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Middle Devonian conodonts from black shales of the Ściegnia section, Góry Świętokrzyskie Mountains, central Poland

(Figs 1–8)

Abstract. The conodont fauna and conodont-based biostratigraphy of a part of the Devonian succession of the Ściegnia section (Lysogóry region, Góry Świętokrzyskie Mountains [Holy Cross Mountains]) are discussed. The studied strata are composed of rhythmically bedded black shales and marly shales with intercalations of marly and coarse-grained limestones. They overlie the shales and sandstones of the Świętomarz beds. This part of the shale-marly succession of the Ściegnia section represents the lower part of Nieczulice beds of the Devonian informal lithostratigraphical scheme for the northern region of the Góry Świętokrzyskie Mountains. The conodont assemblages indicate that the studied sequence ranges from the upper part of the Lower varcus conodont Zone to the Middle varcus conodont Zone of the Givetian.

Key words: Góry Świętokrzyskie Mountains, Lysogóry region, Devonian, Givetian, conodonts, biostratigraphy, Poland.

INTRODUCTION

The earliest basic papers on the stratigraphy of the Devonian in the Lysogóry region were published by Gürich (1896) and Sobolew (1909). New important observations (on the Devonian near the villages of Włochy and Nieczulice) were added much later by Czarnocki (1950). This author referred to the ‘coral limestones’ of Sobolew as the ‘Pokrzywianka beds’ and suggested their Frasnian assignment. Similarly, he attributed to the Frasnian the overlying shales, which he termed the Nieczulice beds. The lower part of these shales were described already by Sobolew (1909) under the name ‘Świętomarz Shales’. Subsequently, Czarnocki’s views on the stratigraphy of the Pokrzywianka and Nieczulice beds were modified by

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Pajchlowa (1957). Based on observations in the Świetomarz-Śniadka section, she referred both units to the Givetian. According to Malec (1996) the lowermost part of the Nieczulice beds of the Skały section belongs to the Middle *varcus* conodont Zone. Not acceptable is the subsequent statement in more recent report by Malec & Turnau (1997, Fig. 7 unit XXVIII, parts A-B), who refer this part of the succession to the stratigraphically younger, *hermani-cristatus* Zone. Namely, the specimen of *Schmidtognathus* sp., indicative of the latter zone was found actually in part C of unit XXVIII, i.e. distinctly above the conodont assemblage of the Middle *varcus* Zone of the Skały section (Dr. Malec oral information from November 2004). Consequently, it cannot be taken as a date of the lowermost part of the Nieczulice beds.

In the western part of the Łysogóry region, the equivalent part of the Devonian succession was long known from the Ściegnia section (formerly known as the Wzdól section), located in the western part of the Bodzentyn Syncline (see Fig. 1). According to Czarnocki (1950), Kościelniańska (1967), and Filonowicz (1962, 1969) this section starts with the Givetian deposits of the Skały and the Świetomarz beds, which are overlain by Frasnian deposits, developed as shales and limestones with the brachiopod *Leiorhynchus polonicus* (Roemer) and tentaculitides, followed by limestones and shales with cephalopods (Filonowicz, 1969). Consequently, this could suggest a lack of the Nieczulice beds in the Ściegnia area.

During recent field works in the Ściegnia area a newly exposed part of the Devonian succession was found. Its lithological characteristics supported by biostratigraphical data suggest that this succession represents an equivalent of the lower part of Nieczulice beds. The present results seem to prove a much larger geographic extent of this lithostratigraphic unit than hitherto assumed.
STRATIGRAPHICAL SETTING

The Ōciegnia section, near Bodzentyn in the Łysogóry (northern) region (Fig. 1) is located in the western part of the Bodzentyn Syncline (Czarnocki, 1950). The Devonian shales and limestones, dipping to the north, are exposed in the bank of a stream, southwest of the exposures of shales and sandstones of the Świętomarz beds (Fig. 2). The succession studied is composed of rhythmically bedded black shales and marly shales, with intercalations of marl and coarse-grained limestone (Fig. 3).

MATERIAL

An eight metres thick part of the succession exposed in the Ōciegnia section was sampled for microfauna. The studied sequence was accessible in two sections, with an observational gap in between estimated for about 20 m (Fig. 3). Among the 17 samples analysed, 11 yielded relatively well preserved and abundant conodont material, with both juvenile and adult specimens represented (Fig. 3). The most abundant and fossiliferous material was found in sample 12.

Besides conodonts the samples yielded numerous dacryoconarids (Fig. 8A–F), leiospheres (Fig. 8G–H), globular microproblematica (Fig. 8I–N), resembling those described by Racki & Sobóñ-Podgórśka (1992, Fig. 9A–E), sclerites of the genus *Eocaudina* (Fig. 8O–P), calcareous sponges (Fig. 8R), and fragments of fish (Fig. 8S, T). Most of dacryoconarid moulds and microproblematica are pyritized,

Fig. 2. Geological uncovered map of the Ōciegnia vicinities after O. Kościelniakowska (1967)
Fig. 3. Distribution of conodonts in limestone layers or lenses of Ściegnia black shales.
and then limonitized. Framboidal pyrite in the form of framboid-raspberries, consisting of densely packed spheroidal aggregates (Fig. 8K–N) is also present. The spheroidal aggregates are 270–360 µm in diameter, which suggests that they formed in conditions of a long-term euxinic state, interrupted by brief sea-floor oxygenation events (Bond et al., 2004).

**BIOSTRATIGRAPHIC RESULTS**

Conodont assemblages found in the studied section include cosmopolitan Middle Devonian taxa, characteristic of the upper Lower-Middle varcus zones. Conodonts from samples 3–11 (Fig. 3), represented by *Polygnathus varcus* Stauffer, *P. timorensis* Klapper, Philip et Jackson, *P. linguiformis linguiformis* Hinde, *P. linguiformis weddigei* Clausen, Leuteritz et Ziegler, *Icriodus cf. excavatus* Weddige and *Belodella resima* (Philip), may indicate both the upper Lower varcus Zone and the Middle varcus Zone (Figs 4–7). According to Ziegler et al. (1976) the base of the Lower varcus Zone, is defined by the lowest occurrence of *P. timorensis* Klapper, Philip et Jackson, whereas the eponymous *P. varcus* Stauffer has the lowest occurrence in the upper part of this zone. Similarly, *P. linguiformis weddigei* Clausen, Leuteritz et Ziegler has the lowest occurrence in the upper part of the Lower varcus Zone and continues higher, into the Middle varcus Zone (Clausen, Leuteritz & Ziegler, 1979; Bulynck, 1987; Uyeno, 1998).

Sample 12, containing the most abundant and diversified conodont assemblage, besides forms listed above also contains: *Polygnathus linguiformis mucronatus* Wittekindt, *P. rhenanus* Klapper, Philip et Jackson. *P. ansatus* Ziegler et Klapper, *Icriodus brevis* Stauffer, *I. cf. lindensis* Weddige, and *Tortodus* sp. A gamma mor-phototype (Sparling, 1999). Most of these taxa range higher, and were also found in samples 13 and 14, where they co-occur with representatives of the genus *Neopanderodus* (Figs 5–7).

The assemblage from samples 12–14 characterises the Middle varcus Zone. It is demonstrated by the presence of *Polygnathus ansatus* Ziegler et Klapper, the lowest occurrence of which defines the base of the zone, and the continuous occurrence of *P. linguiformis mucronatus* Wittekindt and *P. rhenanus* Klapper, Philip et Jackson, which do not range above its upper boundary (Klapper, Philip & Jackson, 1970; Ziegler et al., 1976; Bulynck, 1987; Weddige, 1977). Worthy of note is the common occurrence in the Middle varcus Zone of juvenile *Icriodus cf. lindensis* Weddige and of *Tortodus* sp. A gamma morphotype (Sparling, 1999). Usually these two forms disappear well below the base of this zone.

The specimen of *Icriodus cf. lindensis* (Fig. 5M) resembles *I. brevis* (Fig. 5N), from which it differs in the development of the three denticles of the posterior extension of the middle row, which in the discussed specimen increase regularly in height, similarly as in *I. lindensis* Weddige. The specimen of *Tortodus*, illustrated herein in Fig. 6E, possesses a well developed platform, with the margin bearing delicate nodes. It closely resembles *Tortodus* sp. A gamma morphotype (Sparling, 1999, fig. 5.7–5.9), known from the upper Middle varcus Zone of the Prout Dolomite Formation, Ohio, USA.
Fig. 6. Givetian conodonts from Ściegnia section. A, J–K – *Polygnathus ansatus* Ziegler et Klapper, sample Š-12; B–D – *Polygnathus timorensis* Klapper, Philip et Jackson, B, C – sample Š-12, D – sample Š-14a; E – *Tortodus* sp. A gamma morphotype Sparling, sample Š-12; F–I – *Polygnathus linguiformis mucronatus* Wittekindt, sample Š-12, G – lateral view; A–K – Pa elements, upper views; length of scale bars: A, B, E, F, H, I – 100 µm; C – 30 µm, D, G, J, K – 20 µm
Fig. 7. Givetian conodonts from Ściegnia section. A, B – Neopanderodus sp., A – sample Š-14, B – sample Š-14a; C – Neopanderodus transitans Ziegler et Lidström, sample Š-14a; D–K – Belodella resima (Philip), D, F – sample Š-11, E, H, K – sample Š-14a; I – sample Š-12; A–K – lateral views; length of scale bars: A, C, I, K – 20 μm, B, D, F, G – 10 μm; E, H, J – 30 μm
CONCLUSIONS

The studied part of the succession of the Ściegnia section (samples 3–14), just above the shales and sandstones of the Świętomarz beds, represents an interval spanning the upper Lower *varcus* Zone to the Middle *varcus* Zone.

The conodont assemblage found is very similar to the assemblage reported from the Middle *varcus* Zone of the lower part of the Nieczulice beds of the Grzegorzowice-Skały section, in the eastern part of the Góry Świętokrzyskie Mountains (unit XXVIII, parts A-B in fig. 7 of Malec & Turnau, 1997).

The facies similarity of the studied succession to the Nieczulice beds of the Grzegorzowice-Skały section, supported by the biostratigraphical equivalence of both sections suggest, that the lower part of the shale and marly succession of the studied section should be referred to the Nieczulice beds. However, the conodont assemblage of the Ściegnia section is a little older.

The black colour, the presence of the pyritized planktonic and nektonic fauna, and of framboidal pyrite (Fig. 8K–N), suggest dysoxic conditions in the bottom waters and oxic conditions in the overlying water column during the sedimentation of the black clays.

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