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Revision of stratigraphic ranges of selected invertebrate taxa from the Muschelkalk in Silesia

Robert NIEDŹWIEDZKI

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New occurrences of some invertebrates in the Silesian Muschelkalk are presented, hanging the stratigraphic ranges of these taxa, especially in the Dziewkowice Formation. 13 taxa have been found for the first time in this formation or had their stratigraphic ranges revised in the last two decades.

Robert Niedźwiedzki, Institute of Geological Sciences, Wrocław University, Cybulskiego 30, 50-205 Wrocław, Poland; e-mail: rnied@ing.uni.wroc.pl (received: November 14, 2001; accepted: February 28, 2002).

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INTRODUCTION

The aim of this paper is to review stratigraphic ranges of some invertebrate taxa found in the Silesian Muschelkalk (Middle Triassic). The knowledge of precise stratigraphic ranges is necessary both for palaeoenvironmental studies and for stratigraphic purposes. It is especially important in the reconstruction of migration routes of Tethyan faunas into the Germanic Basin and within the basin as well. Lithostratigraphic subdivision of the Muschelkalk in Silesia related to the chronostratigraphic units is shown in Figure 1. Assmann (1937) and Malinowska (1979, 1986) published important previous works pertinent to this study. Recent studies (e.g. Bodzioch, 1997*b*; Kaim, 1997; Niedźwiedzki, 1998, 2000) reviewed the stratigraphic ranges most of the invertebrate taxa. These investigations clarified previous disagreements regarding species stratigraphic ranges by Assmann (1937) and Malinowska (1979, 1986). In this paper I use the lithostratigraphical units (Fig. 1) established by Assmann (1944) and formalised by Bodzioch (1997*b*: Karchowice Formation = Karchowice Beds *sensu* Assmann, 1944) and Niedźwiedzki (2000: Górażdże Formation = Górażdże Beds; Dziewkowice Formation = Terebratula Beds *sensu* Assmann, 1944). I have decided to use the Assmann's lithostratigraphical names also for the Lower Muschelkalk in the North-Sudetic Basin (see below). Most of the outcrops of the Muschelkalk are located in Upper Silesia (Fig. 2) whereas the Muschelkalk (exclusively the Lower and Upper Gogolin Beds = B and C Beds *sensu* Chrząstek, 1996; the Górażdże Formation = D Beds *sensu* Chrząstek, 1996 and the Dziewkowice Formation = E Beds *sensu* Chrząstek, 1996) in the Sudetes Mountains outcrop only in the North-Sudetic Basin (three outcrops are in Raciborowice and the fourth one is located at Jerzmanice Zdrój).

STRATIGRAPHIC RANGES OF INVERTEBRATE FOSSILS FROM THE MUSCHELKALK IN SILESIA

SPONGES

Assmann (1937) reported sponges from the Karchowice Formation and the Diplopora Beds only. Later, sponges were also found in the Upper Gogolin Beds, the Górażdże Formation and the Dziewkowice Formation (Szulc, 1990; Bodzioch, 1993; Senkowiczowa, 1998). Noetling (1880) found sponges in the Górażdże Formation of the North-Sudetic Basin.

GASTROPODS

Gastropods were reported as a common component of fossil assemblages from the Röt, the Lower Muschelkalk (except the Dziewkowice Formation), the Diplopora Beds (Assmann,

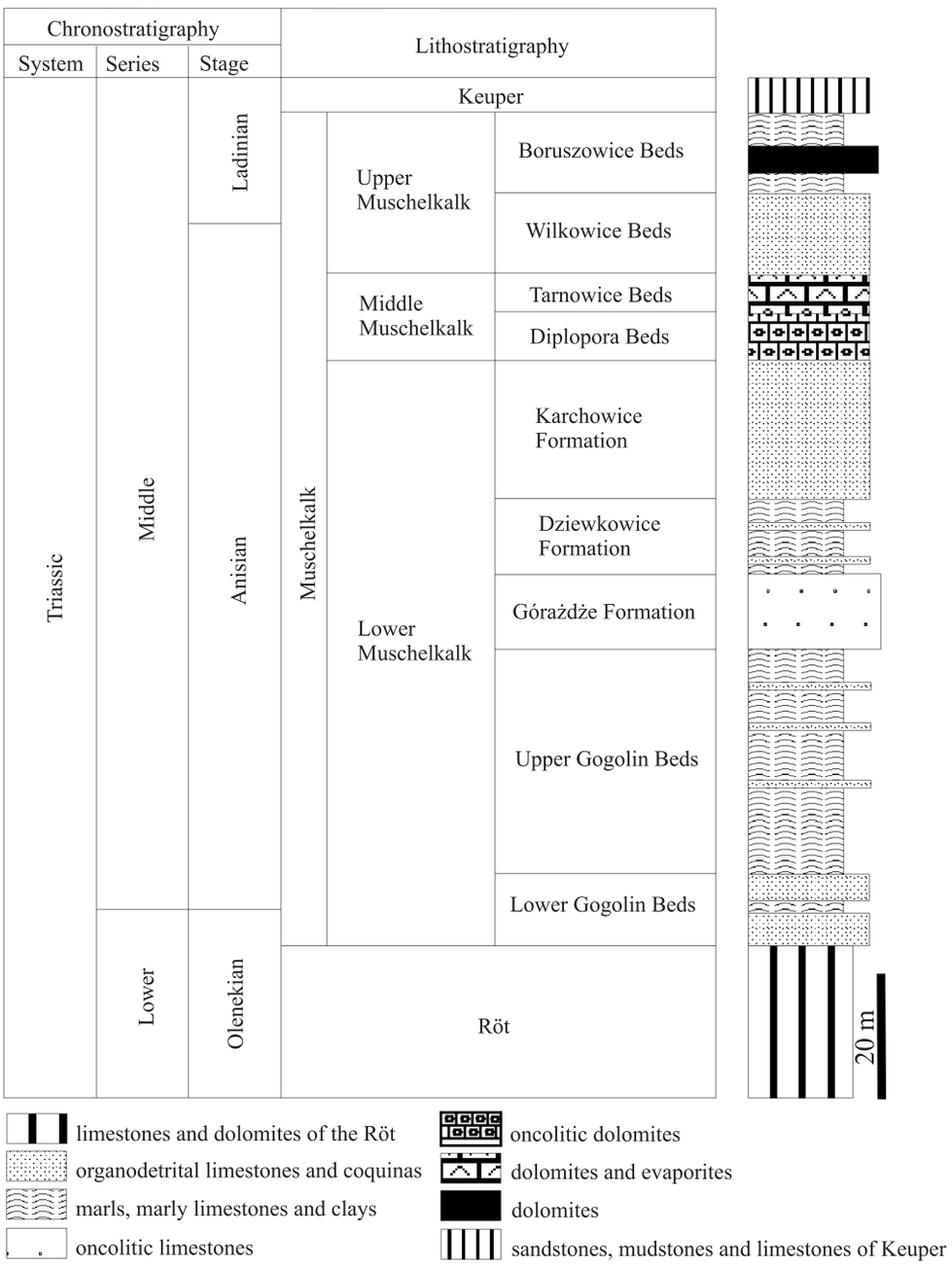

Fig. 1. Stratigraphy of the Muschelkalk from Silesia (after Nawrocki and Szulc, 2000; Niedźwiedzki, 2000)

1937), and the Wilkowice Beds (Szulc, 2000). The absence of gastropods from the Dziewkowice Formation of Upper Silesia was mentioned by Assmann (1937), Senkowiczowa and Kotański (1979*a*, 1986*a*), and Szulc (2000). In later palaeoecological studies (Niedźwiedzki, 1998, 2000) some gastropod moulds and sections were found in the Dziewkowice Formation at the Strzelce Opolskie and Górażdże quarries (Tab. 1). The findings are infrequent and usually poorly preserved thus their precise taxonomic determination is impossible. Some of them, however (e.g. specimen MGUWr 5318s), seems to belong to family Loxonematidae Koken, 1889. In the North-Sudetic Basin gastropods were found in the Röt and in the whole Lower Muschelkalk (e.g. Noetling, 1880; Senkowiczowa and Kotański, 1979*a*; Chrząstek, 1996).

BIVALVES

***Prospondylus ernesti* Assmann, 1937**. Assmann (1937) and Senkowiczowa (in Senkowiczowa and Kotański, 1979*b*, tab. 6; 1986*b*, tab. 7) reported this species only from the Górażdże Formation of Upper Silesia. Later on numerous specimens of *P. ernesti* were also found (Tab. 1) in the Dziewkowice Formation (Kaim, 1997; Niedźwiedzki, 1998) and in the Karchowice Formation (Bodzioch, 1989).

***Hoernesia socialis* (Schlotheim, 1823)**. Assmann (1937) stated an absence of *H. socialis* from the Dziewkowice Formation of Upper Silesia. Later observations (Tab. 1) proved that shells of *H. socialis* occur abundantly in this formation (Bodzioch, 1985; Niedźwiedzki, 1993, 1998; Kaim, 1997). Noetling (1880) reported this species from the Dziewkowice Formation of the North-Sudetic Basin. It supports the previous conclusion of Senkowiczowa (in Senkowiczowa and Kotański, 1979*b*, tab 6; 1986*b*, tab 7) that *H. socialis* occurs throughout the Lower Muschelkalk.

***Plagiostoma* Sowerby, 1814 and *Pseudolimea* Arkell, 1932**. Both Assmann (1937) and Senkowiczowa (in Senkowiczowa and Kotański, 1979*b*, tab. 6; 1986*b*, tab. 7) stated that in the Dziewkowice Formation these genera are represented exclusively by *Plagiostoma striatum* (Schlotheim, 1823). According to tab. 6 (in Senkowiczowa and Kotański, 1979*b*) *P. striatum* is absent from the North-Sudetic Basin but it is mentioned in the same paper that *P. striatum* occurs in this region. Noetling (1880), Leśniak (1978) and Chrząstek (1996) found numerous specimens of this species there. According to Senkowiczowa (in Senkowiczowa and Kotański, 1979*b*, tab. 6; 1986*b*, tab. 7) *Pseudolimea acutecostata* (Assmann, 1937), occurs in the Upper Gogolin Beds of the North-Sudetic Basin and Upper Silesia and in the Karchowice Formation and the Diplopora Beds of Upper Silesia. Moreover, Kaim (1997) found also *P. acutecostata*, *P. dunkeri* (Assmann, 1937), and *P. regularis* (Alberti, 1864) in the Dziewkowice Formation of Upper Silesia (Tab. 1). *P. dunkeri* occurs also in the Karchowice Formation (Assmann, 1937).

***Entolium discites* (Schlotheim, 1820)**. Assmann (1937) reported this species from almost all of the Muschelkalk ranging from the Röt to the Wilkowice Beds (with the exception of the Tarnowice Beds). Senkowiczowa (in Senkowiczowa and Kotański, 1979*b*, tab. 6; 1986*b*, tab. 7) restricted this range to the interval from the Röt to the Górażdże Formation. Regrettably they did not give the reason for such a restriction because the determination of *E. discites* from the Diplopora Beds and the Wilkowice Beds by Assmann (1937) seems to be still valid (Tab. 1). Assmann's opinion is, moreover, supported by abundant presence of *E. discites* in the Dziewkowice Formation (Niedźwiedzki, 1998, 2000), the Karchowice Formation (Bodzioch, 1989) and in the Diplopora Beds (Senkowiczowa, 1998). This species is known from the whole section of the Lower and Upper Muschelkalk from the North-Sudetic Basin (Senkowiczowa and Kotański, 1979*b*, tab. 6; 1986*b*, tab. 7).

AMMONOIDS

***Beneckeia buchi* (Alberti, 1834)**. Senkowiczowa (1979*a*, tab. 7;1986*a*, tab. 8) reported this species in Upper Silesia only from the Upper Gogolin Beds (that is consistent with the data of Assmann, 1937), whereas in the North-Sudetic Basin she reported this species both from the Gogolin Beds and the Górażdże Formation. Unfortunately neither descriptions, illustrations nor information about the curation of the specimens from the Górażdże Formation is given in these papers. Other authors found *B. buchi* only in the Upper Gogolin Beds (Noetling, 1880; Holdefleiß, 1915; Leśniak, 1978). Therefore, in my opinion the presence of this species in the Górażdże Formation from the North-Sudetic Basin is rather doubtful (Tab. 1). One well-preserved specimen of *B. buchi*, probably from the Lower Gogolin Beds in Upper Silesia, was described by Kaim and Niedźwiedzki (1999).

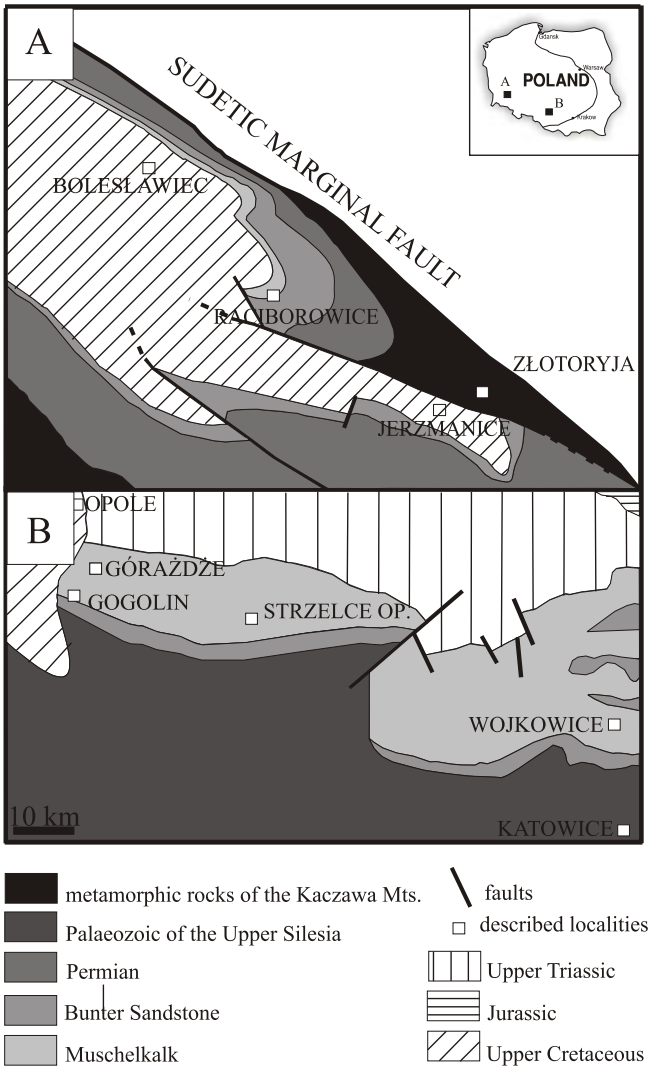

Fig. 2. Geological map of Silesia (after Chrząstek, 1995; Bodzioch, 1997*a*, simplified)

***Balatonites zimmermanni* Rassmuss, 1915, *B. zimmeri* Rassmuss, 1915, and *B. quaternonodatus* Rassmuss,1915**. Senkowiczowa (1979*a*, tab. 7; 1986*a*, tab. 8; in these papers *B. quaternonodatus* was misprinted as *B. quaternonotatus*) stated that these species occur in the Lower to Upper Gogolin Beds and in the Górażdże Formation of the North-Sudetic Basin. This statement is confusing because it is not supported by any new findings. All known specimens of these ammonoids were collected by Rassmuss (1915) from the upper part of the "Unteren Wellenkalkes" (equivalent to the Upper Gogolin Beds).

***Acrochordiceras damesi* Noetling, 1880**. Senkowiczowa (1979*a*, tab. 7; 1986*a*, tab. 8) stated that this species occurs exclusively in the Gogolin Beds and the Górażdże Formation in the North-Sudetic Basin. A single specimen of *Acrochordiceras damesi* of the North-Sudetic Basin was found in the Lower Raciborowice Beds by Noetling (1880). These strata are

Table 1

Stratigraphic ranges of some invertebrates in the Röt and the Muschelkalk from Silesia

Invertebrate taxa		Lithostratigraphical units								
		Rt	Lower Gogolin Beds	Upper Gogolin Beds	Górażdże Formation	Dziewkowice Formation	Karchowice Formation	Diplopora Beds	Tarnowice Beds	Wilkowice Beds
Porifera				**+** U	+ **+** L; U	**+** U	+ U	+ U		
Gastropoda		+ + L;U	+ + L;U	+ + L;U	+ + L;U	+ **+** L;U	+ + L; U	+ U		**+** U
Bivalvia	*Prospondylus ernesti*				+ U	**+** U	**+** U			
	Hoernesia socialis	+ + L;U	+ + L;U	+ + L;U	+ + L;U	+ **+** L;U	+ + L; U	+ U		+ U
	Pseudolimea acutecostata			+ + L?;U		**+** U	+ U	+ U		
	Pseudolimea dunkeri					**+** U	+ U			
	Pseudolimea regularis					**+** U				
	Entolium discites	+ U	+ + L;U	+ + L;U	+ + L;U	+ **+** L;U	+ **+** L; U	**+** U		+ **+** L; U
	Schafhaeutlia		+ U		+ U	**+** U	+ U	+ U		
	Homomya	+ U	+ U	+ U	+ U	**+** U				
Ammonoidea	*Beneckeia buchi*		**+** U	+ + L;U	**-**					
	Balatonites zimmermanni, B. quaternonodatus, B. zimmeri		**-**	+ L	**-**					
	Acrochordiceras damesi		+ L	+? L	**-**	**+** U				
Brachiopoda	*Hirsutella hirsuta*			**+** U	**+** U	+ U	**+** U			
	Tetractinella trigonella		**-**	**+** U	**+** U	**+** U	**+** U	**+** U		
	Coenothyris vulgaris		**+?** L	+ + L;U	+ + L;U	+ + L;U	+ + L;U	+ U		+? U
Echinodermata	*Encrinus liliiformis*			**-**	**-**	**-**	**-**			
	Triadotiaris grandaeva		**-**	**+** + L;U	**+ +** L;U	**+ +** L;U	**+ +** L; U	**+** U		

Bold cross — taxon found in the last twenty years and/or stratigraphic ranges revised; normal cross — earlier stratigraphic ranges not changed; dash — earlier data probably incorrect; question mark — occurrence not sure; L — Lower Silesia (the North-Sudetic Basin; all data only for Röt and Lower Muschelkalk); U — Upper Silesia; sources of data see in text

equivalent to the Lower Gogolin Beds and the lower part of the Upper Gogolin Beds (e.g. Chrząstek, 1996) thus the presence of the genus *Acrochordiceras* in the Górażdże Formation of the North-Sudetic Basin (Tab. 1) is doubtful. Dzik (1990) and Kaim and Niedźwiedzki (1999) recently described four specimens of *Acrochordiceras* (probably *A. damesi*) from the Dziewkowice Formation of Upper Silesia.

BRACHIOPODS

***Hirsutella hirsuta* (Alberti, 1865)**. Assmann (1937) found this species exclusively in the Dziewkowice Formation and in the lower part of the Middle Muschelkalk. Senkowiczowa and Zawidzka (in Senkowiczowa and Kotański, 1979*c*, tab. 3; 1986*c*, tab. 4) modified the range to the Upper Gogolin Beds — the Karchowice Formation. The presence of this species was upheld during further investigations from the Górażdże Formation (Niedźwiedzki, 1998, 2000) and the Karchowice Formation (Bodzioch, 1989).

***Tetractinella trigonella* (Schlotheim, 1820)**. According to Assmann (1937) this species ranges from the Upper Gogolin Beds to the Diplopora Beds. Senkowiczowa and Zawidzka (in Senkowiczowa and Kotański, 1979*c*, tab. 3; 1986*c*, tab. 4) reported that this species is present only in the Lower Gogolin Beds, however, the cited papers do not contain neither descriptions, illustrations nor localisations of the specimens from this unit. Other authors have never reported these brachiopods from the Lower Gogolin Beds; therefore the occurrence of *T. trigonella* cannot be regarded as proven (Tab. 1). The view of Senkowiczowa and Zawidzka (in Senkowiczowa and Kotański, 1979*c*, tab. 3; 1986*c*, tab. 4) that *T. trigonella* occurs exclusively in the Lower Gogolin Beds is wrong. This species is common in the Górażdże Formation (Niedźwiedzki, 1993, 1998, 2000), the Dziewkowice Formation (Bodzioch, 1985; Niedźwiedzki, 1993, 1998, 2000; Kaim, 1997), and in the Karchowice Formation (Bodzioch, 1989; Kaim, 1997). The oldest specimens of *T. trigonella* I found came from the horizon of conglomerates (the lowermost part of the Upper Gogolin Beds) in Wojkowice near Katowice (MGUWr 5319s). This is consistent with the data of Assmann (1937).

***Coenothyris vulgaris* (Schlotheim, 1820)**. According to Assmann (1937) and Senkowiczowa and Zawidzka (in Senkowiczowa and Kotański, 1979*c*, tab. 3; 1986*c*, tab. 4) this terebratulid species ranges from the Upper Gogolin Beds to the Diplopora Beds. The latter authors stated that *C. vulgaris* is absent from the North-Sudetic Basin. However, this species was mentioned from the Upper Gogolin Beds, the Górażdże Formation, and the Dziewkowice Formation of this area by Noetling (1880), Holdefleiß (1915) and Chrząstek (1996) and from B Beds (equivalent of the Lower Gogolin Beds) by Chrząstek (1996).

ECHINODERMS

***Encrinus liliiformis* Lamarck, 1801**. Crinoid columnals of this species are known almost from the whole of the Lower Muschelkalk in Upper Silesia and in the North-Sudetic Basin (e.g. Leśniak, 1978; Senkowiczowa, 1979*b*, tab. 9; 1986*b*, tab. 10; 1998; Niedźwiedzki, 1993). Regrettably neither descriptions nor illustrations of the specimens are provided in these papers. Moreover, Hagdorn and Głuchowski (1993) in their paper on crinoid-based stratigraphy stated that this species is absent from Silesia (consistent with the data of Assmann, 1937) and it is known exclusively from the Upper Muschelkalk of the other regions of Poland (Tab. 1). Therefore, it is quite possible that the columnals of *E. liliiformis* from the Lower Muschelkalk in Poland were incorrectly determined and represent another crinoid species.

***Triadotiaris grandaeva* (Alberti, 1834)**. Assmann (1937) reported this species exclusively from the Upper Gogolin Beds and the Diplopora Beds of Upper Silesia. Senkowiczowa (1979*b*, tab. 9; 1986*b*, tab. 10) reported this species from the Lower to the Upper Gogolin Beds. She did not prove that specimens *T. grandaeva* described by Assmann (1937) from the Diplopora Beds were incorrectly determined. Besides she did not give any proofs (neither descriptions nor localisations of specimens) of the occurrence of this species in the Lower Gogolin Beds. In addition, it is mentioned in the same book that *T. grandaeva* appears in the Upper Gogolin Beds (Senkowiczowa and Kotański, 1979*d*). Kaim (1997) and Niedźwiedzki (1998, 2000) found this species also in the Dziewkowice Formation. This supports earlier observations of Hagdorn and Głuchowski (1993) that *T. grandaeva* has a stratigraphical range from the Upper Gogolin Beds to the Diplopora Beds (Tab. 1). According to Hagdorn and Głuchowski (1993) the oldest specimens of *T. grandaeva* occur above the horizon of conglomerates, but I found spine of this species in the horizon of conglomerates in Wojkowice. Moreover, this species occurs both in the Holy Cross Mountains and in the North-Sudetic Basin (Hagdorn and Głuchowski, 1993).

Assmann (1937) established in Silesia the new echinoid species *Cidaris longispina*. In further works this species was misprinted as *Cidaris longispira* (Senkowiczowa and Kotański, 1979*d*, 1986*d*). In a revision of the Muschelkalk echinoids, Hagdorn (1988 in Hagdorn, 1995) synonymised this species with *Serpianotiaris coaeva* (Quenstedt, 1873).

OCCURRENCE OF FOSSILS IN THE KAMIONEK MARL MEMBER

Szulc (1993) stated that benthic body fossils and trace fossils were absent from the Kamionek Marl Member (the lowermost part of the Dziewkowice Formation = Lower Marls Unit *sensu* Kaim, 1997). As shown by Niedźwiedzki (1998, 2000) this member in Strzelce Opolskie and Górażdże quarries contains a relatively diverse fossil assemblage: bivalves: *Plagiostoma lineatum*, *Hoernesia socialis* (e.g. specimen MGUWr 5315s), *Homomya* sp., *Myophoria* sp., *Schafhaeutlia* sp., *Pseudocorbula* sp.; brachiopods: *Coenothyris vulgaris*; loxonematid and other gastropods, and undetermined crinoid columnals. Trace fossils of the ichnogenus *Palaeophycus* (*sensu* Pemberton and Frey, 1982) are common. Terebratulid brachiopods often occur in thin allochthonous coquina layers but gastropods and bivalves *Pseudocorbula* occur as layers of autochthonous coquina (Niedźwiedzki, 1998). Other bivalves seem to be autochthonous as valves are fragmented only rarely, signs of abrasions are absent and several bivalve shells were not disarticulated. Specimens of the genus, *Schafhaeutlia* (MGUWr 5317s) and *Homomya* (MGUWr 5316s) are reported herein for the first time from the Dziewkowice Formation.

CONCLUSIONS

Earlier data (e.g. Assmann, 1937; Senkowiczowa and Kotański, 1979*a*, *b*) suggest that many of the taxa in the Muschelkalk repeatedly appear and disappear, suggesting considerable variability of the palaeoenvironment during Muschelkalk sedimentation. Revision of the stratigraphic ranges of some invertebrate taxa based on recent studies (e.g. Bodzioch, 1989, 1993; Kaim, 1997; Niedźwiedzki, 1998, 2000) show that most of these taxa have continuous fossil records through long periods. A temporary or definitive disappearance of many species and genera is observed only in the Tarnowice Beds. This was probably caused by a profound change in palaeoenvironment (e.g. by an increase of salinity).

This revision also shows that the taxonomic diversity of fossil assemblages in the Dziewkowice Formation is greater than was estimated in earlier papers (e.g. Assmann, 1937; Senkowiczowa, 1979*a*, *b*; Senkowiczowa and Kotański, 1979*a*). Therefore, suggestions of prolonged anoxia during sedimentation (e.g. Szulc, 1993) are not well founded consider, rather that the waters were impoverished in oxygen during sedimentation of the Górażdże and Karchowice formations.

Abbreviations of cited repositories: MGUWr — Geological Museum of the Institute of Geological Sciences of Wrocław University.

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