

MEGASPORES AND CUTICULAR STUDY OF COAL PEBBLES FROM FLYSCH DEPOSITS OF THE POLISH CARPATHIANS

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ABSTRACT. The megasporite studies were based on the examination of megaspores found in coal material from two coal pebbles and earlier results of J. Zerndt for four pebbles from the Polish Carpathians. A list of the megaspores present was compiled, comprising 15 megaspore taxa and including 4 long-lived species and groups of species and 11 species characteristic of Westphalian, particularly Upper Westphalian. Taxonomic studies and qualitative and quantitative character of the megaspores revealed similarities to those from the Upper Silesian Coal Basin and an attempt was made to assess the age of individual pebbles more accurately.

Material for the cuticular studies came from the two coal pebbles examined for megaspores. Some tens of cuticular fragments were recovered; 30 were mounted in glycerine jelly with thymol as permanent microscope slides. Their analysis revealed 11 types of plant cuticles. 5 of these belong to the genus *Cordaites*. Several cuticles of animal origin and some wood fragments were also found.

KEY WORDS: megaspores, cuticular analysis, coal pebbles, Carboniferous, Polish Carpathians

ORIGIN AND CHARACTERISTICS OF THE MATERIAL STUDIED

Megaspore and cuticular studies were carried out on two coal pebbles found by Słomka (1996) in the Żywiec area. For only megaspores, the results obtained were combined with unpublished and published data of Zerndt (1933) for another four coal pebbles from the Polish Carpathians (pebbles from Czudec, Domaradz, Bartkówka and Woźniki). The locations and structural and lithographical position of the flysch deposits in which the pebbles were found as well as the studies carried out are summarised in Fig. 1 and Tab. 1.

MEGASPORE STUDY

Information on the occurrence of megaspores in Carboniferous coal pebbles was derived from the analysis of megaspore material obtained after maceration from coal pebbles Żywiec PZ-2 and PZ-8 from the Żywiec area. This was combined with a reinterpretation of the work of Zerndt on coal pebbles from Czudec, Domaradz, Bartkówka and Woźniki (Fig. 1).

The following megaspore taxa occur in the coal pebbles examined: *Calamospora* spp., *Cystosporites giganteus* (Zerndt) Schopf, *C. varius* (Wicher) Dijkstra, *Laevigatisporites glabratus* (Zerndt) Pot. et Kr., *Lagenicula*

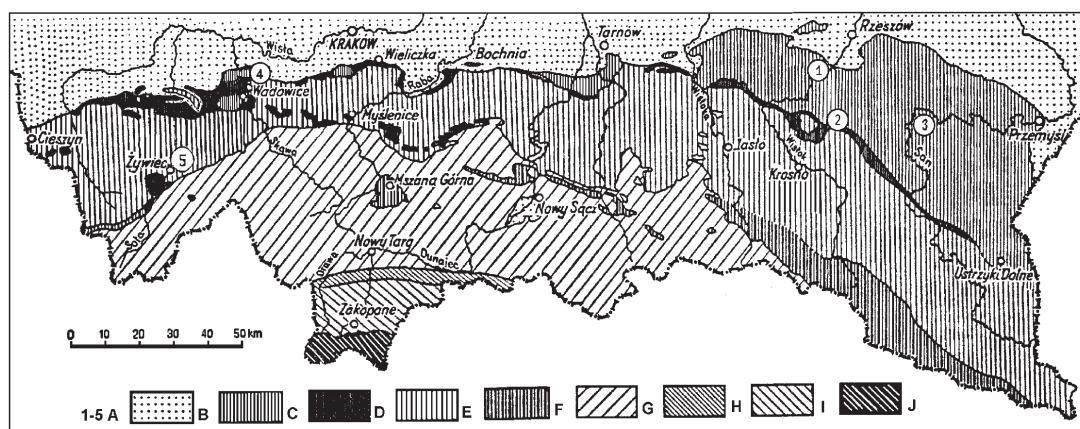


Fig. 1. Tectonic map of the Polish Carpathians (after Atlas Geologiczny Polski 1962). A – origin of the coal pebbles (1 – Czudec, 2 – Domaradz, 3 – Bartkówka, 4 – Woźniki, 5 – Żywiec), B – unfolded miocene, C – Skole Nappe, D – Subsilesian Nappe, E – Silesian Nappe, F – Submagura and Dukla Nappe, G – Magura Nappe, H – Pieniny Klippen Belt, I – Podhale flysch, J – Tatra Mountains

Table 1. Structural, lithostratigraphic and chronostratigraphic characteristics of flysh sediments containing the pebbles examined and studies carried out on the material

Pebbles	Zone	Litostratigraphic units	Age	Studies	
Czudec	Skole Nappe	Babice Shale	Paleocene	Reinterpretation of published and unpublished data in the archives of J. Zerndt	
Domaradz		Menilite Beds	Oligocene		
Bartkówka					
Woźniki	Subsilesian Nappe	Grodzisk Beds	Hauterivian	Examination of samples Źywiec PZ-2 and PZ-8 by S. Florjan and E. Źołdani	
Źywiec		Cieszyn Beds			

Table 2. Megaspores in Carboniferous pebbles from the Carpathians. Long lived species and groups of megaspore species are shaded. Key: 1 – *Cystosporites giganteus*, 2 – *Calamospora* spp., 14 – *Tuberculatisporites* spp., 20 – *Zonalesporites brasserti*, 17 – *Triangulatisporites triangulatus*, 27 – *Lagenicula* spp., 21 – *Setosporites praetextus*, 13 – *Setosporites hirsutus*, 30 – *Cystosporites varius*, 25 – *Lagenoisporites rugosus*, 10 – *Laevigatisporites glabratus*, 11 – *Valvisporites auritus*, 24 – *Zonalesporites superbus*, 12 -*Valvisporites appendiculatus*, 16 – *Triletisporites tuberculatus*

Sample	Megaspores														
	1	2	14	20	17	27	21	13	30	25	10	11	24	12	16
Woźniki		5	27		37		2	1	2		1	39	12		1
Źywiec PZ-8			10	20	366			7			1?	86	75	8	
Źywiec PZ-2	5	32	347	1,189	424				10			174	117		
Czudec				14		205		1	2	1	70	620	95		1
Bartkówka				220		5		76	3	4	6	1	57		3
Domaradz		1	60		14	1	108	4				10	32		

Table 3. Stratigraphic position of the pebbles

Pebbles	Lithostratigraphy	Chronostratigraphy
Woźniki	Łaziska beds (upper part)	
Źywiec PZ-8	Łaziska beds (upper part)	Westphalian C
Źywiec PZ-2	Łaziska beds (lower part) / Orzesze beds (upper part)	
Czudec	Łaziska beds (lower part) / Orzesze beds (upper part)	Westphalian B
Bartkówka	Orzesze beds (upper part)	
Domaradz	Orzesze beds	Westphalian B/A

spp., *Lagenoisporites rugosus* (Loose) Pot. et Kr., *Setosporites hirsutus* (Loose) Ibrahim, *S. praetextus* (Zerndt) Pot. et Kr., *Triangulatisporites triangulatus* (Zerndt) Pot. et Kr., *Triletisporites tuberculatus* (Zerndt) Pot. et Kr., *Valvisporites appendiculatus* (Maśl.) Pot. et Kr., *V. auritus* (Zerndt) Pot. et Kr., *Zonalesporites brasserti* (Stach et Zerndt) S. Dyb.-Jach. et al. and *Z. superbus* (Bartlett) Karcz.

The above assemblage of megaspores consists of long-lived megaspores, which begin to appear in Dinant or Namurian and are present all the way to Westphalian D and taxa characteristic of Westphalian, particularly Upper Westphalian. The latter group comprises: *Cystosporites varius*, *Laevigatisporites glabratus*, *Setospori-*

tes hirsutus, *Triletisporites tuberculatus*, *Valvisporites appendiculatus*, *V. auritus* and *Zonalesporites superbus*. Qualitative and quantitative information about the occurrence of megaspore taxones in individual pebbles is summarised in Tab. 2.

Taxonomic examination and comparison of qualitative and quantitative occurrence of megaspores in the pebbles suggests that the megaspores are similar to those known from the Upper Silesian Coal Basin (Kmiecik 1995). On this basis an attempt was made to assess the age of the individual coal pebbles. Bearing this in mind, the assessment could be carried out on the basis of the range and quantitative occurrence data for megaspore species and groups of species from the Upper Silesian

Coal Basin (Kmiecik 1995). The results of such qualitative and quantitative examination of megaspore assemblies associated with individual pebbles are given in Tab. 3, together with the stratigraphic position of the pebbles.

CONCLUSIONS FROM THE MEGASPORE STUDY

1. Fifteen megaspore species and groups of species were found in the pebbles studied.
2. In addition to long lived ones, species and groups of megaspore species were found which are characteristic of Westphalian limnic sediments.
3. There are similarities between megaspores found in the pebbles and those characteristic of the Upper Silesian Coal Basin.
4. Detailed qualitative, quantitative and taxonomic analysis of megaspore species and groups of species found in the coal pebbles made it possible to define approximately both their stratigraphic and chronostratigraphic position.
5. The occurrence of numerous Carboniferous pebbles in Carpathian deposits (Turnau 1970) suggests that there had been a Westphalian coal basin in that region. This is indicated schematically in palaeogeographic maps of the Upper Carboniferous (Bojkowski & Porzycki 1983). In the light of the present work these maps should now be corrected from both the geographic and stratigraphic point of view.
6. After further detailed sedimentological and palynological studies the determination of the full contour of the Carpathian Westphalian coal basin should be possible.

CUTICULAR STUDY

In the course of cuticular studies, maceration of material from pebbles Żywiec PZ-2 yielded several tens of fragments of cuticles, but from pebble Żywiec PZ-8 only one fragment of plant cuticle was recovered. Moreover, the fragment was difficult to identify. On the basis of Żywiec PZ-2 material 20 permanent microscope slides were prepared (in glycerine jelly with thymol). The largest cuticles found measured about 3 mm.

During microscopic examination of the mounted specimens 11 types of plant cuticles were found. These types were designated by the letters A to K. Cuticles with stomata belonging to types A-E (Pl. 1, figs 1-6) represent the genus *Cordaites* (Sternb., 1822) Unger 1850. Types F-K (Pl. 2, figs 1-7) are characterised by the absence of stomata. These are probably cuticles of

upper leaf epidermis, cuticles of rachis or of stems. The commonest type of cuticles found, represented by 10 specimens, was F (Pl. 2, figs 1, 2), a cuticle with isodiametric or slightly elongated cells and very prominent anticlinal walls. Cuticles of this type were found in material from many coal seams from the Upper Silesian Coal Basin, belonging to sediments classified as Westphalian B and in no. 206/5 coal seam in borehole Góra IG-29 (USCB, Westphalian C) (Florjan 1997). This indirectly confirms that the coal pebble Żywiec PZ-2 is Westphalian.

Some of the cuticles found in pebble Żywiec PZ-2 were not encountered in coal seams from the Upper Silesian Coal Basin, e.g. the type A cuticle (Pl. 1, fig. 1) and type E (Pl. 1, fig. 6). Type A is a cuticle with stomata arrayed in irregular lines, separated by many rows of isodiametric or slightly elongated cells with single papilla. Type E is a cuticle with dispersed stomata and elongated cells. This type of cuticles probably represent upper epidermis of *Cordaites* leaves.

In addition, in material from pebble Żywiec PZ-2 animal cuticles were found, as well as some wood fragments.

Detailed descriptions of the megaspores and cuticles will be published separately.

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PLATES

Plate 1

Cuticles of *Cordaites* spp. from coal pebble Źywiec PZ-2

1. Type A, slide No PZ-2-4, $\times 150$
2. Type B, slide No PZ-2-12, $\times 170$
3. Type C, slide No PZ-2-9, $\times 400$
4. Type D, stoma, slide No PZ-2-1, $\times 500$
5. Type D, stoma, slide No PZ-2-3, $\times 550$
6. Type E, stoma, slide No PZ-2-14, $\times 500$

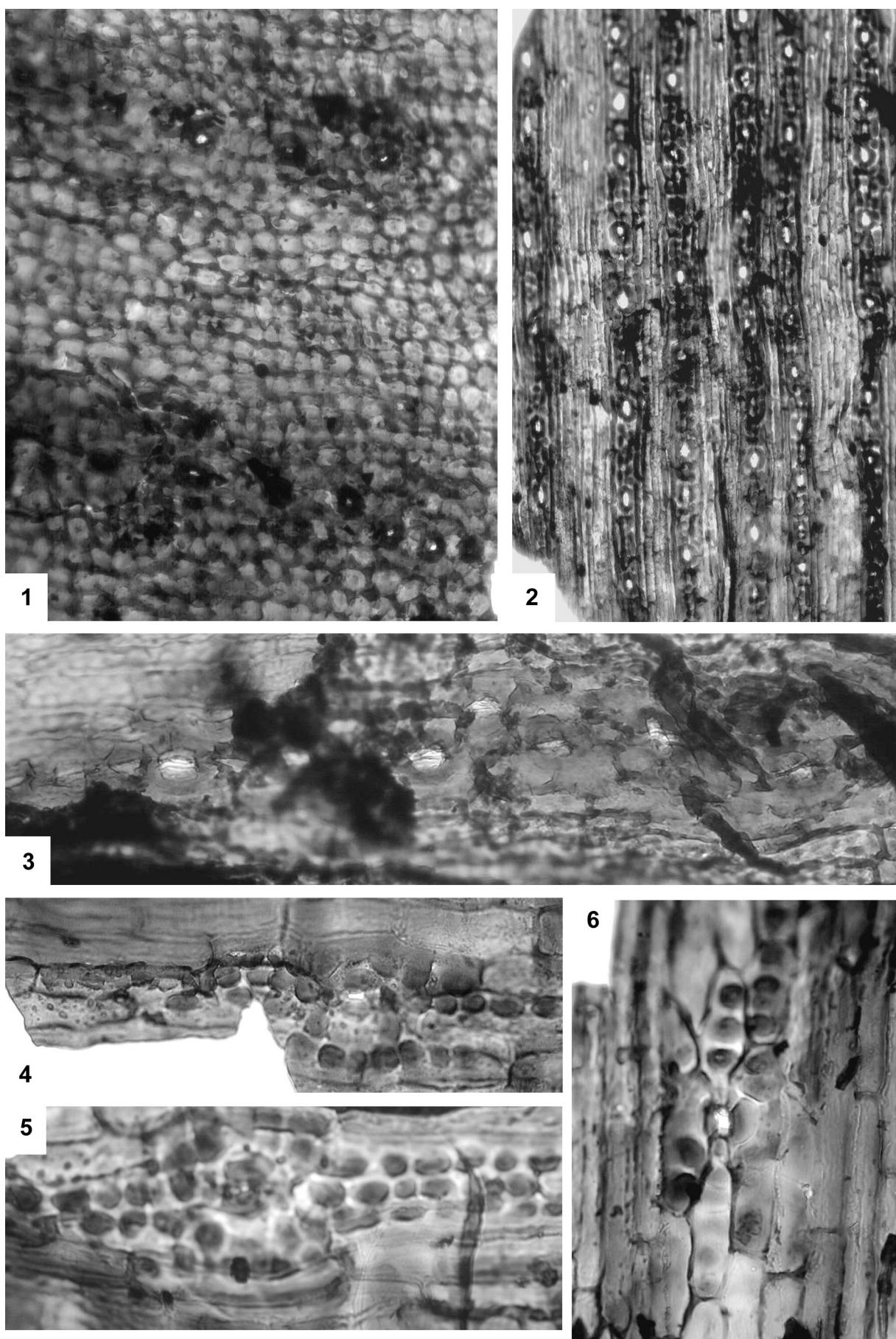


Plate 2

Cuticles from coal pebble Źywiec PZ-2

1. Type F, slide No PZ-2-17, $\times 210$
2. Type F, slide No PZ-2-4, $\times 260$
3. Type I, cuticle from boundary of pebble and surrounding rock, slide No PZ-2-6, $\times 270$
4. Type G, cuticle or fragment of seed, slide No PZ-2-19, $\times 260$
5. Other fragment of specimen from fig. 4, $\times 500$
6. Type H, cuticle with hypodermis (?) or fragment of seed, slide No PZ-2-13, $\times 210$
7. Type J, slide No PZ-2-5, $\times 240$

