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The distribution of dinoflagellate cysts across a Late Cenomanian carbon isotope ($\delta^{13}C$) anomaly in the Pulawy borehole, central Poland

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ABSTRACT – Late Cenomanian dinoflagellate cyst assemblages in the Pulawy borehole, central Poland, exhibit similarities with those from west European and North American localities. A comparable change in assemblage composition around the base of a positive carbon isotope ($\delta^{13}C$) anomaly occurs in all three areas. *J. Micropalaeontol.* **23**(1): 77–80, May 2004.

INTRODUCTION

In a recent paper (Dodsworth, 2000), the distributions of dinoflagellate cysts across the Cenomanian–Turonian Stage boundary in Pueblo, Colorado, USA and Durdle Door, Lulworth, southern England were documented and a review of data from previous studies of coeval sediments in North America and west Europe was given. Range bases and tops of regional and inter-regional dinoflagellate cyst marker taxa were calibrated against planktonic foraminifera and a widespread positive carbon isotope ($\delta^{13}C$) anomaly. The anomaly is probably associated with inter-regional enhanced burial of organic carbon during the interval (Schlanger & Jenkyns, 1976) and may be linked to contemporary faunal turnovers (e.g. Hart, 1996).

This short paper documents new palynological data from the Pulawy borehole, central Poland, from splits of samples that have previously been analysed for foraminifera, calcareous nannofossils and geochemistry (Peryt & Wyrwicka, 1993; Peryt *et al.*, 1994). Danuta Peryt has kindly supplied samples Pul-14 to Pul-19 from the section 844.60–846.40 m, encompassing part of the Late Cenomanian interval (Fig. 1). Inter-regional biostratigraphic markers recorded by Peryt & Wyrwicka (1993) include the range base of the calcareous nannofossil *Quadrum gartneri*, at the depth 844.50 m, and range top of the planktonic foraminiferid *Rotalipora cushmani* at the depth 845.40 m (sample Pul-16). Peryt & Wyrwicka (1993) placed the base of the Turonian Stage at the base of *Q. gartneri*. A carbon isotope ($\delta^{13}C$) anomaly was recorded in samples Pul-16 to Pul-18, encompassing the marly interval 845.60–845.15 m (Fig. 1).

PALYNOLOGICAL DATA

Palynomorphs were extracted using hydrochloric and hydrofluoric acids and sieved at 10 μm. Laboratory oxidation was not given to any samples. Palynological recovery from the section is generally poor. Samples Pul-15, -16, -17 and -19

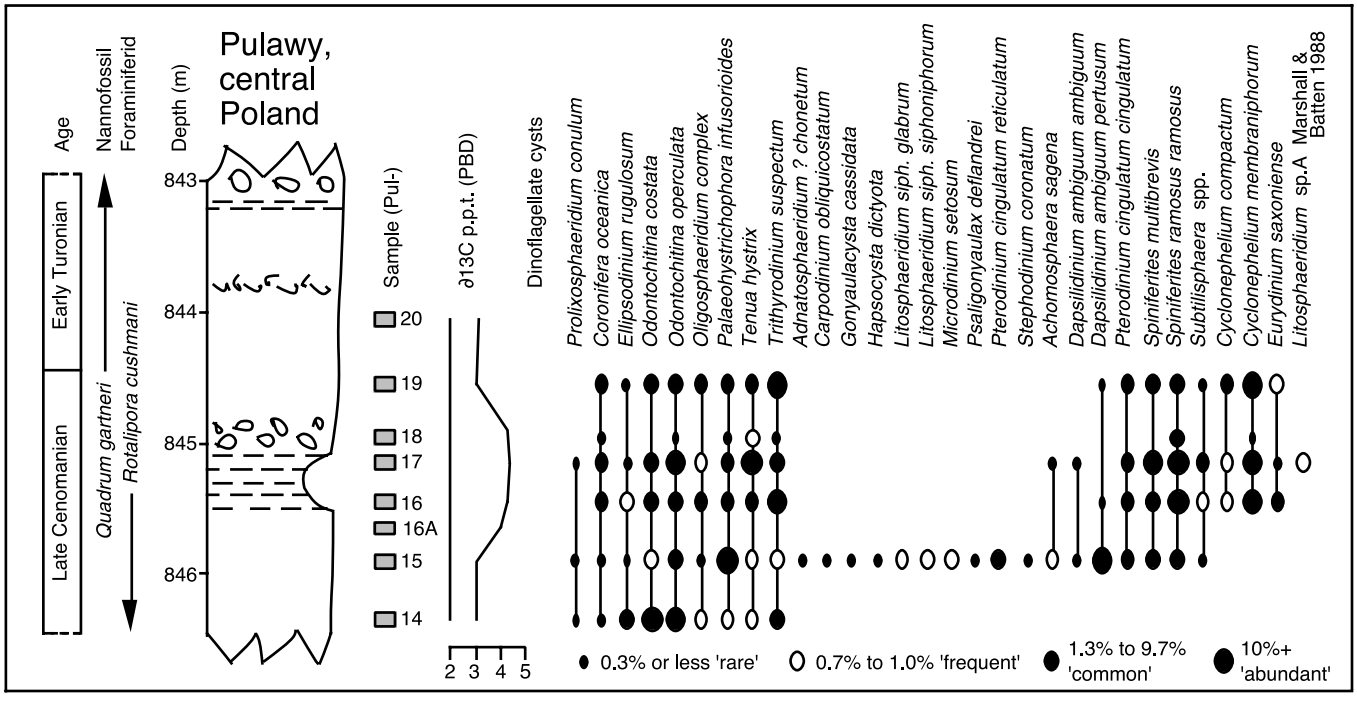

Fig. 1. The distribution of selected dinoflagellate cysts from samples Pul-14 to -19 in the Pulawy borehole, central Poland. The lithological log, foraminiferal, nannofossil and geochemical data are from Peryt & Wyrwicka (1993). The succession is composed of light-coloured limestones (chalk), except the interval 845.60–845.15 m which is more clay-rich and darker coloured.

	Sample Pul-14	Pul-15	Pul-16A	Pul-16	Pul-17	Pul-18	Pul-19
Dinoflagellate cysts							
Cleistosphaeridium spp.	1	2		5			
Coronifera oceanica	1	1		5	3	1	9
Ellipsodinium rugulosum	4	1		2	1		1
Odontochitina costata	13	2		4	10		16
Odontochitina operculata	66	8		10	30	1	11
Oligosphaeridium complex	3	1		16	3		11
Palaeohystrichophora infusorioides	2	94		8	24	1	8
Prolixosphaeridium conulum	1	1			1		
Tenua hystrix	2	3		15	36	2	11
Trithyrodinium suspectum	7	3		38	20	1	67
Achomosphaera ramulifera		5			1		
Achomosphaera sagena		2			1		
Adnatosphaeridium? *chonetum*		1					
Callaiosphaeridium asymmetricum		1			1		
Carpodinium obliquicostatum		1					
Chlamydophorella? spp.		4					
Cleistosphaeridium armatum		1			1		2
Cometodinium spp.		4		2	5		3
Cribroperidinium spp.		1					
Cyclonephelium membraniphorum		?1		37	30	1	30
Cyclonephelium vannophorum		1			1		1
Dapsilidinium ambiguum ambiguum		1			1		
Dapsilidinium ambiguum pertusum		76		1			1
Dapsilidinium laminaspinosum		1			1		2
Dinopterygium cladoides		1				1	
Dorocysta litotes		1					
Endoscrinium campanula		1		1			
Exochosphaeridium bifidum		3		3	1		5
Exochosphaeridium phragmites		3		5			
Florentinia ferox		1			1		1
Fromea amphora		1					
Gonyaulacysta cassidata		1					
Hapsocysta dictyota		1					
Hystrichodinium pulchrum		8			5		
Hystrichodinium spp.		1					
Hystrichostrogylon membraniphorum		1		2	1		
Kalyptea spp.		1					3
Kleithriasphaeridium loffrense		1			1		
Kleithriasphaeridium readei		1					
Litosphaeridium siphoniphorum glabrum		2					
Litosphaeridium siphoniphorum siphoniphorum		2					
Microdinium setosum		2					
Microdinium spp.		1					1
Pervosphaeridium pseudhystrichodinium		1					
Psaligonyaulax deflandrei		1					
Ovoidinium cf. *incomptum* (reworked?)		1					
Pterodinium cingulatum cingulatum		8		10	9		7
Pterodinium cingulatum reticulatum		4					
Spiniferites multibrevis		29		26	51	1	27
Spiniferites ramosus granosus		1		2			
Spiniferites ramosus ramosus		14		33	46	8	17
Stephodinium coronatum		1					
Subtilisphaera spp.		1		6	3		1
Surculosphaeridium? *longifurcatum*		1					
Tanyosphaeridium spp.		1		2	1		1
Trichodinium castanea		1			1		
Trithyrodinium evittii		1		1			
Valensiella reticulata		1					
Wallodinium anglicum		1		2			
Xiphophoridium alatum		1					
Cyclonephelium compactum				2	2		10
Eurydinium saxoniense				6	1		2
Florentinia mantellii				1	1		2

Table 1. Palynological data from samples Pul-14 to -19 from the Pulawy borehole, central Poland.

	Sample Pul-14	Pul-15	Pul-16A	Pul-16	Pul-17	Pul-18	Pul-19
Dinoflagellate cysts *Continued*							
Florentinia radiculata				8	4		2
Hystrichosphaeridium recurvatum				2	2		1
Pervosphaeridium truncatum				1	1		
Eyrea? spp.					3		2
Litosphaeridium sp.A Marshall & Batten 1988					2		
Florentinia deanei					1		
Apteodinium deflandrei					1		
Florentinia aff. *ferox sensu* Davey & Verdier 1976							1
Acritarchs & prasinophyte phycomata							
Cymatiosphaera radiata		1					1
Leiosphaeridia spp.		2		3			3
Micrhystridium spp.		2		1			
Pterospermella spp.		1					
Tasmanites spp.		2		2			2
Foraminiferal test linings		10					
Terrigenous palynomorphs							
Lycopodiumsporites? spp.	1						
Bisaccate pollen		3		1	1		
Classopollis spp.		4					
Classopollis spp. (tetrads)		1					
Deltoidaspora spp.		4		1	1		1
Estimated recovery per sample – palynomorphs per gram (p.p.g.)	<1	2537	0	20	200	1	20

For authors of dinoflagellate cyst species, dates of original descriptions and authors of emended diagnoses, see Williams *et al*. (1998). Up to 300 palynomorphs were counted per sample.

Table 1. *Continued*.

yielded the richest and best-preserved assemblages (Table 1). Dinoflagellate cysts are prominent in all samples. Terrigenous palynomorphs, bisaccate pollen and spores, along with marine acritarchs and prasinophyte algae, are sparse. Figure 1 documents the distribution of dinoflagellate cyst marker taxa, along with taxa that are common to abundant in the section. All microscope slides used in this study are curated in the Palynology Research Facility, University of Sheffield.

Sample Pul-14 yielded a relatively lean assemblage containing longer-ranging Late Cretaceous dinoflagellates cysts, including abundant *Odontochitina* spp. Sample Pul-15, collected from immediately below the $\delta^{13}C$ anomaly, yielded a diversified assemblage, including taxa that have intra-Late Cenomanian range tops: rare *Carpodinium obliquicostatum* and *Gonyaulacysta cassidata* and frequent *Litosphaeridium siphoniphorum glabrum*, *L. siphoniphorum siphoniphorum*, *Microdinium setosum* and *Pterodinium cingulatum reticulatum*. Also present in the assemblage are abundant *Dapsilidinium ambiguum pertusum*, *Palaeohystrichophora infusorioides* and *Spiniferites* spp. Sample Pul-16A is barren of palynomorphs. Samples Pul-16, -17 and -19, collected from within and immediately above the $\delta^{13}C$ anomaly, are characterized by abundant *Cyclonephelium compactum–membraniphorum* 'complex', rare to common *Eurydinium saxoniense* and an absence of the marker taxa recorded in sample Pul-15. This association was first recorded from 'black shales' that span the Cenomanian–Turonian Stage boundary in northern Germany (Marshall & Batten, 1988) and has since been reported from coeval sediments in eastern England and the North Sea Basin (e.g. Dodsworth, 2000, fig. 12). Also present in assemblages from samples Pul-16, -17 and -19 are common *Coronifera oceanica, Odontochitina* spp., *Palaeohystrichophora infusorioides*, *Tenua hystrix* and abundant *Spiniferites* spp. and *Trithyrodinium suspectum*. Occurrences of *Litosphaeridium* sp. A of Marshall & Batten (1988) in sample Pul-17 are noteworthy. Sample Pul-18 yielded an impoverished assemblage. The Early Turonian marker taxon *Heterosphaeridium difficile* was not recorded in the section.

The sequence of Late Cenomanian dinoflagellate cyst events recorded in this central Poland section is comparable to those observed in west European and North American localities (see Dodsworth (2000) for a review). The change in assemblage composition between samples Pul-15 and -16 occurs in the same stratigraphic position, relative to the base of the $\delta^{13}C$ anomaly, indicating a comparable response to changing palaeoceanographic conditions over a wide area.

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