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A Late Saalian Glaciation, Eemian Interglacial and Early Weichselian pollen sequence at Szklarka, SW Poland – Reconstruction of vegetation and climate

Małgorzata Malkiewicz

Laboratory of Paleobotany, Department of Stratigraphical Geology, Institute of Geological Sciences, University of Wrocław, Cybulskiego 34, 50-205 Wrocław, Poland

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ABSTRACT

This paper presents the results of palinological studies of the sediments from the site of Szklarka (Silesian Lowland, SW Poland). The pollen sequence from Szklarka records the longest continuous succession of vegetation covering the Late Saalian, Eemian Interglacial and Early Weichselian in SW Poland. The results of pollen analysis show phases with forest and open vegetation communities in response to climate changes. The pollen zones distinquished represent cool phases of the Late Saalian, a complete Eemian interglacial succession (E1-E7 R PAZ) and two cool intervals (Herning and Redestall) and one warm one (Brörup) from the Early Weichselian. Two main phases have been distinguished in the Brørup Interstadial, an older birch phase and a younger pine phase. During the Brørup Interstadial, towards the end of the birch phase, a cooling event has been recorded.

1. Introduction

Reconstruction of the plants and climate of the last interglacial-glacial cycle is based on natural processes in the natural environment. Significatly, humans had no influence on the environment of that time. The problem of the paleoenvironment of the last interglacial and the stability of its climate has been discussed in numerous papers (e.g. Kukla et al., 2002; Guiter et al., 2005; Klotz et al., 2003; Kühl and Litt, 2003; Müller et al., 2003; Velichko et al., 2005; Börner et al., 2015). Analyses of ice cores in Greenland confirmed the temperature fluctuation of the last interglacial-glacial cycle (Anklin et al., 1993; Dansgaard et al., 1993; McManus et al., 1994). Palaeobotanical and isotope investigations in Germany (Litt et al., 1996) suggest that the Eemian Interglacial had a relatively stable climate with strong oscillations only during the Early Weichselian. Most of the palinological investigations from Europe suggest that the last interglacial was an uninterrupted warm interval with a major oscillation change in winter temperatures during the mesocratic part (Menke and Tynni, 1984; Frenzel, 1991; Zagwijn, 1996). On the other hand, fossil pollen from the Eemian sites in Central and Eastern Europe indicate climate instability at the end of the Eemian Interglacial (Eissmann, 2002; Velichko et al., 2005; Borisova et al., 2007; Hermsdorf and Strahl, 2008; Novenko et al., 2008; Boettger et al., 2009; Mirosław-Grabowska et al., 2015).

Literature on the vegetation history of the Eemian Interglacial in Poland is extensive. At the end of 1980s, 99 Eemian and Eemian-Weichselian sites were known (Mamakowa, 1989). By the end of 2006, nearly twice as many of these had been described (Bruj and Roman, 2007). However, there are very few sites with a continuous sequence comprising the Eemian succession in addition to the Weichselian succession. Profiles containing a continuous record from the Late Saalian through the Eemian Interglacial to the Early Weichselian are even more sparse. At the beginning of the 21st century subsequent sites were described which, except for the Eemian Interglacial, comprise a significant part of the Last Glacial (Weichselian) (Balwierz, 2003; Granoszewski, 2003; Kupryanowicz, 2005, 2008; Kuszell et al., 2007; Roman and Balwierz, 2010; Malkiewicz, 2008, 2010; Kołaczek et al., 2012; Majecka, 2014). However there are still only a few sites with a continuous Eemian-Weichselian succession sequence, and each is very important for understanding the development of vegetation, climate and stratigraphy of the Late Pleistocene.

E-mail address: malgorzata.malkiewicz@uwr.edu.pl.

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There are little floristic data from the period of the Eemian Interglacial and Early Weichselian for the Silesian Lowland. Up to the present, in this area only two sites with a complete fossil flora of the Eemian Interglacial and an almost complete one for the Early Weischelian have been recorded (Mamakowa, 1989; Kuszell and Malkiewicz, 1999; Kuszell et al., 2007). Fig. 1 shows the Late Saalian, Eemian Interglacial and Early Weichselian fossil flora sites from Silesian Lowland recorded in Poland since 2000. For this reason, the Szklarka site appears to be highly significant. It provides new data on local changes in plants and climate changes during the Eemian Interglacial and Early Weichselian in the area of south-western Poland. At the same time, it broadens our knowledge of the regional changes in the natural environment of the last glacial/interglacial cycle. The Szklarka site appears to be equally valuable because, additionally, we can draw conclusions on the changes in the natural environment at the Late Saalian to Eemian Interglacial transition.

2. Regional setting

The Szklarka site is located in south-western Poland on the Oleśnica Plain – part of the Silesian Lowland (Kondracki, 1994) (Fig. 1). In the north, the Oleśnica Plain lies adjacent to the Trzebnica Ridge, a frontal push moraine of Elsterian and partly Saalian Glaciation (= Odranian Glaciation after Lindner, 2005). One characteristic feature of the eastern part of the Oleśnica Plain is the presence of depressions filled with organic sediments of significant thickness in the Widawa River valley (an Odra River tributary). The area investigated is situated within one of the warmest climatic regions in the country. According to Woś (1999), it belongs to the climatic region that is situated within the area of influence of oceanic air masses and the mountain climate of the Sudety Foreland. Mean annual temperature here is ca. 8.5 °C. Winter is relatively short and mild, and summer is long and warm. Total annual precipitation is ca. 550 to 650 mm; westerly winds predominate (Walczak, 1970; Woś, 1999). The present-day natural vegetation of the Oleśnica Plain is represented by numerous plant communities of several classes, such as *Querco-Fagetea, Quercetea robori-petraeae, Vaccinio-Piceetea, Alnetea glutinosae, Nardo-Callunetea, Trifolio-Geranietea*, or *Potametea* (Gorzelak, 2008). Forests are present in the form of small and medium-sized areas, and, in the composition of the forest stands, the present combination of species in the composition of the forest stands significantly departs from that of the forest communities that were shaped several centuries ago (Zielony and Kliczkowska, 2012). At present, in the Oleśnica Plain there are mainly coniferous and mixed forests (*Vaccinio-Piceetea*), as well as acidic oak forests (*Quercetea robori-petraeae*). Some of the deciduous forests communities are substantially altered, others completely run down or are found in isolated blocks and fragments in small areas. These include, first of all, hornbeam forests (*Galio silvatici-Carpinetum*) and beech forests (*Galio odorati-Fagetum* and *Luzulo pilosae-Fagetum*). Depressions and river valleys are places where small areas of riverine forests (*Fraxino-Alnetum* and *Ficario-Ulmetum campestris*) and alder carrs (*Ribo nigri-Alnetum* and *Sphagno squarrosi-Alnetum*) have survived (Kossakowski, 1999; Gorzelak, 2008).

The Szklarka site presented in this paper is one of two fossil depressions, located at a distance of 1 km to the east of the Widawa River, in which fluvial, lacustrine, and swamp deposits were encountered at a depth of 0.0–12.0 m (Fig. 2). The second depression is located at a distance of ca. 2 km to the south of the Szklarka site and it is filled with organic sediments of similar thickness. A precise description of the geology of the area investigated was presented in the papers of Chmal (1998) and Kuszell et al. (2007).

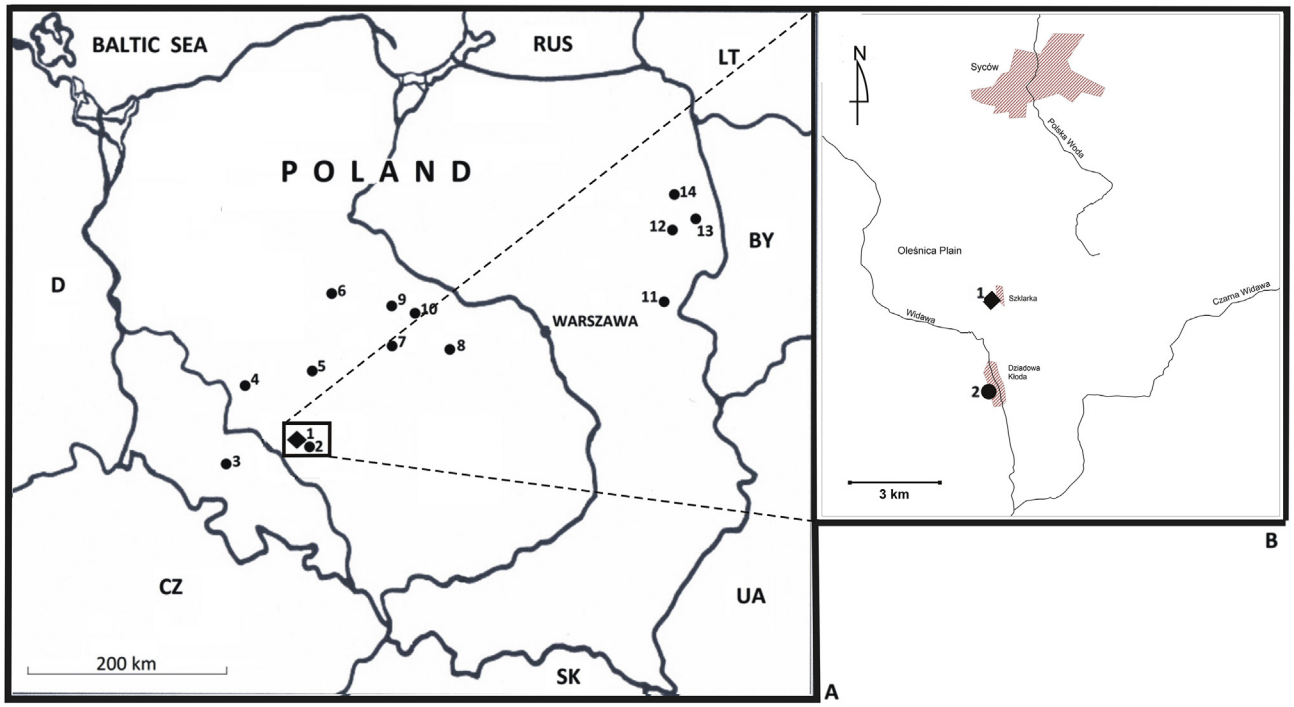

Fig. 1. Location map of the Szklarka site and selected Late Saalian/Eemian/Early Weichselian fossil flora sites cited in the text (A): 1 – Szklarka (Kuszell and Malkiewicz, 1999; this paper), 2 – Dziadowa Kłoda (Kuszell et al., 2007); 3 – Imbramowice (Mamakowa, 1989); 4 – Lechitów (Malkiewicz, 2002); 5 – Gutów (Malkiewicz, 2008, 2010); 6 – Mikorzyn (Stankowski and Nita, 2004); 7 – Ustków (Kołaczek et al., 2012); 8 – Żabieniec Południowy (Majecka, 2014); 9 – Kubłowo (Roman and Balwierz, 2010); 10 – Łanięta (Balwierz, 2003; Roman and Balwierz, 2002); 11 – Horoszki Duże (Granoszewski, 2003); 12 – Solniki (Kupryanowicz, 2008); 13 – Michałowo (Kupryanowicz and Drzymulska, 2002; Kupryanowicz, 2008); 14 – Machnacz (Kupryanowicz, 2008). Location of Szklarka in relation to Syców vicinity (B).

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