as ancient sediments of the Bahaman type (*bahamites* of Beales 1958) also differ in a similar manner from the formation under study (cf. Beales 1956, 1958; Kutek 1969; Jenkyns 1970). In these formation, bioclastic debris play a subordinate role in relation to the precipitated deposits. Formations similar to the Recent Bahama type are as a rule very extensive (Beales 1956, 1968; Wilson 1968; Kutek 1969) and display a moderate lateral facial variability, whereas the lateral facial variability in the Frasnian of the Holy Cross

Mts is so sudden that in practice it makes impossible the correlation of adjoining outcrops based on lithology.

As follows from the comparisons, the formation under study, although marked by the most important characters of reef sedimentation, has not any exact counterparts among the Recent reefs. Klovan (1964) suggests that the Recent Alacran Reef (Gulf of Mexico), located in a shallow epicontinental sea and devoid of an algal ridge, may be a closer analogy to the many Paleozoic reef structures. Analogies of the formation we are interested in to the Bahamian-type sediments are yet more remote. A structure, composed in its main bulk of stromatoporoid-coral limestones, had a character of an extensive bank, in which a flat-topped depositional surface was predominant. The limestones of this extensive interior lagoonal facies were abundantly populated by sessile benthic coelenterates, which locally formed not very large bioherms (cf. Pajchlowa & Stasińska 1965) scattered among generally biostromal deposits. Marginal reefs probably occurred only on the boundary of the interior lagoonal facies and the detrital facies. It is not unlikely that part of detrital limestones filled with large-sized stromatoporoids make up an actual reef core. It is pointed out by Ladd (1950, p. 204), Fairbridge (1950, p. 330) and Klovan (1964, p. 12) that reef core forms only an insignificant part of the entire reef structure and changes to find it preserved in the fossil state are rather meager. The marginal reef and detrital facies, relatively narrow as compared with the extensive interior shelf facies, supplied considerable amounts of grained material to the surrounding basin facies (or off-reef facies). The entire structure described is of the nature of an extensive reef-fringed bank. A frequently used term *table reef* may also be applied here.

HISTORY OF SEDIMENTATION

The sedimentation of calcareous deposits of the Upper Devonian in the western part of the Holy Cross Mts is a continuation of the Givetian dolomitic and calcareous sedimentation. Although, as mentioned before, the boundary between the Middle and Upper Devonian cannot be accurately traced, the limestones documented as Upper Givetian are not of the reef origin. The sedimentation of stromatoporoid limestones, which predominate in the Upper Givetian, is of the bank-type and resembles that suggested by Krebs (1967) for the bank-type Massenkalk in the eastern Rhine Slate Mts. Detrital limestones, containing considerable amounts of reef-derived fossils and skeletal fragments, appear as late as the lowermost Frasnian in the Lower or Middle Polygnathus asymmetricus Zone (*to Ia*). The stromatoporoid-coral limestones and accompanying detrital limestones, had then their most extensive range in the Holy Cross Mts. Detrital limestones with a rich fauna of stromatoporoids and corals reached then in the north as far as the Łysogóry area (Czarnów, Śluchowice). Since no deposits of this age are outcropped further to the north, now it is difficult to answer the question whether or not these detrital limestones occurred yet further in the north. During that period, the stromatoporoid-coral limestones reached far to the south (Kowala). It is difficult to decide if during that period there already existed a reef-fringed bank, or if patch-reefs scattered over the area of a calcareous shelf platform were the source of reef-derived deposits. Micritic brachiopod limestones, locally and periodically appearing (Śluchowice, Kowala), as well as deposits of Wietrznia, transitional to the basin facies, indicate that the latter alternative is more probable.

In the Upper Polygnathus asymmetricus Zone (*to Iβ*), there already existed a fully formed table reef surrounded by the basin facies. The zone occupied by the shallow-water bank and marginal reefs was, however, narrowed as compared with the area occupied by shallow-water stromatoporoid-coral deposits in the lowermost Frasnian. Both in the north at Śluchowice and in the south at Kowala (set *F*), the so far predominant sedimentation of detrital limestones rich in stromatoporoids became replaced by deposits of basin facies reached by turbidity currents and slumps transporting detrital materials from the marginal areas of the table reef. Since those times, the asymmetric distribution of facies had been outlined in the western part of the Holy Cross Mts. The reef-fringed bank, which takes a central position, separates two areas covered by the basin facies, one of which is situated in the north (Śluchowice, Górno, partly Kostomłoty) and corresponds to the specifically developed Frasnian of the Łysogóry region and the other — in the southernmost part of the Kielce region (Kowala). The centrally situated shallow-water platform probably occupied, according to Czarnocki's (1948) supposition, the area (now eroded) of the Dyminy anticline (cf. Fig. 1) and partly also the Gałęzice syncline, where, near Kowala, the Frasnian is developed at Bolechowice (borehole) as massive limestones (Żakowa 1963, Freyer & Żakowa 1967).

No detailed data area available concerning the range of the southern basin facies and the trace of its boundary with the shallow-water platform.

The facies pattern, presented above, departs from previous conceptions (Czarnocki 1950), according to which a symmetric distribution of facies, with a shallow-water facies in the Kielce region and deep-water facies in the Łysogóry region, was supposed to predominate in the Frasnian of the western part of the Holy Cross Mts.

A similar distribution of facies also persists in the Ancyrognathus triangularis (*to Iγ*) and Palmatolepis gigas (*to Iγ—δ*) zones. Fluctuations are recorded only in the detrital facies, which interfingers with limestones of the basin facies. In addition, the Manticoceras Limestones, visible only on the Kadzielnia hill, appear in the Lower Palmatolepis gigas Zone (*to Iγ*). The last-named facies makes up an isolated area of pelagic sedimentation between detrital deposits which fringe it. At Kostomłoty, a sedimentation characteristic of the northern basin facies disappears in the Upper Palmatolepis gigas Zone (*to Iδ*) where it is replaced by the

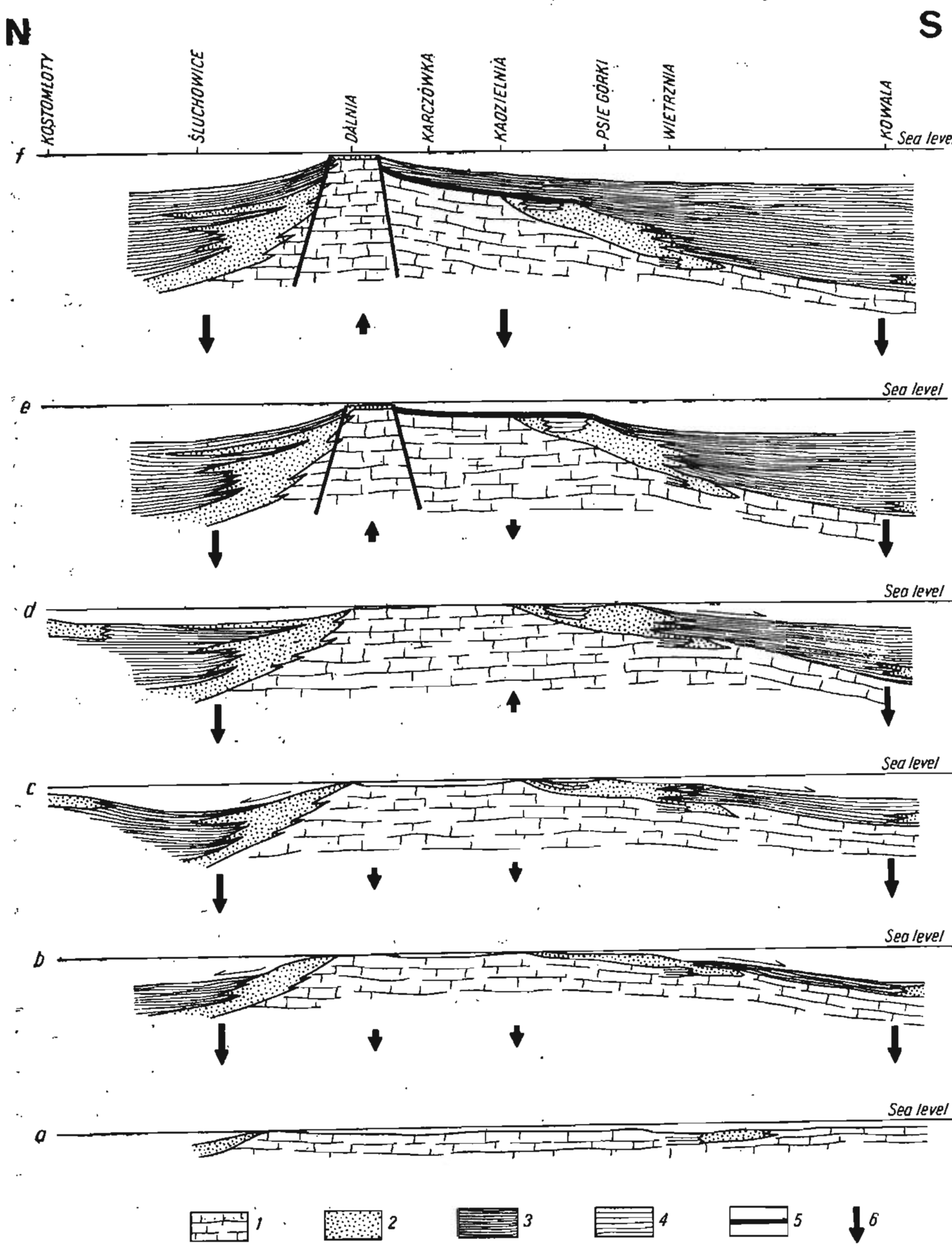


Fig. 11

sedimentation of detrital limestones persisting as far as the boundary with the Famennian. These limestones are not, however, of the nature of reef-derived ones and they were formed on a not very deep shelf, which then occupied the north-western end of the Holy Cross Mts (Szulczewski 1968). Black flints which occur in these limestones cannot be an index of the shallow-water character of these deposits, since in the Upper Devonian flints occur as well in biostromal limestones of Kowala (set *A*) and in the Givetian beds filled with stromatoporoids (Zelejowa).

The reef sedimentation persists in the territory under study at least as far as the Lower Palmatolepis crepida Zone (*to IIα*) and maybe even to the Middle Palmatolepis crepida Zone (*to IIα*), thus considerably exceeding the boundary of the Frasnian and the Famennian and still existing at the beginning of the Cheiloceras Stage. The last proof for it is the sedimentation of detrital limestone on the Psie Górki hill, lasting up to one of the two zones named above. It is very likely that the previous shallow-water bank in the Palmatolepis triangularis (*to Iδ — to I/II*) and Lower to Middle Palmatolepis crepida (*to IIα*) zones was subject to partial uplift and even emersion. These zones or at least parts of them are either absent from the western part of Kadzielnia, or are extremely condensed, while the overlaying Famennian deposits have a very uneven bottom surface and locally contain large blocks of the Kadzielnia limestone. Positive tectonic movements also took place probably in the area of the northern basin facies, since at Śluchowice the Lower to Upper Palmatolepis triangularis zones are strongly condensed and maybe even stratigraphic gaps occur in this part of the profile. Flat pebble intraformational conglomerate, probably of slump origin, whose presence may be indirectly connected with the synsedimentary tectonics, appear in the part of the profile named above at Śluchowice. A very similar conglomerate and in a similar position also appears as an uppermost bed of the profile exposed at Kostomłoty. At the same time, a considerable,

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Fig. 11

Facial development of the Upper Devonian in the western part of the Holy Cross Mts; successive stages of the development are shown for the time of:

a Middle Polygnathus asymmetricus Zone (*to Iα*)
b Upper Polygnathus asymmetricus Zone (*to Iβ*)
c Lower Palmatolepis gigas Zone (*to Iγ*)
d Middle Palmatolepis triangularis Zone (*to Iδ?*)
e Upper Palmatolepis crepida Zone (*to IIα*)
f Lower Palmatolepis quadrantinodosa (*to IIβ*)

1 stromatoporoid-coral limestones, *2* detrital limestones, *3* basin deposits, *4* Manticoceras limestones, *5* Cheiloceras limestones, *6* subsidence or uplift (length of the arrow corresponds to relative rate of vertical displacement) uniform subsidence, causing an incessant sedimentation of rhythmically bedded marly limestones and shales, persists in the southern basin. During that same period, that is, in the Lower or Middle Palmatolepis crepida Zone (*to IIa*), pelagic Cheiloceras Limestones started already their deposition over stromatoporoid limestones in other places of the shallow-water bank. In the Upper Palmatolepis crepida Zone (*to IIa*), they covered a considerable area of the previous table-reef, and they embraced at least an area stretching from Cmentarna hill to Karczówka. These limestones rest on the deposits of various facies, that is, stromatoporoid-coral limestones, detrital limestones and Manticoceras limestones (Figs 3, 4). The extension of the Cheiloceras limestones and the Famennian marl-shaly deposits, which follow them, into the Upper Palmatolepis crepida Zone is already equivalent to the final ceasation and sinking of the Upper Devonian table reef. At the same time, a final and radical change occurs in facial types which turn into pelagic ones. A decrease in the area of table reefs marked from the Upper Polygnathus asymmetricus Zone (*to Iβ*) and its gradual ceasation at the beginning of the Frasnian, reflected in a gradual overlapping of newer and newer pelagic deposits onto the deeply submerged reef structure up to a complete covering of the area occupied by it with marl-shaly basin deposits, give evidence that this reef was transgressive in character. As a matter of fact, the reef formation on the Upper Devonian is contained within a typical transgressive sedimentation cycle, initiated by an advancing transgression of the clastic Lower Devonian and completed with the pelagic sedimentation of the uppermost Famennian until the Lower Carboniferous.

It is very likely that the sinking of the reef took place as a result of its dissection into blocks and non-simultaneous subsidence of theirs (cf. Jenkyns 1970).

In the area occupied by the sedimentation of the Cheiloceras Limestones, the subsidence is very small and these limestones display a certain stratigraphic condensation. During the same period, the extensive adjoining areas are already dominated by the sedimentation of rhythmically bedded marl-shaly deposits, considerably thicker than deposits of various ages belonging to the facies of the Cheiloceras Limestones. At first, these deposits still contained fairly numerous fossils (Kadzielnia, Psie Górki), but later on, when the sedimentation lagged behind a considerable subsidence, they became very poor in fossils. The formations of this facies predominated in most areas, which corresponded to both the previous shallow-water platform and adjoining basins. This facies appears, however, in the area of the previous northern basin facies as early as the Lower or Middle Palmatolepis crepida Zone (*to IIa*), that is, earlier than in the area which corresponded to the table reef. In the northern basin facies (Kowala), the deposits of this facies are a continuation of pelagic marl-shaly deposits of the Frasnian. Facial changes that took place in the territory of the previous platform are here manifested only by the disappearance of turbidites. On the Psie Górki hill, the deposits of this facies appear in the Upper or Middle Palmatolepis crepida Zone (*to IIα*). Finally, latest of all, that is in the Lower Palmatolepis quadrantinodosa Zone (*to IIβ*), this facies appears on the Kadzielnia hill, where it ultimately liquidates the sedimentation of the Cheiloceras Limestones, which afterwards do not occur anywhere above the Palmatolepis rhomboidea Zone (*to IIβ*).

Thus, the deposits of the Marly Facies, much the same as locally underlaying Cheiloceras Limestones, do not appear simultaneously in all outcrops and their bottom boundary is heterochronous in character. A limitation of the occurrence of the Cheiloceras Limestones only to the area corresponding to the previous shallow-water platform, as well as the appearance in this area of the Marly Facies which took place later than in the neighbourhood, indicate that the subsidence in this area was slower than in the remaining area. The slower subsidence was precisely the reason why pelagic facies here appeared later than elsewhere and why the calcareous sedimentation persisted for a longer time than elsewhere. Reminiscences of the Frasnian distribution of subsidence, which was previously decisive as to the foundation of the table reef, are, therefore, still marked in the lowermost Famennian. An extreme facial "conservatism" is displayed in the profile of Dalnia, where a sedimentation of oolitic limestones with extremely reduced thickness probably persisted throughout the Famennian. This is a unique phenomenon in the entire Holy Cross area.

Beginning with the Lower Palmatolepis quadrantinodosa (*to IIβ*), the facies of rhythmically bedded marl-shaly deposits persists throughout the Upper Famennian over almost entire area of the western part of the Holy Cross Mts. Monotonous deposits with a considerable thickness are formed in this facies, which is caused by a generally large subsidence, behind which sedimentation was lagging. Except for a local oolitic facies of Dalnia, in the south-western margin of the Holy Cross Mts, the Upper Famennian deposits are differently developed only in the zone of Gałęzice. Beginning with the Palmatolepis quadrantinodosa Zone, calcareous deposits, strongly condensed and rich in fossils, among them, cephalopods, are formed in this area (cf. Czarnocki 1928, Wolska 1967). This zone was evidently a submarine rise analogous to the German *Schwellen* (Schmidt 1925, Rabien 1956) which was risen above the surrounding area of the basin deposition (*Becken*). Such a distribution of facies persists in the western part of the Holy Cross Mts up to the Spathognathodus bischoffi Zone (*to V/VI*).

FINAL REMARKS

The obtained results present a general picture of stratigraphic and facial conditions for the Upper Devonian of the western part of the Holy Cross Mts. The basing on conodonts as on the analytic material for stratigraphic investigation, as well as basing on petrographic studies for a restoration of the facial development of the deposits, has not hitherto had a greater experience. It therefore appears that further investigations will certainly lead to a more detailed correlation and stratigraphy. It also seems, a number of sedimentary phenomena, only mentioned or abstracted in the present paper, need separate and more advanced elaborations. On the other hand, it may be also believed that the stratigraphy based on conodonts will facilitate further studies on stratigraphic significance of other groups of fossils which have not, so far, been used for a stratigraphic purpose in the Upper Devonian of the area (*e.g.* foraminifers, ostracods, tentaculitoids). Even investigating stratigraphic importance of a better recognized group of fossils, mostly of the macrofossils, the stratigraphic schema based on conodonts may be greatly useful for a more precise age determination — it concerns *e.g.* the brachiopods (cf. Biernat 1971), trilobites, rugose and tabulate corals (cf. Osmólska, Różkowska, Stasińska & Szulczewski, *in preparation*). Finally, the presence of many ammonoid-yielding points, the fauna of which is presently being collected for detailed palaeontological studies (cf. Makowski 1971), can provide a basis for a full conodont/ammonoid interzonation in the entire Upper Devonian of the Holy Cross Mts.

The results obtained in the present study permit an enough satisfactory comparison of the Upper Devonian of the Holy Cross Mts and other areas, some of them far-away situated. Mostly instructive are the analogies with the Rhine Slate Mts and Western Canada (Alberta). In both these regions, an Upper Devonian reef formation overlies bank-phase deposits (Krebs 1968a), the same as in the Holy Cross Mts. The main types of facies, as well as a number of particular petrographic varieties from the latter area have their counterparts in the Devonian reef limestones of the Rhine Slate Mts and of Alberta. Upper Devonian reef deposits from the Holy Cross Mts correspond facially in the northern part of the Rhine Slate Mts to the Dorp Limestone and Eskesberg Limestones, whereas in the eastern Rhine Slate Mts — to a part of the Massenkalk, and finally in the Dill syncline — to the Iberg Limestone (cf. Krebs 1966, 1968a). All these latter types of regionally differentiated limestones are considered by Krebs (1968) as a reef-type Massenkalk representing the Dorp facies. The shaly carbonates of the Flinz facies, containing numerous turbidites (Meischner 1964) are very close in the Holy Cross Frasnian to the basin facies developing all around the reef structure. In the Holy Cross Mts however, the counterparts of the cap-type Iberg facies are lacking. The sunken reefs are covered in both regions either by pelitic sediments or by thin layers of cephalopod limestones (cf. Krebs 1968a). A comparison of all the discussed facies from the Rhine Slate Mts and Western Canada was accurately presented by Krebs (1968a, Table 2) and there is no need to be here repeated.

Although a close relationship between the reef formations of the Rhine Slate Mts, Western Canada and Holy Cross Mts does really exist, remarkable differences in the age of their development must be stressed.

A time-span of reef sedimentation in the Rhine Slate Mts is different in various regions, and it realizes, according to Krebs (1968a), in a lower part of the Frasnian only (Lower to Middle Adorf Stage). It appears, from the data presented by Krebs (1966, p. 33), that the reef sedimentation has lasted from the Polygnathus asymmetricus zones until, at the furthest (cf. Krebs & Ziegler 1965), the Upper Palmatolepis gigas Zone (*to* $I\delta$); in some regions it has not transcended the Ancyrognathus asymmetricus Zone (*to* $I\gamma$).

The reef structures of Western Canada are not isochronous and they occur both in the Beaverhill Lake Formation (corresponding to the Waterways Formation, cf. Murray 1966) and in the Leduc Formation (*e.g.* Klovan 1964). The reef complex in the Beaverhill Lake Formation makes its Swan Hills Member, the thickness of which varies and it may occupy the entire interval of this formation (Pollock 1968; cf. also Murray 1966, Fig. 2). The opinions on the age of the Beaverhill Lake Formation are not however coincided. According to Uyeno (1967) and Pollock (1968), the formation does not exceed over the Middle Polygnathus asymmetricus Zone (*to* $I\alpha$) and in all its entity, the bottom including, belongs to the Upper Devonian. On the contrary, Mound (1968) believes this formation being of the Upper Polygnathus asymmetricus Zone (*to* $I\beta$). The Leduc reefs, according to Mound (1968) and Pollock (1968), reach as high as the Ancyrognathus triangularis Zone (*to* $I\gamma$). Everyone of these formations, both the Swan Hills Member, and the Leduc Formation, is independent and a fully developed reef formation, carpeted by marly limestones and calcareous shales.

In comparison wtih the discussed German and Canadian formations, it is evident that the reef sedimentation in the Holy Cross area has stratigraphically lasted much longer. The particular members of all the discussed reef formations are comparable only in a restricted, viz. facial significance, whereas in the stratigraphy they are evidently heterochronous.

It may be finally pointed that the reef formations in Alberta are conspicuous oil collectors, and the reservoirs are confined to definite facies of these formations. The applying of the stratigraphic and petrographic methods practiced in the Upper Devonian of the western part of the Holy Cross Mts, and resulted in the present paper, may therefore be assumed to be of a commercial importance during the borehole prospecting and penetration throughout the adjacent areas of Poland.

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KONODONTY, STRATYGRAFIA I ROZWÓJ FACJALNY GÓRNEGO DEWONU GÓR ŚWIĘTOKRZYSKICH

(Streszczenie)

Przedmiotem pracy są zagadnienia stratygrafii, zróżnicowania facjalnego oraz historia sedymentacji górnego dewonu w zachodniej części Gór Świętokrzyskich (por. Fig. 1).

W celu właściwego odtworzenia zmienności facjalnej i ewolucji rozkładu facji rozważanego obszaru, koniecznym było przedstawienie szczegółowej korelacji poszczególnych profilów. Stosowany dotychczas podział stratygraficzny, a zwłaszcza protostratygraficzny podział franu, nie mógł spełnić tego zadania. Wykazano, że można natomiast ustalić szczegółowy podział stratygraficzny (Fig. 7 oraz Tab. 1) oparty na stwierdzonym w poszczególnych profilach następstwie konodontów (Tab. 2—9). Konodonty, uzyskane z szeregu odsłonięć m. in. z Kostomłotów, Śluchowic, Kadzielni, Psich Górek, Wietrzni i Kowali, zezwoliły na przeprowadzenie bardziej drobiazgowego i dokładnego określenia wieku odsłaniających się tam utworów (por. Fig. 2—5). Wszystkie uzyskane gatunki konodontów platformowych, a z pozostałych jedynie najbardziej interesujące lub posiadające istotne znaczenie stratygraficzne, opracowano paleontologicznie (por. Pl. 1—20). W sumie oznaczono 80 gatunków, wraz z podgatunkami, należących do 11 rodzajów. Gatunków bądź podgatunków nowych jest pięć; są to *Ancyrodella sinecarina* sp.n., *Palmatolepis circularis* sp.n., *Palmatolepis minuta wolskae* subsp.n., *Polygnathus sinuosus* sp.n., *Pelekysgnathus?* sp.n. W opracowaniu niniejszym położono nacisk na gatunki frańskie, gdyż konodonty z famenu badanego obszaru były w znacznym stopniu wcześniej przedstawione przez Z. Wolską (1967). Stwierdzone w opracowanych profilach następstwo gatunków odpowiada szeroko na świecie rozpoznanej sukcesji konodontów i pozwala na wyróżnienie poziomów konodontowych o uniwersalnym znaczeniu, a wyodrębnionych przez W. Zieglera (1962b). Zebrane konodonty upoważniają do wyróżnienia (por. Fig. 7) przynajmniej 13 poziomów odpowiadających piętru Manticoceras, od dolnego lub

środkowego poziomu Polygnathus asymmetricus (*to Ia*) począwszy, oraz na wyróżnienie niższej części piętra Cheiloceras, aż po poziom Palmatolepis rhomboidea (*to IIβ*) włącznie. Wyższe poziomy famenu rozpoznała wcześniej Z. Wolska (1967). Wyróżnione poziomy konodontowe dają się łatwo skorelować z poziomami głowonogowymi (por. Tab. 1) i są od nich precyzyjniejsze. Ograniczona częstość występowania konodontów nie zawsze jednak zezwala na stosowanie w konkretnych odsłonięciach wydzieleń z dokładnością do jednego poziomu.

W oparciu o konodonty dokonano szeregu korektur stratygrafii regionalnej. Dotyczą one m. in. wieku tzw. warstw kostomłockich oraz korelacji franu regionu kieleckiego i łysogórskiego. Skorygowano także dotychczasowe wyobrażenia o przebiegu granicy pomiędzy franem a famenem i wykazano heterochroniczność ogniw litologicznych najniższego famenu.

W oparciu o obserwacje zjawisk sedymentacyjnych, analizę petrograficzną i rozpatrzenie zespołu skamieniałości wydzielono szereg facji franu i famenu, a w obrębie każdej z nich wyróżniono szereg typów litologicznych (por. Fig. 6, 8—10 oraz Pl. 21—34). Zróżnicowanie osadów franu i zawierających je skamieniałości porównano z modelem współczesnych środowisk sedymentacji rafowej oraz sedymentacji wapiennej typu bahamskiego. Okazało się, że sedymentacja franu świętokrzyskiego posiada szereg cech swoistych, odróżniających ją od obu wspomnianych modeli współczesnej sedymentacji wapiennej. Odpowiada ona w istocie płytkowodnej platformie z marginalną strefą rafową, a wznoszącej się ponad otaczające głębsze baseny. Jest ona porównywalna z licznymi paleozoicznymi rafami płytowymi (ang. *table reefs*).

Przedstawiając historię sedymentacji na badanym obszarze (Fig. 11) stwierdzić można, że w najniższym franie, w dolnym lub środkowym poziomie Polygnathus asymmetricus (*to Ia*), płytkowodna sedymentacja obejmowała cały region kielecki i sięgała aż na region łysogórski. Od górnego poziomu Polygnathus asymmetricus (*to Iβ*) obszar sedymentacji rafowej ulegał zwężaniu. Począwszy od tego poziomu na badanym obszarze panuje symetryczny rozkład facji, w którym dwie strefy głębszych basenów o znacznej subsydencji, północna i południowa, rozdzielone były płytkowodną platformą. Struktura rafowa miała charakter transgresywny i uległa stopniowej likwidacji przed górnym poziomem Palmatolepis crepida (*to IIa*). W wyższym famenie nastąpiło znaczne ujednolicenie facjalne i dominowała sedymentacja pelagiczna. Ten ostatni typ sedymentacji pojawił się jednakże w różnych miejscach badanego obszaru w niejednakowym czasie i obszar pogrążającej się struktury rafowej obejmował stopniowo. Od dolnego poziomu Palmatolepis quadrantinodosa (*to IIβ*) począwszy sedymentacja marglista panowała na całym obszarze zachodniej części Gór Świętokrzyskich z wyłączeniem ograniczonych stref (rejon Dalni, Gałęzic) odpowiadających grzbietom podmorskim.

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