Kwartalnik Geologiczny, t. 24, nr 2, 1980 r., str. 193–216

UKD 551.733.33/.734.2.022.2.024:551.243.3]:56.016.3 konodonty + 563.719:551.352.051(438:234.57 Zdanów)

Maria CHOROWSKA, Józef OBERC

The Stratigraphy and Tectonics of the Uppermost Silurian and Lower Devonian of the Zdanów Section (Góry Bardzkie Mts, Sudety Mts) in the Light of Conodont Studies

In the Zdanów section, up to the present there were known two horizons of graptolite shales with paleontological record and light-coloured, faunistically barren clay shales separating them. Conodonts recently found in the clay shales made it possible to establish their stratigraphic position. There was also found a third horizon of graptolite shales and, thus, the Middle Zdanów Shales. The Silurian/Devonian boundary presumably passes within the Middle Zdanów Shales. The Zdanów section represents reversed and latter refolded Ordovician-Lower Devonian sequence. Strata exposed here may be assigned to the Bavarian facies, widely distributed in the Sudety Mts (Góry Bardzkie and Góry Kaczawskie Mts). At Zdanów, deep-water marine sedimentation has been accompanied by volcanic phenomena in the Wenlockian and Lower Gedinnian times.

INTRODUCTION

The outcrop at Zdanów (Fig. 1) makes it possible to trace lithostratigraphic succession of Silurian and Lower Devonian rocks and to define their tectonics. The Silurian-Devonian boundary beds are also exposed here. New paleontological data, presented in this paper, fully justify the attention paid to that section.

In 1855, O.L. Krug von Nidda reported the occurrence of lydites and black shales with graptolites at that locality. Subsequently, L. Finckh (1932) showed rocks exposed here in his map (sheet Frankenstein 1:25 000) in eastern part of the zone of occurrence of so-called Zdanów Beds (Herzogswalder Schichten), assigned to the Upper Devonian by E. Dathe (1904). E. Bederke (1924) proposed to assign the Zdanów Beds to the Ordovician on account of their dip under the graptolite shales. J. Oberc (1953), with reference to the Silurian section from Łupianka (Góry Bardzkie Mts) described by F. Dahlgrün and L. Finckh (1924), interpreted the rock series from Zdanów as tectonically reversed. In cross-section (J. Oberc, 1957),

Fig. 1. Location of the studied area
Lokalizacja terenu badań

he marked two occurrences of coeval graptolite shales, separated by the Zdanów shales of the Lower Devonian. The northern occurrence of graptolite shales is, according to him, delineated by a fault in the south.

L. Malinowska (1955), in her stratigraphic analysis of southern part of the section, interpreted rocks of the *Monograptus scanicus* zone as the youngest of graptolite shales at Zdanów. L. Teller (1960) and H. Jaeger (1964) found the species *Monograptus hercynicus* in northern part of the section. E. Kuralowicz (1976; L. Teller, E. Kurałowicz, 1977) assigned graptolite shales of the northern part of the section to the *uniformis*, *hercynicus*, *falcarius*, *fanicus* and *craigensis* zones, and J. Oberc (1977) differentiated lower and upper graptolite shales, separated by the Lower Zdanów Shales.

The Lower Zdanów Shales were, however, lacking any paleontological record so M. Chorowska made an attempt to carry out their stratigraphic analysis on the basis of conodonts. In the analysis, she took into account the results of previous studies on graptolites as well as the conclusions drawn from identification of some graptolites (newly found by M. Chorowska) by H. Tomczyk.

Warm thanks are due to E. Tomczykowa and L. Karczewski for identification of bivalves and brachiopods. Thanks are also due to E. Tomczykowa and H. Tomczyk for discussions on the obtained results. The fossils were freed from rock by K. Pałka, technician-geologist, and photos of conodonts were taken by E. Krawczyk.

THE PREMISES OF CONODONT BIOSTRATIGRAPHY OF THE LOWER DEVONIAN

The lower boundary of the Devonian system is delineated at the base of the *uniformis* zone (D.J. Mc Laren, 1977). H. Jaeger (1977*a*) noted that the base of that zone coincides with a marked turning point in evolution of graptolites. Stratigraphic ranges of the species *Monograptus uniformis* and *M. transgrediens* are separated by some interval from which there are not known any graptolites which could be used to differentiate a separate zone. This interval also coincides with sharp change in conodont fauna, connected with a rapid appearance of *Icriodus woschmidti*. In sections with good graptolite record, the first appearance of this species and, at the same time, lower boundary of the range of the *I. woschmidti woschmidti* fauna, is traced somewhere below the base of the *uniformis* zone (G. Klapper, 1977). *Icriodus woschmidti woschmidti* is typical of the lowermost Gedinnian and *I. w. postwoschmidti* – for upper part of the Lower Gedinnian. The succession of conodont assemblages in the Gedinnian, Siegenian and Emsian, mainly defined on the basis of the presence of representatives of the genus *Icriodus*, was given by W. Ziegler (1971), and the succession of assemblages in the Emsian, established on the basis of analysis of the genus *Polygnathus* – by K. Weddige and W. Ziegler (1977). G. Klapper and D.B. Johnson (1977) treat identical faunistic units as conodont zones.

The representatives of the genus *Icriodus* are often missing in conodont assemblages of the Gedinnian and Siegenian. When this is the case, the stratigraphic succession of strata of that time interval may be established on the basis of analysis of stratigraphic ranges of the representatives of the genera *Spathognathodus*, *Plectospathodus* and *Neoprioniodus* (Fig. 2).

Among the species of the genus *Spathognathodus*, very important is *S. steinhornensis remscheidensis*. It appears somewhat earlier than *Icriodus woschmidti woschmidti* and in the narrow stratigraphic unit it occurs together with the *S.s. eosteinhornensis*. The *eosteinhornensis* zone (O.H. Walliser, 1964) comprises the uppermost Silurian. Other important taxa are the representatives of the group comprising *Spathognathodus asymmetricus* Bischoff et Sannemann, *S. transitans* Bischoff et Sannemann, *S. johnsoni* Klapper and *S.* cf. *johnsoni* Klapper (according to G. Klapper, 1969, *S.* cf. *johnsoni* is a transitional form between *S. johnsoni* and *S. asymmetricus*). In the North America, *S. johnsoni* and *S. transitans* were found in the *Spirigerina* stratigraphic unit (G. Klapper, 1969), dated at the Siegenian on the basis of brachiopods, mainly *Spirigerina* cf. *supramarginalis* and *Toquimella koyi*. According to G. Klapper and others (1971, p. 290), the "fauna 4", comprising *Icriodus pesavis, Spathognathodus johnsoni* and *S. transitans*, is of the Siegenian age as it occurs in association with *Monograptus hercynicus nevadensis,* coeval with the nominal subspecies *M. hercynicus* (W.B.N. Berry *fide* G. Klapper et al., 1971). In Europe, *Spathognathodus asymmetricus* and *S. transitans* were found in Gedinnian assemblages of the Guadarrama Formation in Spain (P. Carls, 1969), the Lower Siegenian of the Carnic Alps (R. Schulze, 1968) and so-called Transgressionhorizont of the Frankenwald, possibly of the Siegenian age (G. Bischoff, D. Sannemann, 1958). Siegenian conodont assemblages are still poorly known which impedes precise dating of rocks from which G. Bischoff and D. Sannemann described the assemblage subsequently included to the *Ancyrodelloides-Icriodus pesavis* faunistic unit (Catalogue of Conodonts, t. I, 1973). Upper part of this unit may comprise partly the Siegenian.

The species *Spathognathodus stygius* is also of stratigraphic importance. In North America, it is known from the "fauna 3 and 4", that is the Upper Gedinnian and Lower Siegenian (Catalogue of Conodonts, t. I, 1973) and in Europe – from rocks dated at the Gedinnian-Lower Emsian (R. Schulze, 1968). The species *S. inclinatus wurmi*, known from the Gedinnian and Emsian, may also be regarded as typical for the Lower Devonian.

Of the species of the genus *Plectospathodus*, attention should be paid to *P. robustus*, common in the assemblage of the Frankenwald (G. Bischoff, D. Sannemann, 1958). It follows from the above discussion that the assemblage, previously assumed to be of the Siegenian age (G. Bischoff, D. Sannemann, 1958), may actually represent the Upper Gedinnian or Lower Siegenian.

Plectospathodus alternatus, common in conodont assemblages of the Gedinnian and Siegenian and appearing in the Upper Ludlovian, is also of stratigraphic importance.

The number of conodo

Species	*Eosteinhornensis* zone	*Woschmidti–postwoschmidti* fauna						Upper Gedinnian – Middle Siegenian							Gedinnian – Middle Si			
	9/74	10/74	8/74	6/74	6b/74	5/74	4/74	2/71	3/71	9/71	13/71	14/71	15/71	16/71	12/74	1/71	7/71	11/
Drepanodus sp. div.	1													1				
Hindeodella equidentata Rhodes	1										3			8	1			
Hindeodella priscilla Stauffer	1						1	1			1		2	2	1			
Hindeodella sp. div.								1		1						2		
Icriodus cf. *woschmidti postwoschmidti* Mashkova		1		2	1		1											
Icriodus ex gr. *woschmidti*			3	4	1	1												
Icriodus sp.				1	4		3											
Ligonodina sp. a								1										
Ligonodina sp. div.																		
Lonchodina greilingi Walliser										1								
Lonchodina sp. a								1		1	1			1				
Lonchodina sp. div.																1		
Neoprioniodus bicurvatus (Branson et Mehl)	3							1	1		1					2		
Neoprioniodus cf. *bicurvatus* (Branson et Mehl)							1						2					
Neoprioniodus sp. cf. *excavatus* (Branson et Mehl)								1										
Neoprioniodus latidentatus Walliser																		
Neoprioniodus multiformis Walliser										1								
Neoprioniodus sp. div.																		
Ozarkodina denckmanni Ziegler							1											
Ozarkodina media Walliser											1							
Ozarkodina sp. a																		
Ozarkodina sp. div.																		
Panderodus cf. *unicostatus unicostatus* (Branson et Mehl)				1			12									1		
Panderodus sp. div.				1			14						1					
Plectospathodus alternatus Walliser																		
Plectospathodus cf. *alternatus* Walliser																		
Plectospathodus robustus Bischoff et Sannemann											2	5	1					
Plectospathodus cf. *robustus* Bischoff et Sannemann														2				
Plectospathodus sp. div.										2	1	1	1	2	2			
Spathognathodus inclinatus inclinatus (Rhodes)																		
Spathognathodus inclinatus wurmi (Bischoff et Sannemann)												5	3	5				
Spathognathodus inclinatus subsp. a Schulze										1								
Spathognathodus sp. ex gr. *inclinatus*				1														
Spathognathodus sp. ex gr. *johnsoni* Klapper								2	1									
Spathognathodus steinhornensis remscheidensis Ziegler								2							1	4		
Spathognathodus cf. *steinhornensis remscheidensis* Ziegler																	1	
Spathognathodus steinhornensis eosteinhornensis Walliser	4																	
Spathognathodus sp. ex gr. *steinhornensis*	1																	
Spathognathodus stygius Flajs										8								
Spathognathodus cf. *transitans* Bischoff et Sannemann										1								
Spathognathodus sp. div.								1			3						1	
Trichonodella cf. *excavata* (Branson et Mehl)											1			1				
Trichonodella inconstans Walliser													1			2	1	
Trichonodella cf. *inconstans* Walliser																		
Trichonodella sp. div.													2	1				
Branching form	13			2	4		2	4	3	8	12	16	13	5	16	5		
Forms from the simple cones group							21			2	3		4			2		
Lingula sp.								1	1									

Table 1

;edinnian – Emsian			Upper Silurian – Middle Siegenian			Silurian – Middle Siegenian			Silurian – Lower Devonian														Ordovician – Lower Devonian	
sample																								
5/74	15/74	13/74	4/71	5/71	10/71	16/77	15/77	15a/77	1	1a/71	6/71	1a/75	14/77	13/77	12/77	11/77	18/74	4/77	3a/77	3/77	2/77	1/77	14/74	12a/17
																1								
		2									1	4		2							2	2		
		1																						
		1					1					5				1			2	1	1			
								1			1		1	1			1							
		1	1																					
									1		1													
				1																				
	1		1	1										1										
												1												
			1		2	1	1	1																
				1																				
														1										
			1																			1		
			1						1	1														
			1	1												1								
		7										7							2				1	
		21	1				2														2	1		2
			1																					
		5																			3	1		
																						1		
1	1	2													1									
														1										
	1									1										1	2	1		
			2					1			1													
							1							1		1					1			
	1												1	1	1			1	1	1				
	4	7		3		7	15	9	2			12	3	13	6				2		12	14		
	3	12			1		5					3												
				2						1		1												
	1											4												

Fig. 3. Geological section of the exposure by the road at Zdanów

Przekrój geologiczny odsłonięcia przy szosie w Zdanowie

O r d o v i c i a n: Jodłownik Beds – 1 – gray, usually medium-grained sandstones, 2 – dark-gray shales turning olive under weathering; S i l u r i a n: 3 – lydites with intercalations of black siliceous shales; Lower Graptolite Shales: 4 – black, siliceous shales with lydite intercalations, 5 – black, siliceous and clay shales with intercalations of greenish siliceous shales, 6 – greenish siliceous shales; 7 – basic tuffites; Lower Zdanów Shales: 8 – light-brown, brown-yellow and yellow clay and siltstone shales with intercalations of black clay shales; Middle Graptolite Shales: 9 – black siliceous shales; L o w e r D e v o n i a n: lower member of Middle Zdanów Shales: 10 – brown-yellow and yellow clay and siltstone shales; upper member of Middle Zdanów Shales: 11 – gray-brown and gray-greenish clay shales with siltstone intercalations; 12 – diabase; Upper Graptolite Shales: 13 – black siliceous-clay and clay shales with intercalations of siliceous shales; 14 – phosphoritic nodules; 15 – tectonic contacts; 16 – zones of tectonic reduction: 1 – the lack of lower and upper members of Middle Zdanów Shales, 2 – 5 – the lack of *Monograptus uniformis* zone and possibly some unidentified part of Zdanów Shales; 17 – strike and dip of bedding and stratification planes; 18 – strike and dip of anti- or synform axes; 19 – sampled points. Notice: Letter symbols, e.g. dz, GfzZ, are explained in the chapter "The tectonics..." at p. 199. The length of outcrop was measured from south to north. The 72nd meter is in the place where identical value has been reported by L. Teller (L. Teller, E. Kuraɫowicz, 1977). The differences in the scale result from profilling of bends of outcrop walls, extending individual sections in relation to the road, along the total length of the exposure was measured. The azimuths of strike of bedding and stratification planes are given in relation to the direction N, shown in the section

O r d o w i k: warstwy z Jodłownika – 1 – piaskowce szare, przeważnie średnioziarniste, 2 – łupki ciemnoszare, wietrzejące na kolor oliwkowy; s y l u r: 3 – lidyty z wkładkami czarnych łupków krzemionkowych; dolne łupki graptolitowe: 4 – łupki czarne, krzemionkowe z wkładkami lidytów, 5 – łupki czarne, krzemionkowe i ilaste z wkładkami zielonkawych łupków krzemionkowych, 6 – zielonkawe łupki krzemionkowe, 7 – tufity zasadowe; dolne łupki zdanowskie; 8 – łupki ilaste i mułowcowe, jasnobrunatne, brunatnożółte i żółte z wkładkami czarnych łupków ilastych; środkowe łupki graptolitowe: 9 – łupki czarne, krzemionkowe; d e w o n d o l n y: środkowe łupki zdanowskie, ogniwo dolne: 10 – łupki ilaste i mułowcowe, brunatnożółte i żółte; środkowe łupki zdanowskie, ogniwo górne: 11 – łupki ilaste, szarobrunatne i szarozielonkawe z wkładkami mułowców; 12 – diabaz; łupki graptolitowe górne: 13 – łupki krzemionkowo-ilaste i ilaste, czarne z wkładkami łupków krzemionkowych, jasnych zielonkawoszarych; 14 – buły fosforytowe; 15 – kontakty tektoniczne; 16 – strefy redukcji tektonicznej: 1 – brak ogniwa dolnego i górnego środkowych łupków zdanowskich, 2 – 5 – brak poziomu *Monograptus uniformis* i ewentualnie bliżej nieokreślonej części łupków zdanowskich; 17 – bieg i upad powierzchni uławicenia i warstwowania; 18 – kierunek i upad osi anty- lub synformy; 19 – miejsce pobrania próbek. Uwaga: Oznaczenia literowe np. dz, GfzZ itd. omówiono w rozdziale "The tectonics..." str. 199. Długość odsłonięcia zmierzono od S ku N – 72-gi metr bieżący przypada w miejscu, w którym wartość tę podaje L. Teller (L. Teller, E. Kurałowicz, 1977). Różnice podziałki wynikają z profilowania załomów skalnych wydłużających odcinki względem szosy, wzdłuż której mierzono całość odsłonięcia. Azymuty biegu powierzchni uławicenia i warstwowania podano względem kierunku N oznaczonego na przekroju

Table 2

The stratigraphic position of the Lower Zdanów Shales and Upper Graptolite Shales in the Zdanów section

Lithostratigraphic units	Lithology	Conodonts (after M. Chorowska, in this paper)	Tectonic unit	Graptolites (after H. Tomczyk)	Tectonic unit	Bivalves and brachiopods (after E. Tomczykowa, L. Karaczewski)	Tectonic unit	Age	Graptolites (after E. Kurałowicz, 1976; L. Teller, E. Kurałowicz, 1977)	Tectonic unit
Upper Graptolite Shales	Black siliceous-clay and clay shales with intercalations of light-coloured, green-gray siliceous shales (>4.0 m thick)	*Hindeodella equidentata* (I, 1),* *H. priscilla* (I, 2), *Ligonodina* sp. a (I, 10, 11), *Lonchodina greilingi* (II, 1), *L.* sp. a (II, 2), *Neoprioniodus bicurvatus* (II, 3), *N.* cf. *excavatus* (II, 4), *N. latidentatus* (II, 6, 7), *N. multiformis* (II, 5), *Ozarkodina media* (II, 10), *O.* sp. a, *Panderodus* cf. *unicostatus unicostatus* (III, 2), *Plectospathodus alternatus* (III, 3), *P. robustus* (III, 4, 5), *Spathognathodus inclinatus wurmi* (III; 7, 8), *S. inclinatus* subsp. a Schulze 1968 (III, 9), *S.* sp. ex gr. *johnsoni* (IV, 1–3), *S. steinhornensis remscheidensis* (IV, 4–6), *S. stygius* (IV, 10–13), *S.* cf. *transitans* (IV, 14), *Trichonodella* cf. *excavata*, *T. inconstans* (IV, 15–16)	NfsZ, 3gg ŚfsZ, 1gg			*Lingula* sp.	NfsZ, 3gg	Middle Siegenian – Upper Gedinnian	*Monograptus craigensis*, *M. telleri*, *N. fanicus*, *M. falcarius*, *M. aequabilis notoaequabilis*, *M. hercynicus hercynicus*, *M. hercynicus subhercynicus*, *M.* cf. *praehercynicus*, *M. aequabilis aequabilis*, *M. microdon microdon*	NfsZ, 3gg, 2gg ŚfsZ, 1gg
Upper Graptolite Shales	Black siliceous shales (3.2 m thick)								*Monograptus uniformis uniformis*, *M.* cf. *praehercynicus*, *M. hercynicus subhercynicus*, *M. uniformis parangustidens*, *M. uniformis angustidens*, *M. microdon microdon*, *M. aequabilis aequabilis*, *Linograptus posthumus*	NfsZ, 3gg ŚfsZ, 1gg
Middle Zdanów Shales – Upper Member	Alternating layers of light-gray and black clay shales a few mm thick (0.9 m thick)									
Middle Zdanów Shales – Upper Member	Gray-brown and gray-green clay shales with intercalations of siltstones with phosphatic nodules and diabase 0,5 m thick (3.0 m thick)	*Hindeodella equidentata*, *H. priscilla*, *Panderodus* cf. *unicostatus unicostatus* (III, 1), *Spathognathodus inclinatus wurmi*, *Hindeodella equidentata*, *H. priscilla*, *Neoprioniodus* cf. *excavatus*, *Spathognathodus inclinatus wurmi*, *S.* ex gr. *steinhornensis* Forms of the genus *Icriodus* of the *Icriodus woschmidti woschmidti* – *I. w. postwoschmidti* (I, 4–9) groups and *Hindeodella priscilla*, *Neoprioniodus* cf. *bicurvatus*, *Ozarkodina denckmanni* (II, 8), *Panderodus* cf. *unicostatus unicostatus* (II, 12), *Spathognathodus* ex gr. *inclinatus*, *S.* cf. *steinhornensis remscheidensis*	NfsZ, 2śz ŚfsZ, 1śz ŚfsZ, 1śz			*Grammysia* sp., *Lingula* sp., *Orbiculoidea* sp.	ŚfsZ, 1śz NfsZ, 2śz	Interval with *Icriodus woschmidti woschmidti*, *I. w. postwoschmidti* fauna – lowermost Gedinnian – uppermost Silurian		
Middle Zdanów Shales – Lower Member	Brown-yellow and yellow clay shales and siltstones (2.0 m thick)	*Drepanodus* sp., *Hindeodella equidentata*, *H. priscilla*, *Neoprioniodus bicurvatus*, *Spathognathodus* ex gr. *steinhornensis*, *S. steinhornensis eosteinhornensis* (IV, 7)	ŚfsZ, 1śz	Imprint of rhabdosome fragment (about 6 thecas) of the *Monograptus* sp. type, Late Silurian graptolites	ŚfsZ, 1śz			uppermost Silurian – *eosteinhornensis* zone		
Middle Graptolite Shales	Black siliceous shales (2.4 m thick)	*Hindeodella equidentata*, *Ozarkodina media*, *Plectospathodus* sp. (III, 6), *Trichonodella* cf. *inconstans*	GfsZ, śg	Numerous specimens, mainly of the genera *Pristiograptus* and *Linograptus*. Some specimens display features suggesting that they most probably belong to the "ultimus" group, and others – the "dubius" and "transgrediens" groups	GfsZ, śg			Upper Silurian		
Lower Zdanów Shales	Packets of light-brown, brown-yellow and yellow clay and silty shales about 0.5 m thick, separated by layers of brown graptolite-bearing clay shales a few cm thick (>9.2 m thick)	*Hindeodella equidentata*, *Ozarkodina media*, *Plectospathodus* sp. (III, 6), *Trichonodella* cf. *inconstans*	GfsZ, dz					Upper Silurian		

* Number of plate and figure; tectonic unit after J. Oberc

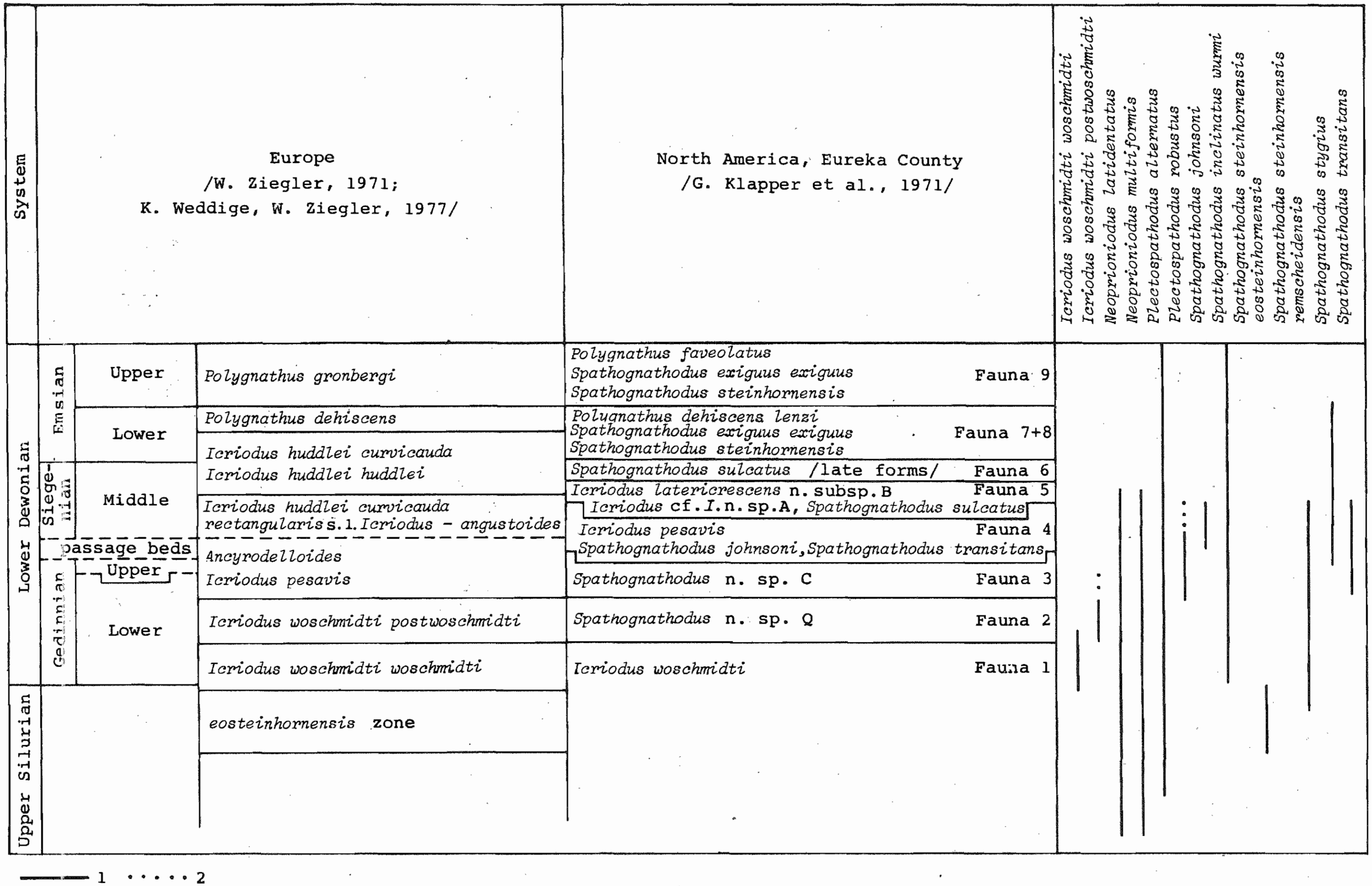


Fig. 2. Stratigraphic range of species evidencing uppermost Silurian and Lower Devonian strata at Zdanów, after: G. Bischoff, D. Sannemann (1958), E.C. Druce (1970), G. Klapper (1969, 1977), A.G. Link, E.C. Druce (1972), A.E.H. Pedder et al. (1970), C.J. Mehrtens, S.G. Barnett (1976), R. Schulze (1968), O.H. Walliser (1964), Catalogue of Conodonts, t. I and II (1973, 1975)

Zasięg stratygraficzny gatunków dokumentujących utwory najwyższego syluru i dolnego dewonu ze Zdanowa według: G. Bischoff, D. Sannemann (1958), E.C. Druce (1970), G. Klapper (1969, 1977), A.G. Link, E.C. Druce (1972), A.E.H. Pedder i in. (1970), C.J. Mehrtens, S.G. Barnett (1976), R. Schulze (1968), C.H. Walliser (1964), Catalogue of Conodonts, t. I i II (1973, 1975)

1 – controlled range, 2 – inferred range

1 – zasięgi stwierdzone, 2 – zasięgi przypuszczalne

The genus *Neoprioniodus* also comprises some species important for analysis of age of Lower Devonian rocks. The species *N. latidentatus* Walliser, 1964 and *N. multiformis* Walliser, 1964, unknown from rocks younger than the Middle Siegenian (A.G. Link, E.C. Druce, 1972), indicate the Middle Siegenian as the upper boundary of the age of rocks in which they were recorded.

The above given premises were taken into account in using the recorded conodonts to date uppermost Silurian and Lower Devonian rocks of the Zdanów section (Fig. 2). The recorded species occur in assemblages, a part of which may be described using the apparatus taxonomy. However, the number of specimens is too small for statistical treatment of the material so the taxonomy of forms has been used.

THE CHARACTERISTICS OF CONODONTS RECORDED IN THE ZDANÓW SECTION

Conodonts are rather innumerous in Lower Devonian rocks of the Zdanów section. Here predominate branching forms and those of the group of single cones. There were identified representatives of the genera *Drepanodus*, *Hindeodella*, *Icriodus*, *Ligonodina*, *Neoprioniodus*, *Ozarkodina*, *Panderodus*, *Plectospathodus*, *Spathognathodus* and *Trichonodella* (Table 1).

The identification was made on the basis of imprints so it was impossible to take into account all the diagnostic features of a given species. That is why the majority of species are identified to the range of "conformis".

Imprints of conodonts were found on the surfaces of bedding and some of them were obtained in result of etching light-coloured siliceous-clay shales with hydrofluoric acid. The method failed to give complete specimens. Some imprints have brown coating of Fe oxides and, in single cases, there are preserved relicts of phosphatic matter, from which conodonts are made (Pl. II, Figs. 9, 11).

The photos (Pls. I–IV) are of limited value as they fail to show some details discernible on original specimens.

THE STRATIGRAPHIC EVIDENCE AND SUCCESSION OF STRATA IN THE STRATIGRAPHIC SECTION

Conodonts found in 49 samples are listed in Table 2. On the basis of conodonts and with reference to the results of studies on graptolites, the strata were dated and their succession in the stratigraphic section was established (Table 2).

In the Zdanów exposure, strata of a given stratigraphic unit reappear in different tectonic units (Fig. 3). In order to facilitate comparisons of the section of that exposure with the image given by L. Teller and E. Kurałowicz (1977, Fig. 2), the length of the exposure was measured from the south northwards, placing the 72nd meter in the place wherefrom identical value has been reported by L. Teller (L. Teller, E. Kurałowicz, 1977). It should be noted here that differences in the horizontal scale in the section of the exposure are related to mapping of its walls, including bends displaying distinct geological details, which resulted in extension of individual sections in relation to the asphalt road along which the total length of the exposure was measured.

In individual parts of the Zdanów section, some conodont and graptolite horizons are missing. The strata are here developed in deep-water marine facies so the gaps cannot be interpreted as stratigraphic but rather as a result of tectonic squeezings.

The tectonic squeezings are here shown in the section (Fig. 3). Attention should be paid to a packet of alternating layers of light-gray and black clay shales, 0.9 m thick (201 – 202 m), presumably representing top part of the Upper Member of the Middle Zdanów Shales. The packet should reappear in other parts of the section but it is missing there in result of that tectonic process.

A special attention should be paid to a zone of tectonic loosening (137 – 140 m). According to L. Teller and E. Kurałowicz (1977), rocks of the uppermost Silurian (the *transgrediens* zone) here contact with shales of the *uniformis* zone, Lower Gedinnian. It follows that the authors assume a continuous transition from the Silurian to Devonian within black siliceous shales (Upper Graptolite Shales). However, the conodont data obtained for light-coloured clay-siltstone shales, assigned to the uppermost Silurian and lowermost Gedinnian (the *eosteinhornensis* zone with Late Silurian graptolite; interval with *Icriodus woschmidti woschmidti* – *I.w. postwoschmidti* fauna), show that the black siliceous shales adjoining the shales of the *uniformis* zone in the south do not belong to the Upper Graptolite Shales. Originally, that is before the tectonic disturbances, the black shales were separated from those of the *uniformis* zone by the above mentioned light-coloured clay-siltstone shales which were completely removed by later tectonic translocations from that place. Black siliceous shales cropping out in the interval 134 – 140 m may, therefore be assigned to the Middle Graptolite Shales. In the interval 134 – 136 m, the shales (samples 4/77 and 5/77) mainly yield graptolites of the genera *Pristiograptus* and *Linograptus*. Thecas of some specimens seem to be typical of the *transgrediens* group, and others – of the *ultimus* and *dubius* groups. It follows that the strata exposed here do not belong to the uppermost graptolite zone of the Upper Silurian. In the light of secondary lack of light-coloured clay-siltstone shales beneath black shales of the *uniformis* zone in the Zdanów section, graptolite fauna of the interval 137 – 140 m requires a thorough analysis. Such analysis would contribute to the question of detailed correlation of the Zdanów section with those of the Saxony and Carnic Alps, developed in shaly facies only and in which the Silurian/ /Devonian boundary passes within the Upper Graptolite Shales (H. Jaeger, 1976, 1977*b*). The question of paleontological criteria of the Silurian/Devonian boundary also reappears here. The results of studies on conodonts imply that we should not expect the continuity of the *transgrediens* and *uniformis* zones in black siliceous shales. The Silurian/Devonian boundary should not be passing within the Upper Graptolite Shales but within the Upper Member of the Middle Zdanów Shales.

The separation of the Middle Zdanów Shales in the studied section followed the interpretation of black graptolite shales from the interval 134 – 140 m as the Middle Graptolite Shales. A more detailed characteristics of this stratigraphic unit is out of scope of this paper. It should be only noted here that the Middle Graptolite Shales have not been found in any other part of the section as the Lower Zdanów Shales are also missing here.

In the Upper Graptolite Shales, exposed in three different horizons (Fig. 3 – 1gg, 2gg, 3gg), there were recorded conodont species, the stratigraphic ranges of which do not extend above the *Monograptus hercynicus* zone. The representatives of the genus *Polygnathus*, quantitatively predominating in conodont assemblages of the Emsian, are also missing here. Therefore, the present authors cannot accept the viewpoint of E. Kurałowicz (1976; L. Teller, E. Kurałowicz, 1977), who assigned the strata to the graptolite *hercynicus*, *falcarius*, *fanicus* and *craigensis* zones and stated that sedimentation of the Upper Graptolite Shales was still continuing in the Emsian. The point of view of E. Kurałowicz (1976; L. Teller, E. Kurałowicz, 1977) has been questioned by H. Jaeger (1978), according to whom the graptolites identified by E. Kuraɫowicz as *Monograptus falcarius*, *M. fanicus* and *M. craigensis* undoubtedly belong to *M. hercynicus* and there are no indications for the presence of graptolites typical of zones younger than the hercynicus zone at Zdanów. *Monograptus hercynicus* has been reported from that locality for the first time by L. Teller (1960) and subsequently by H. Jaeger (1964). The latter author has also reported the presence of the species *M. praehercynicus* here (H. Jaeger, 1959).

THE TECTONICS OF SILURIAN AND LOWER DEVONIAN STRATA OF THE ZDANÓW SECTION

In discussing evolution of views on the tectonics of Lower and Middle Paleozoic strata cropping out by the road at Zdanów, the following statements should be mentioned:

1. A normal sequence is exposed here; the Zdanów Beds (Herzogswalder Schichten) are older than the Silurian (Ordovician), overlaying them (E. Bederke, 1924).
2. The Zdanów Shales are younger than the Graptolite Shales, overlaying them in reversed sequence; graptolite shales cropping out in northern part of the exposure are coeval with those from the south (J. Oberc, 1953).
3. According to the interpretation of the tectonics of northern part of the section, given by E. Kuraɫowicz (L. Teller, E. Kuraɫowicz, 1977), the bulk of the Zdanów Shales represent a core part of syncline. The syncline is "northwards inclined" and its limbs are built of graptolite shales displayed by northern and central parts of the section. A narrow horizon of graptolite shales, separating the Zdanów Shales, would represent a syncline within syncline.
4. According to J. Oberc (1977), it is possible to differentiate here the Lower (southern) and Upper (northern) Graptolite Shales, separated by the Lower Zdanów Shales. The whole Zdanów section north of sandstones of the Jodɫownik Beds has the character of reversed northern limb of false Zdanów syncline.

A detailed profilling of the Zdanów outcrops and the dating of the Lower and two members of the Middle Zdanów Shales on the basis of conodonts (M. Chorowska, in this paper) as well as the Middle (as interpreted here) and Upper Graptolite Shales (L. Malinowska, 1955; L. Teller, 1960; H. Jaeger, 1959, 1964; E. Kuraɫowicz, 1976; L. Teller, E. Kuraɫowicz, 1977; M. Chorowska, in this paper) made it possible to reinterpret the tectonics of strata exposed here.

Two features of the Zdanów section are important for the reinterpretation:

1. Younger stratigraphic horizons are here overlain by the older, which is typical of reversed fold limbs; in this part of the Bardo structure, the vergence is southern and dips are mostly of medium-value, southward (J. Oberc, 1957).
2. The Upper Graptolite Shales appear three times in the section, and the Middle Zdanów Shales – two times, evidencing secondary folding of the reversed series[1]. Core of this structure is situated in southern part of the section.

S o u t h e r n p a r t o f t h e s e c t i o n. The core of this structure is built of the Jodɫownik Beds (J. Oberc, 1968). J. Oberc (1957, 1977) assigned the strata to the Silurian with reference to the lack of the oldest graptolite zones (L. Malinowska, 1955). At present, it appears that sandstones are intercalated by thick layers

[1] J. Oberc (1957) found a syncline built of Lower Carboniferous rocks at the western extension of the false Zdanów syncline. If the two synclines have been formed at the same time, it would follow that the overturning of rock series of the false Zdanów syncline has taken place earlier, that is in the earliest phase of folding of the Bardo structure. It cast some light on the style of pre-Early Carboniferous folding in this area and the origin of all the false Zdanów synclines separated in this paper may be related to post-Early Carboniferous movements (Sudetic phase).

of dark-gray clay shales, turning olive in result of weathering, which evidence that sedimentation was continuing here for a long time. The strata, possibly with the exception of top parts of the Jodłownik Beds, presumably belong to the Ordovician (F. Dahlgrün, L. Finckh, 1924; L. Teller, 1960).

The syncline developed in the Jodłownik Beds is clearly asymmetric. The zone of southward dips is markedly reduced and secondary folds are found in its northern limb whereas the southern limb, with northward dips, is small. Sandstone layers are boudinated and rotated in the plastic shales.

Lower Silurian lydites are plunging beneath the Jodłownik Beds in the south and north. Further to the north, the Lower Graptolite Shales, Lower Zdanów Shales, Middle Graptolite Shales (Middle Zdanów Shales are here tectonically squeezed out) and Upper Graptolite Shales successively dip beneath the former. This part of the section makes a classic image of false syncline (a syncline within a reversed series), previously named as the false Zdanów syncline (J. Oberc, 1957) and here renamed as the major false Zdanów syncline by J. Oberc.

The northern part of the section begins as the zone of intense small-scale folds in the first zone of the Upper Graptolite Shales (counting from the south). Because of reappearance the coeval stratigraphic horizons, J. Oberc proposes their numeration increasing northwards. In order to avoid misunderstanding, the proposed numeration comprises the zone of the Lower Zdanów Shales, Middle Graptolite Shales, Middle Zdanów Shales and also the first zone of the Upper Graptolite Shales belonging to the major false Zdanów syncline. The numeration is as follows:

	symbols used in the section
zone of the Lower Zdanów Shales	dz
zone of the Middle Graptolite Shales	śg
first zone of the Upper Graptolite Shales	1gg
first zone of the Middle Zdanów Shales	1śz
second zone of the Upper Graptolite Shales	2gg
second zone of the Middle Zdanów Shales	2śz
third zone of the Upper Graptolite Shales	3gg

The above listed zones form the following tectonic units, shown in Fig. 3:

dz + śg + southern part of 1gg form the major false Zdanów syncline – GfsZ;

1śz – middle false Zdanów syncline – ŚfsZ; the Upper Graptolite Shales of the zones 1gg and 2gg occur in limbs of that syncline;

2śz – northern false Zdanów syncline – NfsZ; the Upper Graptolite Shales of the zones 2gg and 3gg occur in limbs of that syncline.

The false synclines represent anticlinal turns with southward dip. Figure 1 presents interpretation of the structure and only additional comments are given here by J. Oberc.

The zone 1gg, adjoining the middle false Zdanów syncline in the south, displays asymmetry in structure and is widening downwards. This example indicates that we are dealing here with an anticline with northward (backward) vergence and reversed northern limb or a false syncline with southern vergence, predominating in this part of the Mountains. However, the form contacts older strata both in the north (Middle Zdanów Shales) and south (Middle Graptolite Shales). In northern part of the zone 1gg, graptolite shales display very numerous small-scale folds. Orientation of axial planes of these folds suggests that this is a reversed limb with northern vergence. The folds, shown in the cross-section, are built of rocks of the younger, *Monograptus hercynicus* horizon at the direct contact of the unit ŚfsZ in the north, and of the *M. uniformis* horizon at the southern contact. The small-scale folds point to a normal limb with northward vergence. In the case of southern vergence, the interpretation of both limbs would be an opposite.

The zone 2gg is clearly asymmetric. It is narrowing downwards due to shear by tectonic plane of secondary folds marked in the south and, therefore, asymmetric.

The zone 2śz, squeezed in between two zones of the Upper Graptolite Shales, similarly as the above mentioned zone of the Middle Zdanów Shales, is named the northern false Zdanów syncline. This unit also displays secondary folds.

The secondary folds are also displayed by the zone 3gg. Rocks of the *Monograptus uniformis* zone occur in a synform in northern part of the structure so it would be more appropriate to treat it as a false anticline (providing that vergence is southwards).

The above interpretation of the tectonics is the first widely based on paleontological record. The existing graptolite record is here supplemented with the conodonts, which makes it possible to evaluate tectonic reductions in zones of loosening or overthrusting. The reductions as well as the points where major paleontological horizons were recorded are shown in the section (Fig. 3).

FACIES AND PALEOGEOGRAPHIC CONCLUSIONS

The Zdanów section displaying Silurian and Lower Devonian rocks may, as it was stated above, be subdivided into the Lower, Middle and Upper Graptolite Shales separated by light-coloured clay, partly siltstone shales. These fine clastic, mostly pelitic deposits originated in deep marine basin. This is supported by large content of radiolarians, found in shales throughout the studied series, as well as small size of very rare bivalves and brachiopods (shells attaining 1 to 2 mm in size).

The Zdanów section closely resembles sections of exclusively shaly Silurian and Lower Devonian from Saxony and Carnic Alps (H. Jaeger, 1976, 1977*b*). According to H. Jaeger (1976, p. 279), the latter represent extremely euxine sedimentation in the deepest, most internal parts of the Paleotethys. Light-coloured shales separating the Lower and Upper Graptolite Shales series are the equivalents of ochre limestones (Ockerkalk) which, according to that author, do not represent euxinic deposits but rather those originating at large depths in weakly-aerated water. E. Tomczykowa and H. Tomczyk (1978) explain the change in sedimentation and resulting origin of ochre limestones and their equivalents (green clays) by a change in bathymetry, related to movements of the Caledonian Cracow phase.

Approximate thickness of Silurian and Lower Devonian rocks in the Zdanów section is at least 53.2 m (lydites – 7.6 m, Lower Graptolite Shales – 22.0 m, Lower Zdanów Shales – over 9.2 m, Middle Graptolite Shales – 2.4 m, Middle Zdanów Shales, lower member – 2.0 m, upper member – 3.0 m, and Upper Graptolite Shales – over 7.0 m).

Deep-water marine rocks of the Zdanów section were assigned by H. Jaeger (1977*b*) to the Bavarian facies. The marked significance of this facies in the Saxothuringian-Lugian zone was emphasized by that author (H. Jaeger, 1963, 1964) in early sixties, that is before the presence of deep-water Middle and Upper Devonian rocks was evidenced in the Góry Kaczawskie and Góry Bardzkie Mts. The presence of rocks of that type in eastern part of the Góry Kaczawskie Mts was found by Z. Urbanek (1974, 1978) and in northern part of the Bardo structure – by J. Haydukiewicz (1973, 1978). Upper Devonian siliceous shales with flintstone intercalations and paleontological record, known from western Fore-Sudetic area, especially the Jelenin IG 1/I borehole column, presumably also belong to the Bavarian facies (M. Chorowska, 1976, 1978). In that facies, the Silurian and the whole Devonian are often represented by shaly series without any limestone layers. L. Greiling (1966) described Silurian-Devonian shaly series from the Frankenwald and H. Brause (1968) – Lower, Middle and Upper Devonian clay-siliceous shales and flintstones from the Lusatia.

The Silurian-Lower Devonian section of Zdanów contains basic tuffites and diabases. Tuffite intercalations were found in the Wenlockian (L. Malinowska, 1955; L. Teller, E. Kurałowicz, 1977) and diabase – in the uppermost layers of the Lower Gedinnian (Fig. 3).

Oddział Dolnośląski
Instytutu Geologicznego
Wrocław, al. Jaworowa 19
Instytut Nauk Geologicznych
Uniwersytetu Wrocławskiego
Wrocław, ul. Cybulskiego 30
Received: 12.XII.1978

REFERENCES

BEDERKE E. (1924) – Das Devon in Schlesien und das Alter der Sudetenfaltung. Forschr. Geol. Paläeont., 7. Berlin.

BISCHOFF G., SANNEMANN D. (1958) – Unterdevonische Conodonten aus dem Frankenwald. Notizbl. Hess. L.–A. Bodenforsch., **86**, p. 87–110. Wiesbaden.

BRAUSE H. (1968) – Das verdecte Paläozoikum der Lausitz und seine regionale Stellung. Abh. Deutsch. Akad. Wiss., Kl. Bergbau, Hüttenwesen Montangcol, **1**, Berlin.

CARLS P. (1969) – Die Conodonten des tieferen Unter–Devons der Guadarrama (Mittel–Spanien) und die Stellung des Grenzbereiches Lochkovium/Pragium nach der rheinischen Gliederung. Senckenbergiana leth., **50**, p. 303–354. Frankfurt a.M.

CATALOGUE OF CONODONTS, t. I (1973) – Editor W. Ziegler. Stuttgart.

CATALOGUE OF CONODONTS, t. II (1975) – Editor W. Ziegler. Stuttgart.

CHOROWSKA M. (1976) – Górnodewońskie utwory krzemionkowe w otworze wiertniczym Jelenin IG 1/I. Kwart. Geol., **20**, p. 425–426, nr 2. Warszawa.

CHOROWSKA M. (1978) – Dewon zachodniej części obszaru przedsudeckiego. Przew. L Zjazdu Pol. Tow. Geol., p. 108–113. Warszawa.

DAHLGRÜN F., FINCKH L. (1924) – Ein Silurprofil aus dem Warthauer Schiefergebirge. Jb. Preuss. Geol. L.–A., **7**, p. 281–289. Berlin.

DATHE E. (1904) – Geologische Karte von Preussen und benachbarten deutschen Ländern, 1:25 000. Blatt Neurode und Erläuterungen. Berlin.

DRUCE E.C. (1970) – Conodonts from the Garra Formation (Lower Devonian), New South Wales. Bull. Bur. Min. Res. Geol. Geoph., **116**, p. 29–52. Canberra.

FINCKH L. (1932) – Geologische Karte von Preussen und benachbarten deutschen Ländern, 1:25 000. Blatt Frankenstein. Berlin.

GREILING L. (1966) – Sedimentation und Tektonik im Paläozoikum des Frankenwaldes. Erlanger Geol. Abh., **63**. Erlangen.

HAYDUKIEWICZ J. (1973) – Upper Devonian Conodonts from Mikołajów Slates, Bardo Mts. Sudetes. Bull. Acad. Pol. Sc. Ser. Sc. Terre, **21**, p. 233–236, nr 3/4. Warszawa.

HAYDUKIEWICZ J. (1978) – Stratygrafia serii żdanowskiej w północnej części struktury bardzkiej na podstawie konodontów. Bibl. Inst. Nauk. Geol. U Wr. Wrocław.

JAEGER H. (1959) – Graptolithen und Stratigraphie des jüngsten Thüringer Silurs. Abh. Deutsch. Akad. Wiss. Kl. Chem., Geol. Biol., **2**. Berlin.

JAEGER H. (1963) – Monograptus hercynicus in den Westsudeten und das Alter der Westsudeten–Hauptfaltung. Ber. Geol. Ges., **8**, p. 649–652, nr 5/6. Berlin.

JAEGER H. (1964) – Monograptus hercynicus in den Westsudeten und das Alter der Westsudeten–Hauptfaltung, Teil. I. Geologie, **13**, p. 249–277, nr 3. Berlin.

JAEGER H. (1976) – Das Silur und Unterdevon vom thüringischen Typ in Sardinien und seine regionalgeologische Bedeutung. Nova Acta Leopoldina. Neue Folge, **45**, p. 263–299, nr 224. Halle.

JAEGER H. (1977*a*) – Graptolites. In: The Silurian–Devonian Boundary. IUGS Series A, **5**, p. 337–345. Stuttgart.

JAEGER H. (1977*b*) – Das Silur/Lochkov – Profil im Frankenberger Zwischengebirge (Sachsen). Freiberger Forschungshefte, C, **326**, p. 45–59. Berlin.

JAEGER H. (1978) – Late Graptoloid Faunas and the Problem of Graptoloid Extinction. Acta Paleont. Pol., **23**, nr 4. Warszawa.

KLAPPER G. (1969) – Lower Devonian Conodont Sequence, Royal Creek, Jukon Territory and Devon Island, Canada. A.R. Ormiston–Section on Devon Island Stratigraphy. J. Paleont., **43**, nr 1. Tulsa.

KLAPPER G. (1977) – Conodonts. In: The Silurian–Devonian Boundary. IUGS Series A, **5**, p. 318–319. Stuttgart.

KLAPPER G., JOHNSON D.B. (1977) – Lower and Middle Devonian Conodont Sequence in Central Nevada. In: Western North America: Devonian, ed. A.M. Murphy, W.B.N. Berry, C.A. Sandberg. University of California, Riv. Comp. Mus. Contr., **4**, p. 33–54. Riverside.

KLAPPER G., SANDBERG Ch.A., COLLINSON Ch., HUDDLE J.W., ORR R.W., RICKARD L.V., SCHUMACHER D., SEDDON G., UYENO T.T. (1971) – North American Devonian Conodont Biostratigraphy. Symposium on Conodont Biostratigraphy. Geol. Soc. Amer. Memoir, **127**, p. 285–316.

KRUG VON NIDDA O.L. (1855) – Graptolithen bei Herzogswalde (Brief an Herrn von Carnall) Z. Dtsch. Geol. Ges., **5**, p. 671–672. Berlin.

KURAŁOWICZ E. (1976) – Lower Devonian Graptolite Fauna from the Bardo Mts (Sudetes). Acta Geol. Pol., **26**, p. 485–488, nr 4. Warszawa.

MC LAREN D.J. (1977) – The Silurian–Devonian Boundary Committee. A Final Raport. IUGS Series A, **5**. Stuttgart.

LINK A.G., DRUCE E.C. (1972) – Ludlovian and Gedinnian Conodont Stratigraphy of the Jass Basin, New South Wales. Bull. Dep. Nat. Develop. Bur. Min. Res. Geol. Geoph., **134**, p. 1–136. Canberra.

MALINOWSKA L. (1955) – Stratygrafia gotlandu Gór Bardzkich. Biul. Inst. Geol., **95**, p. 5–88. Warszawa.

MEHRTENS C.J., BARNETT S.G. (1976) – Conodont Subspecies from the Upper Silurian – Lower Devonian of Czechoslovakia. Micropaleontology., **22**, p. 491–500, nr 4. New York.

OBERC J. (1953) – Problematyka geologiczna Gór Bardzkich. Rocz. Pol. Tow. Geol., **21**, p. 415–451, nr 4. Kraków.

OBERC J. (1957) – Region Gór Bardzkich (Sudety). Wyd. Geol. Warszawa.

OBERC J. (1968) – Ordowik, Góry Bardzkie i okolice Kłodzka. W: Budowa geologiczna Polski, Stratygrafia, cz. 1, p. 214. Inst. Geol. Warszawa.

OBERC J. (1977) – The Góry Bardzkie. In: Geology of Poland, 4, Tectonics. Inst. Geol. Warszawa.

PEDDER A.E.H., JACKSON J.H., PHILIP G.M. (1970) – Lower Devonian Biostratigraphy in the Wee Jasper Region of New South Wales. J. Paleont., **44**, p. 206–251, nr 2. Menasha.

SCHULZE R. (1968) – Die Conodonten aus dem Paläozoikum der mittleren Karawanken (Seeberggebiet). Neues Jb. Geol. Paläont. Abh., **130**, p. 133–245, nr 2. Stuttgart.

TELLER L. (1960) – Poziom *Monograptus hercynicus* z warstw żdanowskich w Górach Bardzkich. Acta. Geol. Pol., **10**, p. 325–338, nr 3. Warszawa.

TELLER L., KURAŁOWICZ E. (1977) – Field Excursion Guide to the Bardo Range (Central Sudetes), September 17th, 1977, First International Conference. Recent Advances in Graptolite Research. Warszawa.

TOMCZYKOWA E., TOMCZYK H. (1978) – Sylur Polski jako wskaźnik zróżnicowania szelfu Fennosarmacji i rozwoju oceanu Prototetydy. Prz. Geol., **26**, p. 14–22, nr 1. Warszawa.

URBANEK Z. (1974) – On the Occurrence of Upper Devonian Rocks in the Epimetamorphic Complex of the Kaczawa Mts (Western Sudetes). Bull. Acad. Pol. Sc. Ser. Sc. Terre, **22**, p. 167–171, nr 3/4. Warszawa.

URBANEK Z. (1978) – The Significance of Devonian Conodont Faunas for the Stratigraphy of Epimetamorphic Rocks of the Northern Part of the Góry Kaczawskie. Geol. Sudetica, **13**, p. 7–26, nr 1. Wrocław.

WALLISER O.H. (1964) – Conodonten des Silurs. Abh. Hess. L.–A. Bodenforsch., **41**, p. 1–106. Wiesbaden.

WEDDIGE K., ZIEGLER W. (1977) – Correlation of Lower/Middle Devonian Boundary Beds. Newsl. Stratigraph., **6**(**2**), p. 67–84. Berlin. Stuttgart.

ZIEGLER W. (1971) – Conodont Stratigraphy of the European Devonian. Geol. Soc. Amer. Memoir, **127**, p. 227–284.

Maria CHOROWSKA, Józef OBERC

STRATYGRAFIA I TEKTONIKA NAJWYŻSZEGO SYLURU I DOLNEGO DEWONU W PROFILU ZDANOWA NA PODSTAWIE KONODONTÓW (SUDETY, GÓRY BARDZKIE)

Streszczenie

Przedstawiono stratygrafię i tektonikę najwyższego syluru i dolnego dewonu na podstawie konodontów, z wykorzystaniem dotychczasowych wyników badań graptolitów (L. Malinowska, 1955; L. Teller, 1960; H. Jaeger, 1964; E. Kurałowicz, 1976; L. Teller, E. Kurałowicz, 1977) oraz nieopublikowanych oznaczeń graptolitów (H. Tomczyk).

Jako podstawę stratygrafii analizowanych utworów przyjęto, że: 1 – pierwsze wystąpienie i zarazem dolna granica *Icriodus woschmidti woschmidti* przypada nieco poniżej spągu poziomu *uniformis* (G. Klapper, 1977), który wyznacza dolną granicę systemu dewońskiego (D.J. Mc Laren, 1977); 2 – *Icriodus woschmidti woschmidti* charakteryzuje najniższy żedyn; wyższą część żedynu dolnego określa *I. w. postwoschmidti*.

Z powodu braku przedstawicieli rodzaju *Icriodus*, wyznaczającego młodsze poziomy żedynu i zigenu (W. Ziegler, 1971), wnioski stratygraficzne oparto na analizie wiekowego zasięgu konodontów z rodzajów *Spathognathodus*, *Plectospathodus* i *Neoprioniodus* (fig. 2), w tym głównie: *S. steinhornensis eosteinhornensis*, *S. steinhornensis remscheidensis*, *S. asymmetricus*, *S. transitans*, *S. johnsoni*, *S.* cf. *johnsoni*, *S. stygius*, *S. inclinatus wurmi*, *Plectospathodus robustus*, *P. alternatus*, *Neoprioniodus latidentatus* i *N. multiformis*. Gatunki te występują w Zdanowie w zespołach, które można by częściowo opisywać według taksonomii aparatów. Z uwagi na małą liczbę okazów, co utrudnia ujęcie statystyczne badanego materiału, zastosowano taksonomię form.

Określanie fauny z odcisków uniemożliwiło rozpoznanie wszystkich cech diagnostycznych. Stąd w większości przypadków gatunki są zdefiniowane w zakresie „conformis". Tablice I–IV przedstawiają wartość orientacyjną, gdyż częściowo nie oddają szczegółów widocznych na odciskach.

W proflu Zdanowa oprócz wyróżnionych dotychczas górnych łupków graptolitowych oraz dolnych łupków zdanowskich (J. Oberc, 1977) wydzielono środkowe łupki graptolitowe i w następstwie tego środkowe łupki zdanowskie, które rozdzielono na ogniwo dolne i górne.

Intensywna tektonika doprowadziła do wyciśnięcia niektórych ogniw litostratygraficznych (fig. 3). Na uwagę zasługuje odcinek 137—140 m, w którym między środkowymi a górnymi łupkami graptolitowymi brak dolnych łupków zdanowskich. Na innych odcinkach profilu w obrębie tych ostatnich stwierdzono najwyższy sylur — najniższy żedyn (poziom *eosteinhornensis* z graptolitem górnosylurskim i interwał z fauną *Icriodus woschmidti woschmidti* — *I. w. postwoschmidti*). Nie ma tu zatem ciągłości poziomów *transgrediens* i *uniformis*, którą przyjmuje E. Kurałowicz (L. Teller, E. Kurałowicz, 1977). W świetle wyników badań konodontowych granica sylur/dewon winna przebiegać w obrębie górnego ogniwa środkowych łupków zdanowskich, a nie wśród górnych łupków graptolitowych. Fauna graptolitowa z odcinka 137—140 m zasługuje na dalsze wnikliwe badanie, co dopiero pozwoli w pełni porównać profil Zdanowa z czysto łupkowymi profilami Saksonii i Alp Karnijskich, gdzie granica sylur/dewon przebiega w obrębie górnych łupków graptolitowych (H. Jaeger, 1976, 1977*b*).

Jak wskazują konodonty, górne łupki graptolitowe nie sięgają w tabeli stratygraficznej powyżej graptolitowego poziomu *hercynicus*. Potwierdza to wniosek H. Jaegera (1978), który uznał, że wydzielone przez E. Kurałowicz (1976; L. Teller, E. Kurałowicz, 1977) poziomy *falcarius*, *fanicus* i *craigensis* należą do poziomu *hercynicus*.

Dokładne sprofilowanie odsłonięcia i poznanie wieku poszczególnych ogniw litostratygraficznych (L. Malinowska, 1955; L. Teller, 1960; H. Jaeger, 1959, 1964; E. Kurałowicz, 1976; L. Teller, E. Kurałowicz, 1977; M. Chorowska, praca przekładana) pozwoliło na ujęcie szczegółów tektoniki. W profilu starsze ogniwa zalegają często na młodszych i powtarzają się wielokrotnie, co dowodzi wtórnego przefałdowania serii odwróconej (fig. 3). Wiek przefałdowania wiąże J. Oberc (1957) z fazą sudecką. W okolicy Zdanowa panuje wergencja południowa fałdów.

Studium profilu[1] wymaga jedynie komentarza:

1 — strefa 1gg wraz z drobnymi fałdami ma geometryczne cechy antykliny obalonej ku północy; przy wergencji południowej byłaby to fałszywa antyklina;

2 — strefa 3gg interpretowana jest jako fałszywa synklina; w obrębie małej synformy na północnym krańcu profilu występuje bowiem poziom *uniformis*, najstarszy w ramach górnych łupków graptolitowych.

Głębokomorskie utwory syluru i dolnego dewonu z profilu w Zdanowie wiąże H. Jaeger (1977*b*) z facją bawarską, w której często sylur i cały dewon rozwinięte są jako seria łupkowa bez wapieni. Drobnoklastyczne osady dewonu dolnego i środkowego, odpowiadające tej facji, udokumentowane zostały ostatnio w strukturze bardzkiej (J. Haydukiewicz, 1973, 1978), w Górach Kaczawskich (Z. Urbanek, 1974, 1978) i w zachodniej części obszaru przedsudeckiego (M. Chorowska, 1976, 1978).

Sedymentacji głębokomorskiej w Zdanowie towarzyszy wulkanizm w wenloku (tufity — L. Malinowska, 1955) i w górnej części żedynu dolnego (diabaz).

Мария ХОРОВСКА, Юзеф ОБЕРЦ

СТРАТИГРАФИЯ И ТЕКТОНИКА ВЫСШЕЙ ЧАСТИ СИЛУРА И НИЖНЕГО ДЕВОНА В ПРОФИЛЕ ЗДАНОВА СОГЛАСНО КОНОДОНТАМ (СУДЕТЫ, БАРДЗКИЕ ГОРЫ)

Резюме

В статье приводится стратиграфия и тектоника верхов силура и нижнего девона согласно конодонтам, с учётом имеющихся результатов изучения граптолитов (Л. Малиновска, 1955; Л.

[1] Na profilu 72-gi metr zaznaczono w miejscu, w którym tę odległość podają L. Teller, E. Kurałowicz (1977, fig. 2). Zróżnicowanie skali poziomej jest spowodowane kartowaniem ścian, w tym również załomów z wyraźnymi szczegółami geologicznymi, co wydłuża odcinki względem szosy, wzdłuż której mierzono długość profilu.

Теллер, 1960; H. Jaeger, 1964; Э. Куралович, 1976; Л. Теллер, Э. Куралович, 1977). Кроме того были приняты во внимание выводы неопубликованных определений граптолитов, выполненных Г. Томчиком.

За основу конодонтовой стратификации анализированных пород было принято что: 1 — первое залегание и одновременно нижняя граница фауны *Icriodus woschmidti woschmidti* приходится несколько ниже подошвы горизонта *uniformis* (G. Klapper, 1977), определяющего нижнюю границу девонской системы (D.J. Mc Laren, 1977); 2 — фауна *Icriodus woschmidti woschmidti* характерна для самых низов жедина. Вышележащую часть нижнего жедина определяет фауна *I.w. postwoschmidti*.

Ввиду отсутствия представителей рода *Icriodus*, определяющих младшие горизонты жедина и зигена (W. Ziegler, 1971), автор обосновал свою стратиграфию анализом возрастного распространения конодонт рода *Spathognathodus*, *Plectospathodus*, *Neoprioniodus* (фиг 2). В том числе главным образом видами *Spathognathodus steinhornensis eosteinhornensis*, *S. steinhornensis remscheidensis*, *S. asymmetricus*, *S. transitans*, *S. johnsoni*, *S.* cf. *johnsoni*, *S. stygius*, *S. inclinatus wurmi*, *Plectospathodus robustus*, *P. alternatus*, *Neoprioniodus latidentatus*, *N. multiformis*. Эти виды встречаются в Зданове группами, которые частично можно было бы описать по таксономии формы. Таксономия форм применена ввиду малочисленности экземпляров, что утрудняет статистику изучаемого материала.

Определение фауны по отпечаткам ограничивает возможность установления всех её диагностических черт. Отсюда в большинстве случаев виды определяются *conformis*. Снимки (табл. I—IV) дают общее представление о фауне, так как не показывают деталей, наблюдаемых в отпечатках.

Кроме выделенных до сих пор граптолитовых сланцев и нижних здановских сланцев (Ю. Оберц, 1977), в статье выделены средние граптолитовые сланцы и, как следствие, средние здановские сланцы, которые разделены на два звена — нижнее и верхнее.

Интенсивные тектонические процессы привели к выжиманию некоторых литостратиграфических звеньев (фиг. 3). Обращает на себя внимание отрезок профиля 137—140 м, где между средними и верхними граптолитовыми сланцами отсутствуют нижние здановские сланцы, в пределах которых в других интервалах залегает самый верхний силур — самый нижний жедин (горизонт *eosteinhornensis* с верхнесилурским граптолитом и интервал с фауной *Icriodus woschmidti woschmidti* — *I.w. postwoschmidti*). Таким образом залегание горизонтов *transgrediens* и *uniformis* не отличается непрерывностью, как утверждает Э. Куралович (Л. Теллер, Э. Куралович, 1977). Граница силур-девон, в свете изучения конодонт, должна проходить в пределах верхнего звена средних здановских сланцев, а не в верхних граптолитовых сланцах. Граптолитовая фауна в интервале 137—140 м заслуживает дальнейшего углублённого изучения. Только такой подход позволит полностью сравнивать разрез Зданова с чисто сланцевыми разрезами Саксонии и Карнийских Альп где граница силур-девон проходит в верхних граптолитовых сланцах (H. Jaeger, 1976, 1977*b*).

Верхние граптолитовые сланцы, как видно по конодонтам, в стратиграфической схеме не выходят за пределы граптолитового горизонта *hercynicus*. Что подтверждает вывод H. Jaeger (1978) о принадлежности горизонтов *falcarius*, *fanicus*, *craigensis*, выделенных Э. Куралович (1976, 1977), к горизонту *hercynicus*.

Детальное профилирование обнажения и познание возраста отдельных его литостратиграфических звеньев (Л. Малиновска, 1955; Л. Теллер, 1960; H. Jaeger, 1959, 1964; Э. Куралович, 1976; Л. Теллер, Э. Куралович, 1977; М. Хоровска, настоящая статья) позволяет детально изучить тектонику. Часто случается, что в разрезе старшие по возрасту породы залегают на более молодых и многократно повторяются, что служит доказательством повторной складчатости опрокинутой серии (фиг. 3). Время этой перестройки Ю. Оберц (1957) относит к судетской фазе. В окрестностях Зданова виргация складок направлена в основном на юг.

Объяснения к описанию профиля[1]: 1 — зона 1gg вместе с мелкими складками по своей геометрии сходна с опрокинутой на север антиклиналью; при южной виргации она может быть

[1] На профиле (фиг. 3) 72-ой метр показан в том месте, где это расстояние дают Л. Теллер и Э. Куралович (1977). Дифференцированность горизонтального масштаба является следствием картирования стен, в том числе изгибов с чётко выраженными геологическими деталями, что удлиняет отрезки профиля по сравнению с линией шоссе, вдоль которого измерялась длина профиля.

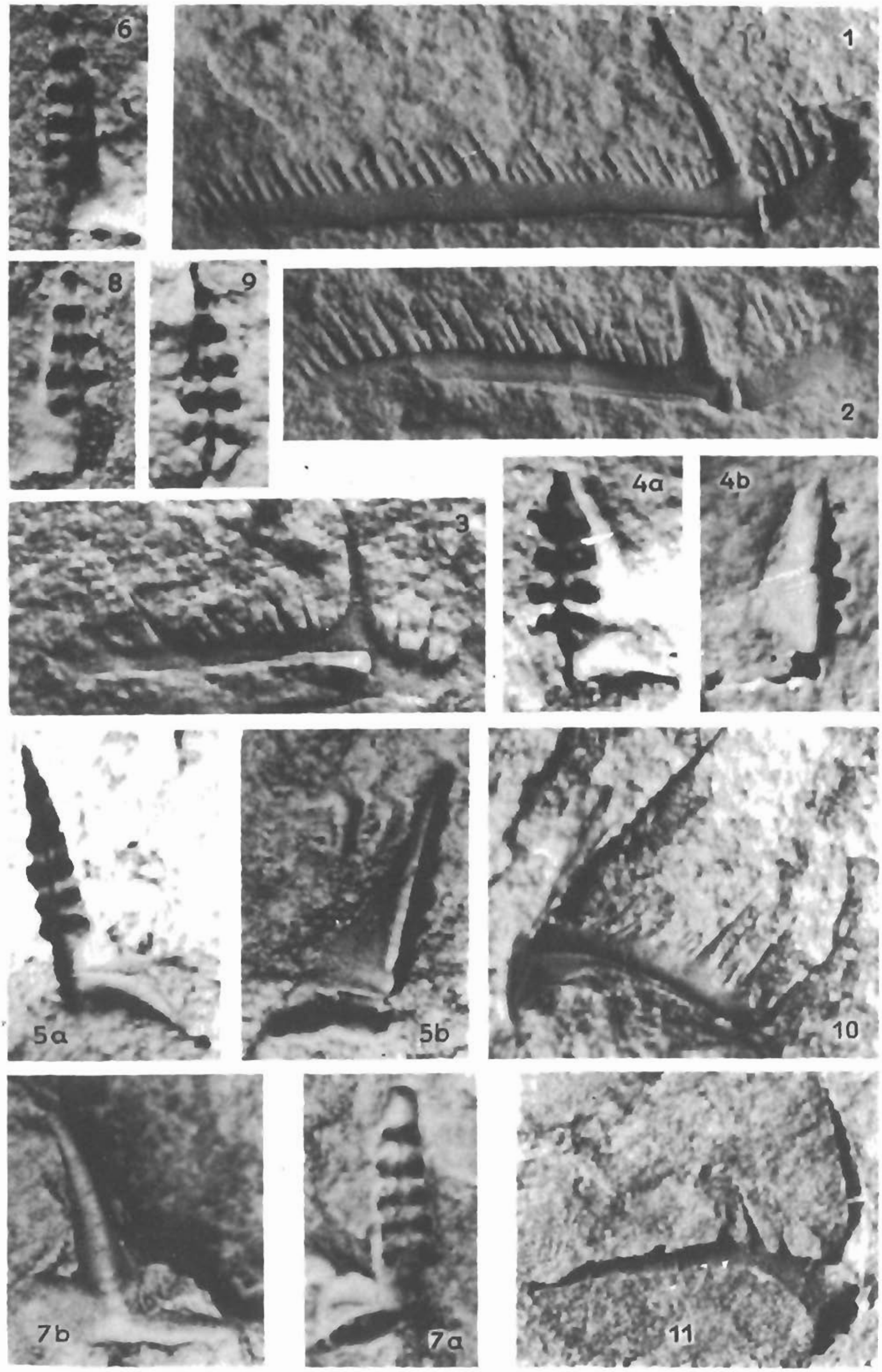
фальшивой антиклиналью; 2 — зона 3gg интерпретируется как фальшивая синклиналь; в пределах малой синформы на северной оконечности профиля залегает горизонт *uniformis*, самый старший в пределах верхних граптолитовых сланцев.

Глубокоморские отложения силура и нижнего девона в профиле Зданова H. Jaeger (1977*b*) относит к баварской фации, в которой зачастую силур и весь девон представлены сланцевой серией без известняков. Мелкообломочные породы нижнего и среднего девона, отвечающие этой фации, отмечены и документально подтверждены в последнее время на бардзкой структуре (Я. Гайдукевич, 1973, 1978), в Качавских горах (З. Урбанек, 1974, 1978) и на западе Предсудетской территории (М. Хоровска, 1976, 1978).

Глубокоморская седиментация в Зданове сопровождалась вулканизмом в венлоке (туфиты — Л. Малиновска, 1955) и в верхах нижнего жедина (диабаз).

PLATE I

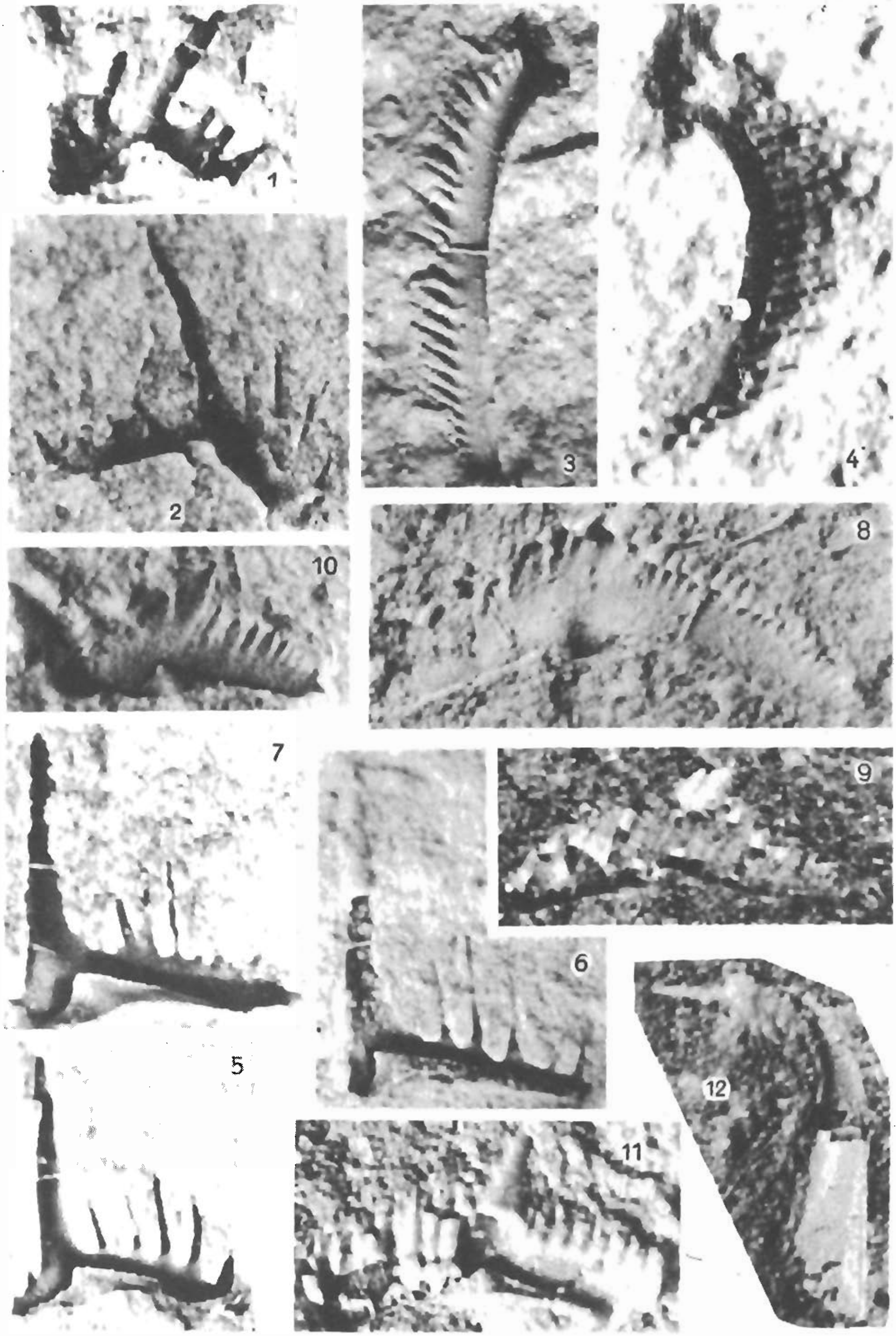
Fig. 1. *Hindeodella equidentata* Rhodes
Sample (próbka) 16/71, specimen (okaz) 5, ODIG/8.1.
Fig. 2. *Hindeodella priscilla* Stauffer
Sample (próbka) 15/71, specimen (okaz) 5, ODIG/8.2
Fig. 3. *Hindeodella* sp.
Sample (próbka) 2/71, specimen (okaz) 5, ODIG/8.3
Fig. 4a, b. *Icriodus* cf. *woschmidti postwoschmidti* Mashkova
Sample (próbka) 10/74, specimen (okaz) 1, ODIG/8.4
Fig. 5a, b. *Icriodus* cf. *woschmidti postwoschmidti* Mashkova
Sample (próbka) 6/74, specimen (okaz) 1, ODIG/8.5
Fig. 6. *Icriodus* cf. *woschmidti postwoschmidti* Mashkova
Sample (próbka) 6/74, specimen (okaz) 3, ODIG/8.6
Fig. 7a, b. *Icriodus* cf. *woschmidti postwoschmidti* Mashkova
Sample (próbka) 6b/74, specimen (okaz) 1, ODIG/8.7
Fig. 8. *Icriodus* sp. ex gr. *woschmidti*
Sample (próbka) 8/74, specimen (okaz) 1, ODIG/8.8
Fig. 9. *Icriodus* sp. ex gr. *woschmidti*
Sample (próbka) 8/74, specimen (okaz) 2, ODIG/8.9
Fig. 10. *Ligonodina* sp. a
Sample (próbka) 13/77, specimen (okaz) 6, ODIG/8.10
Fig. 11. *Ligonodina* sp. a
Sample (próbka) 18/74, specimen (okaz) 1, ODIG/8.11
Enl. × 50; Figs. 1 and 2 enl. × 30
Pow. 50 ×; Fig. 1 i 2 pow. 30 ×



Maria CHOROWSKA, Józef OBERC – The Stratigraphy and Tectonics of the Uppermost Silurian and Lower Devonian of the Zdanów Section (Góry Bardzkie Mts, Sudety Mts) in the Light of Conodont Studies

PLATE II

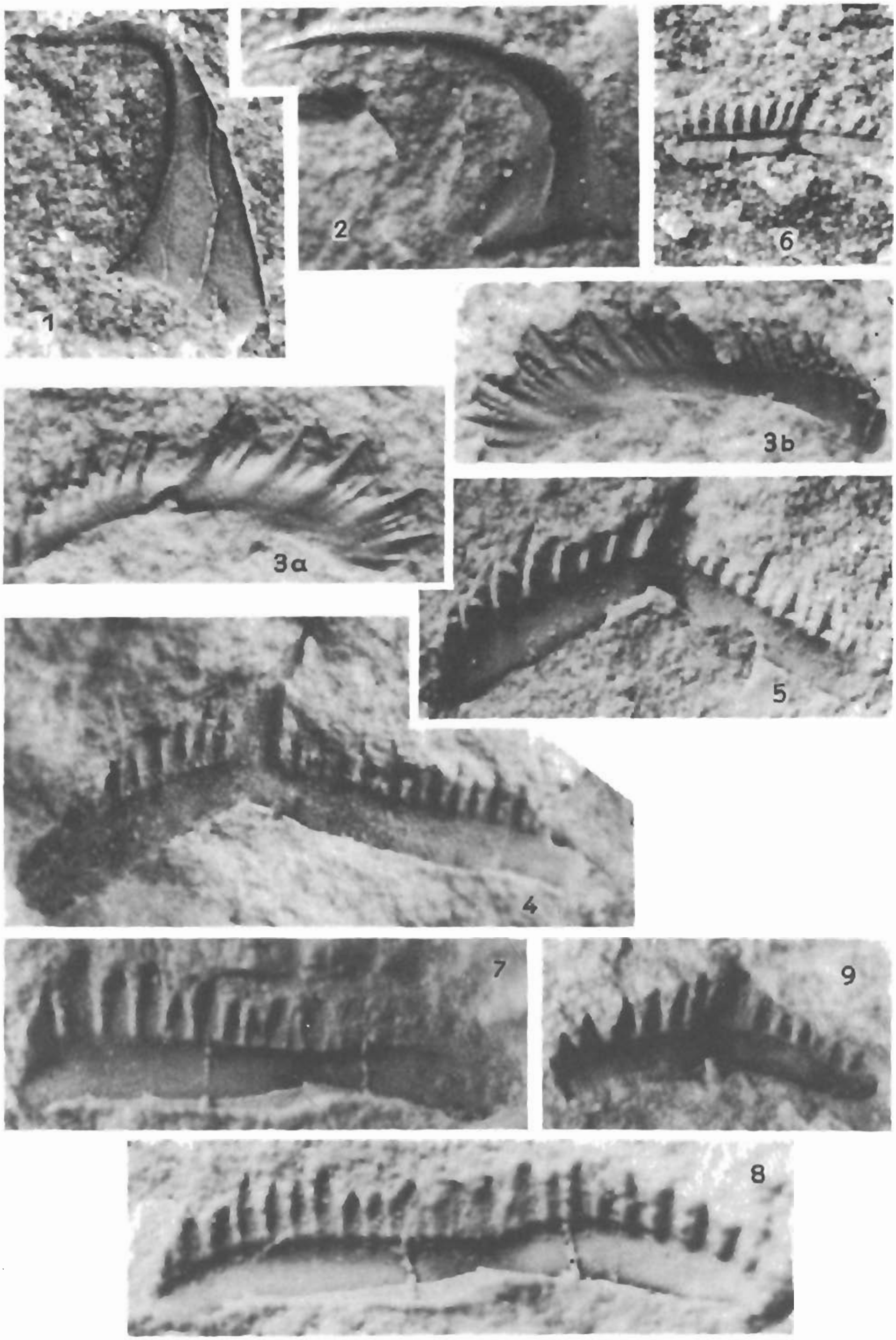
Fig. 1. *Lonchodina greilingi* Walliser
Sample (próbka) 9/71, specimen (okaz) 11, ODIG/8.12
Fig. 2. *Lonchodina* sp. a
Sample (próbka) 2/71, specimen (okaz) 9, ODIG/8.13
Fig. 3. *Neoprioniodus bicurvatus* (Branson et Mehl)
Sample (próbka) 2/71, specimen (okaz) 7, ODIG/8.14
Fig. 4. *Neoprioniodus* cf. *excavatus* (Branson et Mehl)
Sample (próbka) 2/71, specimen (okaz) 6, ODIG/8.15
Fig. 5. *Neoprioniodus multiformis* Walliser
Sample (próbka) 5/71, specimen (okaz) 3, ODIG/8.16
Fig. 6. *Neoprioniodus latidentatus* Walliser
Sample (próbka) 4/71, specimen (okaz) 7, ODIG/8.17
Fig. 7. *Neoprioniodus latidentatus* Walliser
Sample (próbka) 10/71, specimen (okaz) 2, ODIG/8.18
Fig. 8. *Ozarkodina denckmanni* Ziegler
Sample (próbka) 4, specimen (okaz) 17, ODIG/8.19
Fig. 9. *Ozarkodina denckmanni* Ziegler
Sample (próbka) 1/74, specimen (okaz) 20, ODIG/8.20
Fig. 10. *Ozarkodina media* Walliser
Sample (próbka) 13/71, specimen (okaz) 7, ODIG/8.21
Fig. 11. *Ozarkodina media* Walliser
Sample (próbka) 1/74, specimen (okaz) 15, ODIG/8.22
Fig. 12. *Panderodus* cf. *unicostatus unicostatus* (Branson et Mehl)
Sample (próbka) 4/74, specimen (okaz) 20, ODIG/8.23
Enl. × 50; Fig. 3 enl. × 30
Pow. 50 ×; Fig. 3 pow. 30 ×



Maria CHOROWSKA, Józef OBERC – The Stratigraphy and Tectonics of the Uppermost Silurian and Lower Devonian of the Zdanów Section (Góry Bardzkie Mts, Sudety Mts) in the Light of Conodont Studies

PLATE III

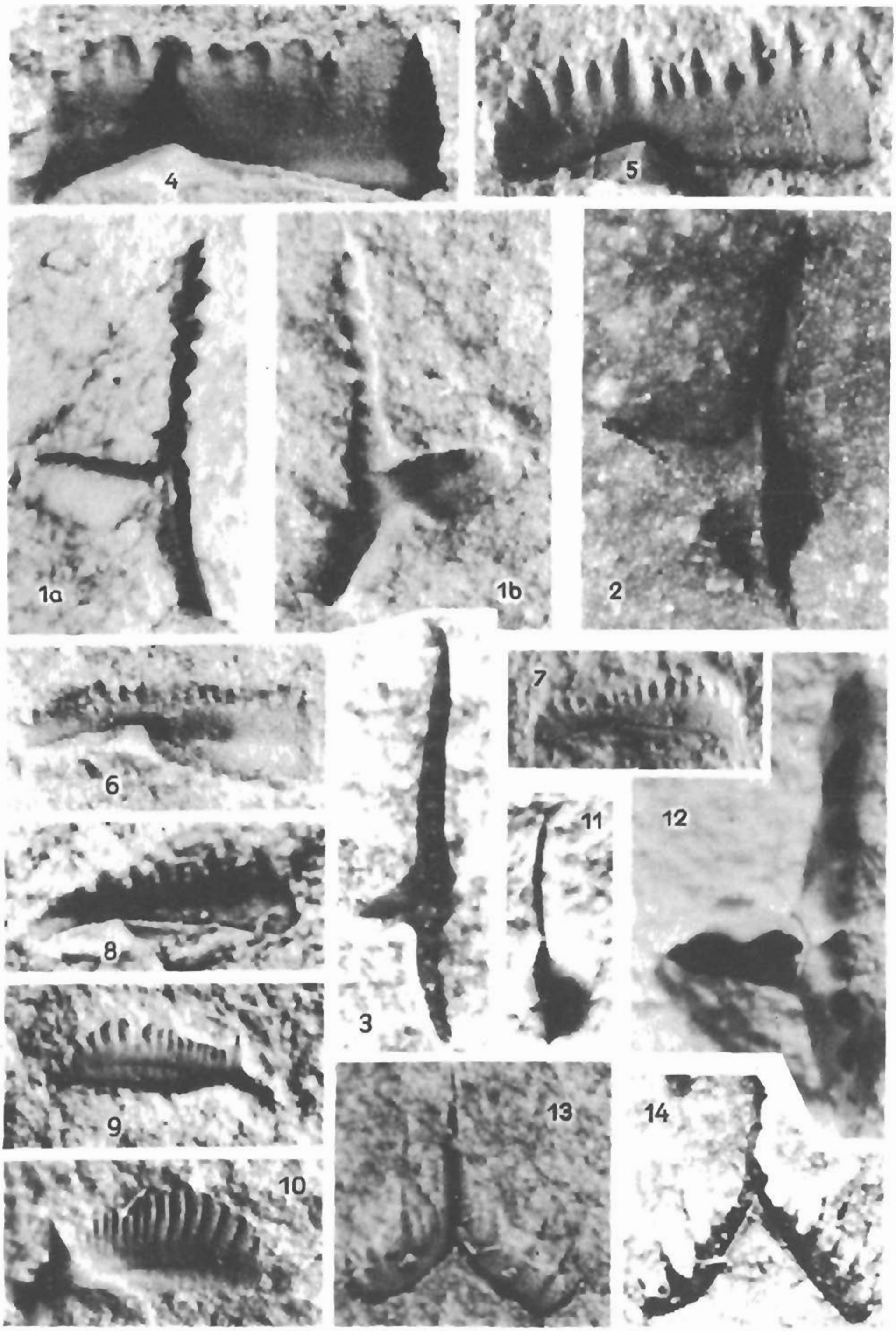
Fig. 1. *Panderodus* cf. *unicostatus unicostatus* (Branson et Mehl)
Sample (próbka) 13/74, specimen (okaz) 14, ODIG/8.24
Fig. 2. *Panderodus* cf. *unicostatus unicostatus* (Branson et Mehl)
Sample (próbka) 1/71, specimen (okaz) 5, IDIG/8.25
Fig. 3a, b. *Plectospathodus alternatus* Walliser
Sample (próbka) 4/71, specimen (okaz) 10, ODIG/8.26
Fig. 4. *Plectospathodus robustus* Bischoff et Sannemann
Sample (próbka) 14/71, specimen (okaz) 6, ODIG/8.27
Fig. 5. *Plectospathodus robustus* Bischoff et Sannemann
Sample (próbka) 14/71, specimen (okaz) 5, ODIG/8.28
Fig. 6. *Plectospathodus* sp. (Rhodes)
Sample (próbka) 1/77, specimen (okaz) 1, ODIG/8.29
Fig. 7. *Spathognathodus inclinatus wurmi* (Bischoff et Sannemann)
Sample (próbka) 12/71, specimen (okaz) 9, ODIG/8.30
Fig. 8. *Spathognathodus inclinatus wurmi* (Bischoff et Sannemann)
Sample (próbka) 12/71, specimen (okaz) 10, ODIG/8.31
Fig. 9. *Spathognathodus inclinatus* subsp. a Schulze 1968
Sample (próbka) 9/71, specimen (okaz) 10, ODIG/8.32
Enl. × 50
Pow. 50 ×



Maria CHOROWSKA, Józef OBERC – The Stratigraphy and Tectonics of the Uppermost Silurian and Lower Devonian of the Zdanów Section (Góry Bardzkie Mts, Sudety Mts) in the Light of Conodont Studies

PLATE IV

Fig. 1a, b. *Spathognathodus* sp. ex gr. *johnsoni* Klapper
Sample (próbka) 2/71, specimen (okaz) 3, ODIG/8.33
Fig. 2. *Spathognathodus* sp. ex gr. *johnsoni* Klapper
Sample (próbka) 3/71, specimen (okaz) 1, ODIG/8.34
Fig. 3. *Spathognathodus* sp. ex gr. *johnsoni* Klapper
Sample (próbka) 2/71, specimen (okaz) 1, ODIG/8.35
Fig. 4. *Spathognathodus steinhornensis remscheidensis* Ziegler
Sample (próbka) 11/71, specimen (okaz) 1, ODIG/8.37
Fig. 5. *Spathognathodus steinhornensis remscheidensis* Ziegler
Sample (próbka) 1/71, specimen (okaz) 3, ODIG/8.38
Fig. 6. *Spathognathodus steinhornensis remscheidensis* Ziegler
Sample (próbka) 2/71, specimen (okaz) 2, ODIG/8.36
Fig. 7. *Spathognathodus steinhornensis eosteinhornensis* Walliser
Sample (próbka) 9/74, specimen (okaz) 9, ODIG/8.39
Fig. 8. *Spathognathodus* sp. ex gr. *steinhornensis* Ziegler
Sample (próbka) 9/74, specimen (okaz) 7, ODIG/8.40
Fig. 9. *Spathognathodus stygius* Flajs
Sample (próbka) 9/71, specimen (okaz) 7, ODIG/8.41
Fig. 10. *Spathognathodus stygius* Flajs
Sample (próbka) 9/71, specimen (okaz) 1, ODIG/8.42
Fig. 11. *Spathognathodus stygius* Flajs
Sample (próbka) 9/71, specimen (okaz), 5, ODIG/8.43
Fig. 12. *Spathognathodus* cf. *transitans* Bischoff ef Sannemann
Sample (próbka) 9/71, specimen (okaz) 17, ODIG/8.44
Fig. 13. *Trichonodella inconstans* Walliser
Sample (próbka) 7/71, specimen (okaz) 2, ODIG/8.45
Fig. 14. *Trichonodella inconstans* Walliser
Sample (próbka) 15a/77, specimen (okaz) 2, ODIG/8.46
Enl. × 50
Pow. 50 ×



Maria CHOROWSKA, Józef OBERC – The Stratigraphy and Tectonics of the Uppermost Silurian and Lower Devonian of the Zdanów Section (Góry Bardzkie Mts, Sudety Mts) in the Light of Conodont Studies