CONODONT EVIDENCE FOR THE MID-GIVETIAN TAGHANIC EVENT IN SOUTH-EASTERN POLAND

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The Pełcza Member of the Telatyn Formation (Middle Devonian) of Lublin area, SE-Poland, displays sedimentological and biofacies evidence of a distinct transgressive pulse. The conodont fauna of Lublin area, supported by data from western Ukraine, constrains the age of the transgressive event to the Middle *Polygnathus varcus* Zone. Both biostratigraphic and sedimentological data indicate the occurrence of the worldwide transgressive Taghanic Event recognized herein for the first time in Poland. Conodont biofacies pattern in the studied sections is consistent with current models of Middle Devonian conodont ecology which postulate more open marine and/or deeper-water environments for the *Polygnathus*-dominated assemblages and more proximal and/or shallow-water settings for the *Icriodus*-dominated assemblages.

Key words: Conodonta, biostratigraphy, paleoecology, Taghanic Event, Middle Devonian, Poland.

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INTRODUCTION

Conodont data from Polish sections indicate the presence of one of the most important worldwide transgressive Devonian events, namely the Taghanic Event recorded at the base of the Taghanic onlap (e.g., JOHNSON 1970; HOUSE 1983,1985; JOHNSON *et al.* 1985; HOUSE and KIRCHGASSER 1993). This event is equivalent to the IIa transgression opening the second Devonian depophase of JOHNSON *et al.* (1985). According to KLAPPER and JOHNSON (1980), the timing of the event is confined to the Middle *Polygnathus varcus* Zone (see also JOHNSON *et al.* 1985; SANDBERG *et al.* 1988). The Taghanic transgression is regarded by KLAPPER and JOHNSON (1980) as a turning point in Devonian conodont biogeography. It marks a transition from the provincial, early Givetian faunas to the cosmopolitan, late Givetian and Late Devonian faunas.

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REGIONAL BACKGROUND

The study area is located in south-eastern Poland, in the south-eastern part of the Lublin region close to the Ukrainian border (Fig. 1). During the Middle Devonian times this area formed a part of the pericontinental basin located at the southern passive margin of the Old Red Continent or Laurussia (NARKIEWICZ 1988). Its paleolatitudes were comparable with those of Rhenish, Belgian, and Western Canada basins (e.g., SCOTESE and MCKERROW 1990).

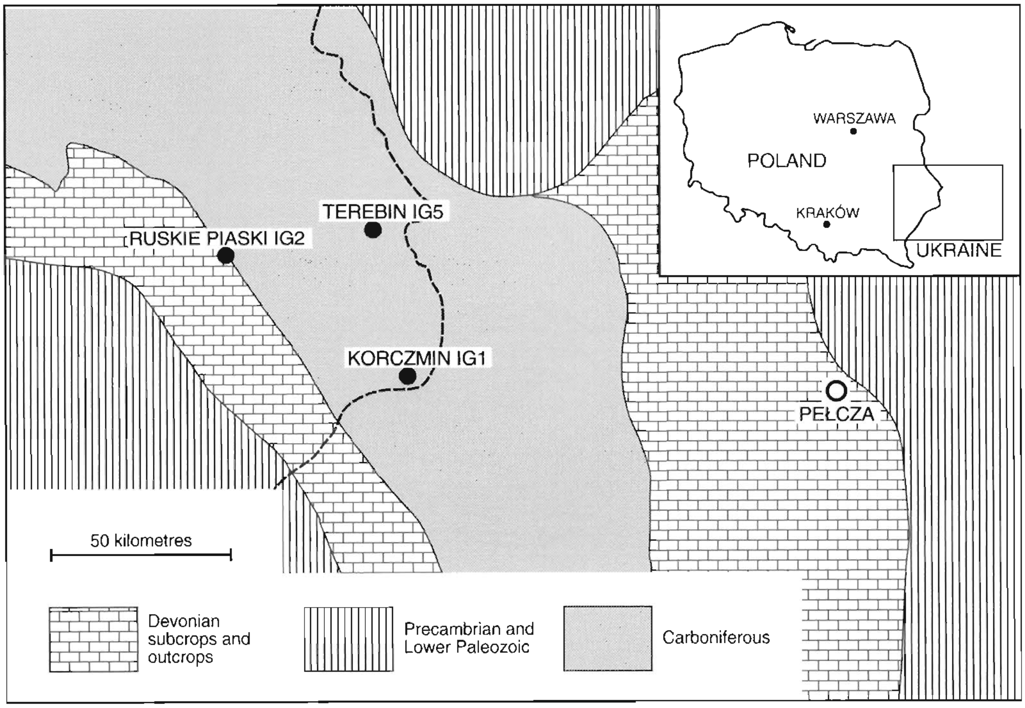

Fig. 1

Simplified map of the sub-Permian geology of south-eastern Poland and western Ukraine showing location of the studied well-sections. Ruskie Piaski IG 2 well in the west and the Pełcza outcrops in the east represent the maximum E-W extent of the investigated Pełcza Mb.

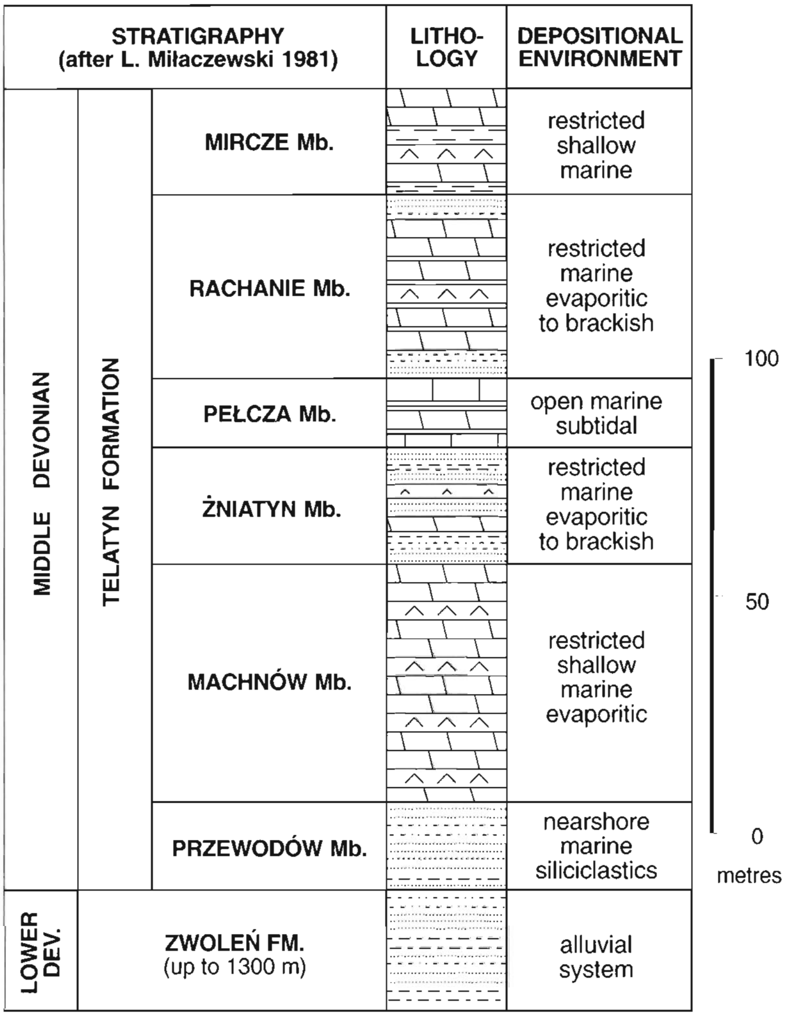

Fig. 2
Stratigraphic subdivision and depositional environments of the Middle Devonian in south-eastern part of the Lublin area (after MIŁACZEWSKI 1981). Depth is given in metres.

The Pełcza Member belongs to the Middle Devonian Telatyn Formation (MIŁACZEWSKI 1981; Fig. 2). This formation includes several sub-units representing mostly restricted, nearshore marine environments. In contrast, the Pełcza Member represents a predominantly open marine settings (see below for details). Outcrops and subcrops of the unit stretch for about 200 kilometres from the Pełcza village exposures in western Ukraine to the Ruskie Piaski IG 2 well in the Lublin area (Fig. 1).

The critical interval has been studied in two fully cored well-sections, Terebin IG 5 and Korczmin IG 1 (Fig. 3). The Pełcza Member consists of skeletal wackestones to packstones with variable admixture of terrigeneous clay, and with intercalations of unfossiliferous dark shales. Diverse open marine biotic assemblage is dominated by abundant brachiopods and crinoids. Corals, trilobites, gastropods and fish remains are less common. Bioturbation is very common, ranging from distinct burrows to complete reworking. The Pełcza Member litho- and biofacies characteristics are unique when compared to the typical, clastic and evaporitic, deposits of the Middle Devonian sequence in the area (Fig. 2). Clearly, Pełcza Member represents an open, generally subtidal, marine episode within a succession of restricted very shallow-water facies dominated by clastics and evaporites. At the same time, there are no indications of any tectonic events influencing subsidence patterns on a local or regional scale. Observations by the second author point to a tectonic stability prevailing during the Middle Devonian in the Lublin area. In view of the above data, it seems reasonable to interpret the Pełcza level as a record of a transgressive pulse of, at least, basinwide importance. The amplitude of a sea-level rise can be estimated to have reached at least few tens of metres.

CONODONT BIOSTRATIGRAPHY

All processed samples – weighing on average one kilogram – contained conodonts. Five samples from the Terebin IG 5 section yielded 43 conodont elements, and six samples from the Korczmin IG 1 section yielded 87 elements. We were able to determine fourteen species belonging to three genera: *Polygnathus*, *Icriodus*, and *Belodella*. Table 1 summarizes the distribution of taxa. All the samples included in the table are from the Pełcza Mb. except for a single sample from the base of the underlying Żniatyn Mb. in the Terebin IG 5 section (depth 1605.3 m – cf. Table 1).

Table 1

Conodont occurrence in the Korczmin IG 1 and Terebin IG 5 well sections. All samples are from the Pełcza Member except for the lowermost one in the Terebin IG 5 section (1605.3 m) from the Żniatyn Member. Abbreviations: L.–M.–U. *varcus* – Lower–Middle–Upper *P. varcus* Zone; M.v. – Middle *P. varcus* Zone, h.–c. – *S. hermanni–P. cristatus* Zone; transit. – *Palmatolepis transitans* Zone.

Conodont zone	Korczmin IG 1						Terebin IG 5				
	L.–M. *varcus*	M. *varcus*				M.v.– transit.	M.–U. *varcus*	M.v.– h.–c.	M. *varcus–disparilis*		
Sample depth (meters)	2492.3	2492.0	2489.0	2488.6	2485.0	2483.0	1605.3	1577.2	1576.6	1574.7	1574.6
Icriodus arkonensis	2							2			
Icriodus aff. *arkonensis*		2									
Icriodus brevis					3						
Icriodus cf. *brevis*	1						1		1		
Icriodus difficilis									2	1	
Icriodus eslaensis	2	2	2		4						
Icriodus expansus s.l.			1				1			1	
Icriodus aff. *latecarinatus*									1		
Icriodus cf. *latecarinatus*											1
Icriodus sp. indet.				4					4	1	2
Polygnathus ansatus		1	1								
Polygnathus cf. *ansatus*	1										
Polygnathus denisbriceae		1			1						
Polygnathus ensensis		1			1						
Polygnathus ensensis → *timorensis*					1						
Polygnathus l. linguiformis	1	6	4	9	2			1		4	
Polygnathus parawebbi				2			6				
Polygnathus timorensis	1	2	2		1			1	1		
Polygnathus cf. *timorensis*		1			1						
Polygnathus xylus xylus	1	1				1					
Polygnathus sp. indet.	5	5	5		5			3	3	1	2
Belodella triangularis										1	2
Belodella sp.						1					

Conodont taxa that were important in identifying conodont zones and constraining the age of the Pełcza Mb. in terms of the conodont zonation are shown on Pl. 1. The taxonomic study was based on current concepts of the Middle Devonian conodont element taxonomy (ZIEGLER *et al.* 1976; WEDDIGE 1977; BRICE *et al.* 1978; BULTYNCK 1987). In most cases, studied material enabled straightforward taxonomic decisions. However, four taxa (briefly discussed below) display morphologic features or stratigraphic range that are not entirely consistent with the literature.

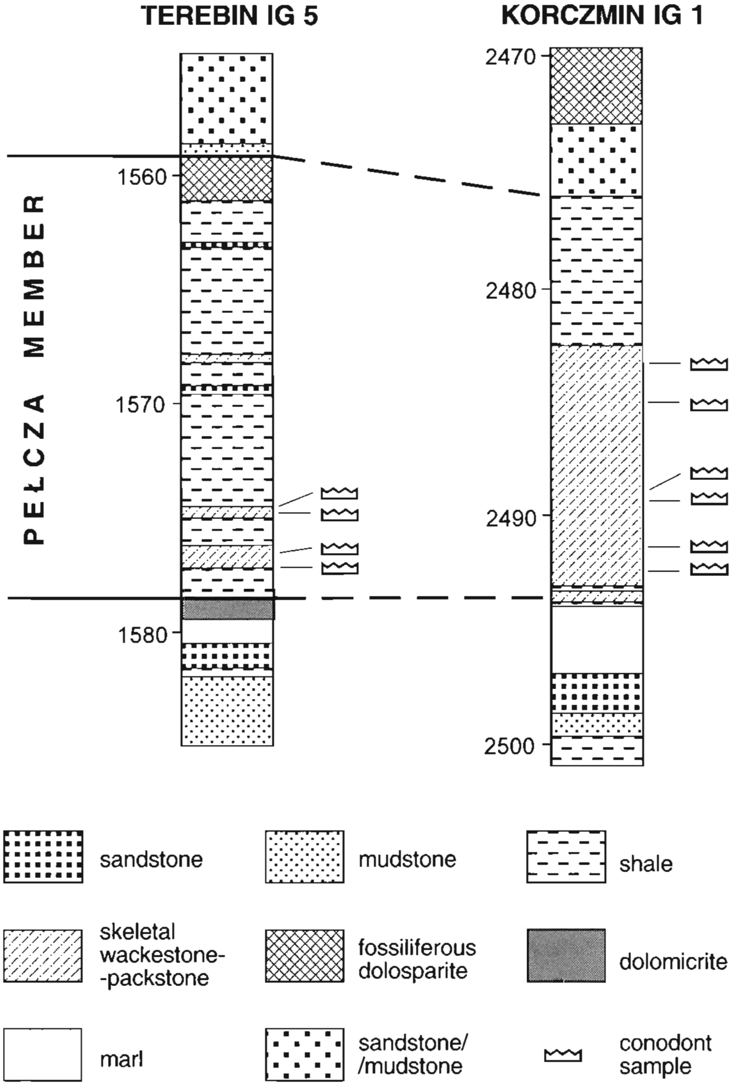

Fig. 3
Studied intervals of the Terebin IG 5 and Korczmin IG 1 well-sections with location of the conodont samples.

Typical representatives of *Polygnathus ensensis* ZIEGLER *et* KLAPPER display three to five serrations on both sides of the platform margin. However, in phyletically late forms, there are two serrations on the inner side and none or only one on the outer side (ZIEGLER *et al.* 1976; BULTYNCK 1989). Such a form has been found in the Korczmin IG 1 section at depth of 2492.0 m. The illustrated specimen, from 2485.0 m in the same section, displays two distinct serrations on the inner side and three weak serrations on the outer side (Pl. 1: 12). Atypical specimens with reduced number of serrations have been described by BULTYNCK (1989) from the Jbel Ou Driss section in Marocco, near the Eifelian/Givetian boundary.

The youngest *Polygnathus parawebbi* CHATTERTON has been found within the Lower *P. varcus* Zone in northern Africa and North America (e.g., ZIEGLER *et al.* 1976). However, in Middle Asia (Tadzhikistan) the species has been noted from the strata ascribed to the Middle *P. varcus* Zone (BARDASHEV and ZIEGLER 1985) and MAWSON and TALENT (1989) found its last occurrence in the Upper *P. varcus* Zone.

In Europe, according to BULTYNCK (1987, 1995), *Icriodus arkonensis* STAUFFER ranges from the upper part of the *Tortodus kockelianus* Zone to the Lower *P. varcus* Zone. In the Middle Asia, however, it has also been found in the *P. varcus* to *Schmidtognathus hermanni–Polygnathus cristatus* zones (BARDASHEV and ZIEGLER 1985). *Icriodus arkonensis* has been found in both the studied sections (Pl. 1: 18).

In western Europe and north Africa, the lower limit of *Icriodus expansus* s.l. BRANSON *et* MEHL is within the *Palmatolepis disparilis* Zone (BULTYNCK 1995). In North America this limit runs lower, i.e. in the Upper *S. hermanni–P. cristatus* Zone. Also, it has been found in the deposits of Middle *P. varcus* age in the Cantabrian Mountains of Spain (RAVEN 1983), in Canada (NORRIS *et al.* 1982), and in China (HONG-FEI *et al.* 1985). Our data confirm this extended range of *Icriodus expansus* s.l. (illustrated on Pl. 1: 8, 9) in Europe. In applying the wide taxonomical concept of *I. expansus* s.l., we follow the suggestion by BULTYNCK (personal communication). In his opinion, the name *Icriodus expansus* has been used for different icriodids with a biconvex upper surface which may have in fact represented different species.

The ranges of the stratigraphically most important taxa have been compiled using the literature data (BULTYNCK 1987, 1995; HOU HONG-FEI *et al.* 1985; MAWSON and TALENT 1989; NORRIS *et al.* 1982; ZIEGLER *et al.* 1976). Fig. 4 shows the selected stratigraphic ranges and the Givetian conodont zonation (CLAUSEN *et al.* 1993). The ranges of the conodont taxa from the Pełcza Mb. in the Terebin IG 5 section indicate the Middle *P. varcus* to *S. hermanni–P. cristatus* (and *P. disparilis*?) zones. The single sample from the Żniatyn Mb. (1605.3 m – Table 1) falls within the Middle to Upper *P. varcus* zonal interval. In the Korczmin IG 1 section, the age of the samples covering depth interval from 2492.0 to 2485.0 m can be narrowed to the Middle *P. varcus* Zone as justified by the occurrence of *Polygnathus ansatus* (Pl. 1: 3, 4) and *P. ensensis* (Pl. 1: 12). The conodont data from the Terebin IG 5 well make it probable that, in both studied sections, the base of the Pełcza Mb. occurs within the Middle *P. varcus* Zone. The age of this lithostratigraphic level is independently confirmed by the results of conodont investigations reported by DRYGANT (1994) from the north-eastern part of the Lvov Trough in western Ukraine. This region represents the eastern part of a continuous Devonian sedimentary basin studied by the present authors in the Lublin area. DRYGANT (1994) listed the following conodont assemblage from the Pełcza Suite (i.e. the Ukrainian lithostratigraphic counterpart of the Polish Pełcza Mb.): *Polygnathus timorensis, P. varcus, P. xylus xylus, P. ansatus, P. ovatinodosus, P. denisbriceae, P. beckmanni, P. linguiformis linguiformis, Icriodus difficilis, I. brevis, I. arkonensis*, and *I. subterminus*. The above forms indicate the presence of the Middle *P. varcus* Zone in the western Ukrainian sections of the Pełcza Suite.

Table 2

Geographic distribution of the investigated conodont taxa from the Pełcza Member in sections representing the Middle *P. varcus* Zone. Based on BARDASHEV and ZIEGLER (1985), BULTYNCK (1987), HONG-FEI *et al.* (1985), KLAPPER and JOHNSON (1980), MAWSON and TALENT (1989), NORRIS *et al.* (1982), ZIEGLER *et al.* (1976).

	Western Europe	North Africa	North America	South China	Middle Asia	Australia
P. timorensis	•	•	•	•	•	•
P. ansatus	•	•	•	•	•	•
P. l. linguliformis	•	•	•	•	•	•
I. difficilis	•	•	•	•	•	•
I. brevis	•	•	•	•		•
P. denisbriceae	•	•	•			
I. expansus	•		•	•		•
P. x. xylus	•	•	•			•
P. ensensis	•		•	•		•
P. eslaensis	•		•			
I. latecarinatus	•	•				
P. parawebbi					•	•
I. arkonensis					•	

Thus, the conodont data from Poland and western Ukraine demonstrate a precise time-correlation of the Pełcza level with the global Taghanic Event. This correlation and the interpretations of the depositional and subsidence patterns (outlined above) collectively suggest that the studied level represents the initial Taghanic transgressive pulse rather than a local, structurally controlled sea-level rise.

It is also worth stressing that our data point to the cosmopolitan character of the conodont assemblage found in the Pełcza Member. In Table 2, based on the available literature, we plotted the occurrences of the Pełcza taxa in various geographic settings. Clearly, most of the taxa display a worldwide distribution. This confirms the biogeographical significance of the Taghanic transgression as a major turning point between endemic and cosmopolitan Devonian faunas, as proposed by KLAPPER and JOHNSON (1980).

CONODONT BIOFACIES

Conodont data were analyzed to explore any potential ecologically controlled pattern. Percentages were calculated at the generic level for each of the sections. This procedure appears valid because no vertical trends in generic percentages were recognized. This implies that, in each of the sections, the conodont "biofacies" remained rather uniform throughout the period of deposition of the Pełcza Mb. According to our calculations, equal proportions of *Icriodus* and *Polygnathus* (I/P = 1.0) characterizes the Pełcza Mb. in the Terebin IG 5 section whereas biofacies found in the Korczmin IG 1 well is *Polygnathus*-dominated (I/P = 0.4). Also, it is significant that *Belodella* is more frequent in the former section (8% of all elements counted) than in the latter one (1%). Additionally, the conodont assemblage in the Terebin IG 5 well is characterized by the occurrence of both delicate forms (e.g., *P. timorensis, I. brevis*) and more robust elements (e.g., *P. parawebbi, P. linguiformis linguiformis, I. arkonenesis*). In the Korczmin IG 1 section, delicate forms dominate over robust ones.

Middle Devonian conodont biofacies, unlike those known from Late Devonian times (e.g., SANDBERG 1976), have not yet been defined quantitatively. In general, current models of the Middle Devonian conodont paleoecology associate the *Polygnathus* forms with more distal and/or deeper-water environments and *Icriodus* and the *Belodella* forms with more proximal and/or shallow-water settings (WEDDIGE and ZIEGLER 1976; WEDDIGE 1988; WANG 1991). There also seems to be a correlation between the general morphology of elements and their environmental "preferences", with delicate forms being more characteristic of deeper, offshore conditions (WANG 1991).

In our example, the above models of Middle Devonian conodont distribution imply that the Korczmin IG 1 section represents an offshore location and the Terebin IG 5 section a more proximal setting. Indeed, the latter section is located closer to the basin margin whereas the former represents a distal locality. Lithologic comparison of the two sections (Fig. 3) shows that the Terebin IG 5 sequence is more shaly, which apparently contradicts the above interpretation. However, sedimentologic and biotic features of the shales point to intermittent brackish and/or estuarine environments rather than distal open marine conditions. Such a depositional model would be in accordance with a nearshore setting of the Terebin IG 5 section.

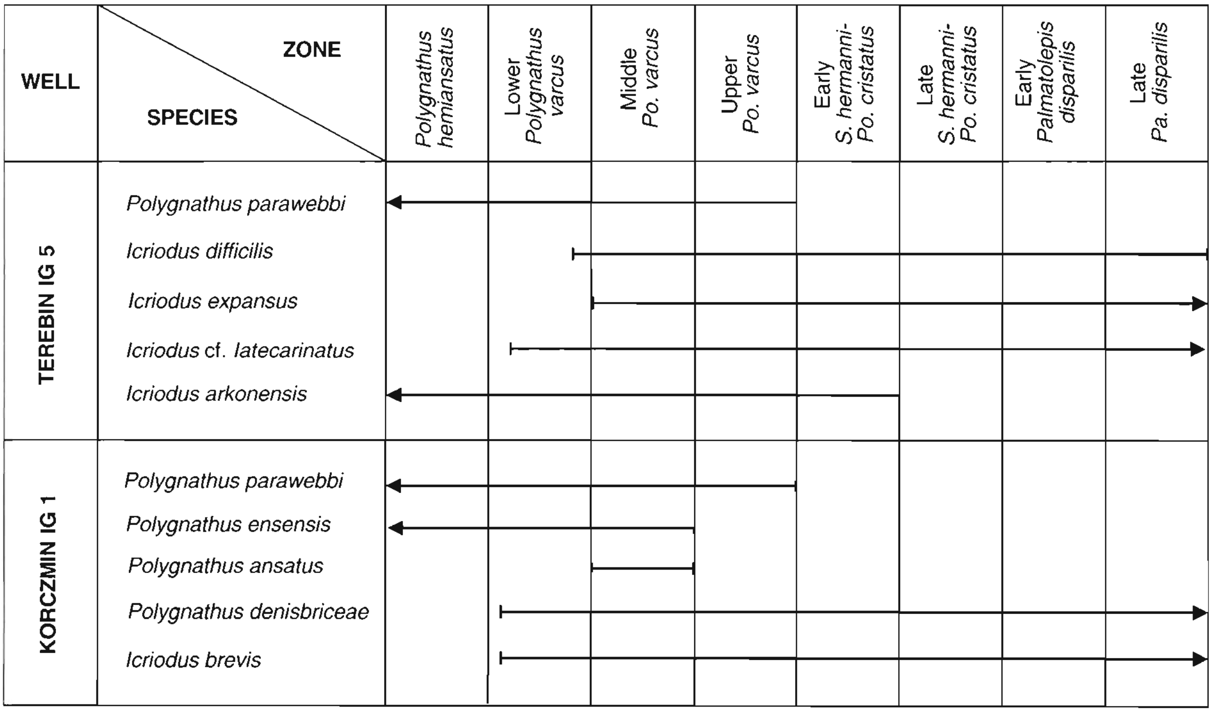

Fig. 4

Ranges of selected conodont species found in the studied sections. Conodont zonation after CLAUSEN *et al.* 1993. Conodont ranges after BULTYNCK (1987,1996), HONG-FEI *et al.* (1985), MAWSON and TALENT (1989), NORRIS *et al.* (1982), ZIEGLER *et al.* (1976).

CONCLUSIONS

1. The investigated Middle Devonian unit, Pełcza Member, displays sedimentological and biofacies evidence of a distinct transgressive event apparently not related to a sudden increase of a tectonic subsidence.

2. The conodont fauna of Lublin area, as well as previously reported data from western Ukraine (DRYGANT 1994), narrow the age of the event to the Middle *P. varcus* Zone.

3. Both biostratigraphic and sedimentological data from the Pełcza Mb. document (for the first time in Poland) the occurrence of the worldwide IIa transgression (JOHNSON *et al.* 1985), or the Taghanic Event starting the Taghanic onlap.

4. Conodont biofacies pattern in the studied sections is consistent with current models of the Middle Devonian conodont ecology which postulate more open marine and/or deeper-water environments for *Polygnathus*-dominated assemblages and more proximal and/or shallow-water settings for the *Icriodus*-dominated assemblages.

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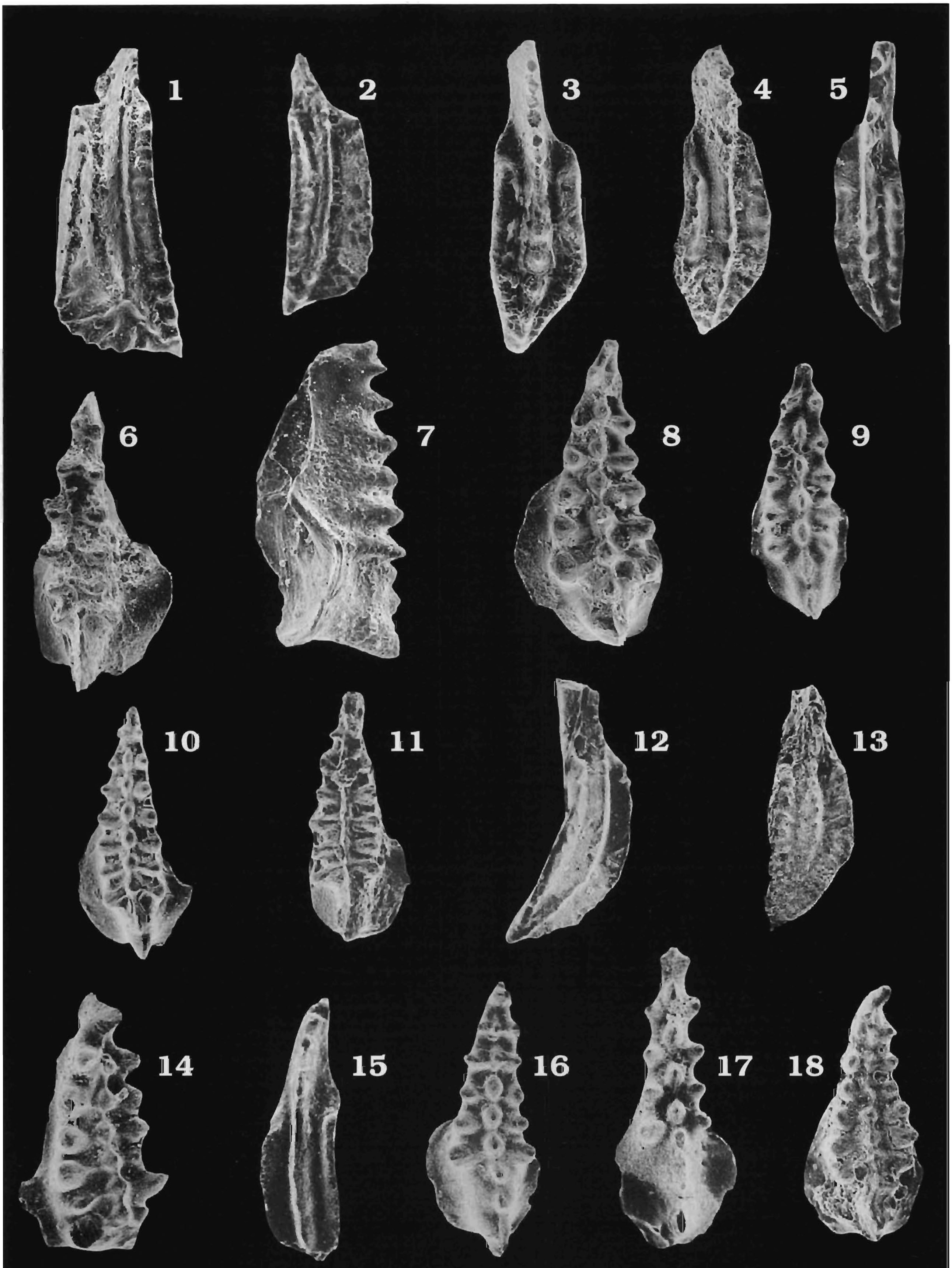
CONODONT EVIDENCE FOR THE MID-GIVETIAN TAGHANIC EVENT IN SOUTH-EASTERN POLAND

PLATE 1

All photographs are SEM upper views except for number 7 (side view)

1. *Polygnathus parawebbi* CHATTERTON. Terebin IG 5, depth 1605.3 m, × 120.
2. *Polygnathus parawebbi* CHATTERTON. Korczmin IG 1, 2488.6 m, × 80.
3. *Polygnathus ansatus* ZIEGLER *et* KLAPPER. Korczmin IG 1, 2489.0 m, × 120.
4. *Polygnathus ansatus* ZIEGLER *et* KLAPPER. Korczmin IG 1, 2492.0 m, × 120.
5. *Polygnathus* cf. *timorensis* KLAPPER, PHILIP *et* JACKSON. Korczmin IG 1, 2485.0 m, × 76.
6. *Icriodus eslaensis* VAN ADRICHEM BOOGAERT. Korczmin IG 1, 2492.0 m, × 140.
7. *Icriodus eslaensis* VAN ADRICHEM BOOGAERT. Korczmin IG 1, 2492.0 m, × 160.
8. *Icriodus expansus* s.l. BRANSON *et* MEHL. Korczmin IG 1, 2489.0 m, × 150.
9. *Icriodus expansus* s.l. BRANSON *et* MEHL. Terebin IG 5, 1574.7 m, × 81.
10. *Icriodus difficilis* ZIEGLER *et* KLAPPER. Terebin IG 5, 1576.6 m, × 60.
11. *Icriodus* aff. *arkonensis* ZIEGLER *et* KLAPPER. Korczmin IG 1, 2492.0 m, × 63.
12. *Polygnathus ensensis* ZIEGLER *et* KLAPPER. Korczmin IG 1, 2485.0 m, × 62.
13. *Polygnathus denisbriceae* BULTYNCK. Korczmin IG 1, 2492.0 m, × 51.
14. *Icriodus* cf. *latecarinatus* BULTYNCK. Terebin IG 5, 1574.7 m, × 65.
15. *Polygnathus xylus xylus* STAUFFER. Korczmin IG 1, 2483.0 m, × 83.
16. *Icriodus* aff. *latecarinatus* BULTYNCK. Terebin IG 5, 1576.6 m, × 75.
17. *Icriodus brevis* STAUFFER. Korczmin IG 1, 2485.0 m, × 106.
18. *Icriodus arkonensis* STAUFFER. Terebin IG 5, 1577.2 m, × 60.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