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Testing the congruence of the microfossil versus microfossil record in the Turonian–Coniacian boundary succession of the Wagon Mound–Springer composite section (NE New Mexico, USA)

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ABSTRACT:

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The Turonian–Coniacian boundary succession from the Wagon Mound–Springer composite section in the US Western Interior shows a virtually identical macrofaunal record to that revealed in the proposed candidate Coniacian GSSP in the Salzgitter-Salder–Słupia Nadbrzeżna composite section in central Europe, with easy identification in both regions of the base of the Coniacian Stage, as defined by the first appearance of the inoceramid bivalve species, *Cremnoceramus deformis erectus* (Meek). The macrofaunal boundary definition is additionally confirmed by the foraminiferal and nannofossil data, demonstrating the high potential of the inoceramid marker for the base of the Coniacian. The former claims about distinct diachroneity between macrofossil and microfossil dates in the trans-Atlantic correlations, resulted from methodological deficiencies, and have no factual basis.

Key words: Turonian; Coniacian; Europe; Western Interior of North America; Inoceramids; Macrofauna; Microfauna; Correlations; GSSP.

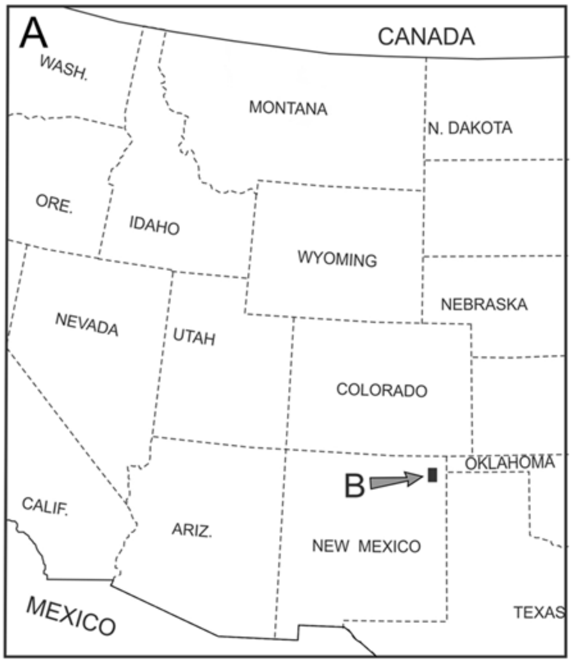
INTRODUCTION

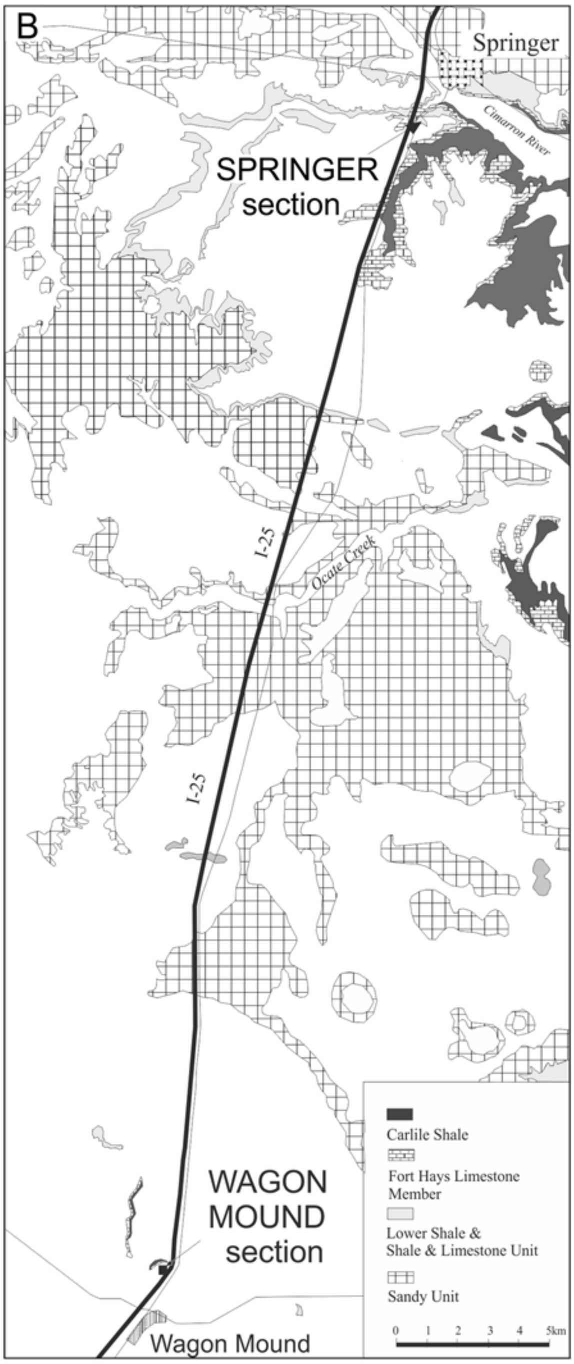
The Wagon Mound section in northeast New Mexico, USA (US Western Interior) was one of the two main proposals as a GSSP for the base of the Coniacian Stage during the Cretaceous Symposium in Brussels (Kauffman *et al.* 1996). However, as was subsequently shown by Walaszczyk and Cobban (1999, 2000), based on both inoceramid bivalves and ammonites, the succession exposed in a road-cutting near the town of Wagon Mound is entirely Turonian. This is additionally confirmed by observations on the Springer section (located about 25 miles north [=40 km] of Wagon Mound), where the Wagon Mound succession ranges higher, up to the base of the Coniacian, dated directly with inoceramid and *Didymotis* bivalves. As may be judged from the faunal lists, the mis-correlation of the Wagon Mound section resulted from differences in the species concepts applied to the early *Cremnoceramus* taxa. Subsequently, however, a return to the original stratigraphical interpretation of the Wagon Mound section and claims about its stratigraphical equivalence to the Turonian–Coniacian boundary interval in the Salzgitter-Salder section in northern Germany were published by Sikora *et al.* (2004). Although admitting that the macrofossil content (ammonites and inoceramid bivalves) differed significantly between the two sections, they tried to prove the equivalence of both sections in terms of microfossils. Consequently, they generally questioned the isochroneity of the macrofossil zonation in this interval and the suitability of *Cremnoceramus deformis erectus* (and of other macrofossils) as a boundary marker.

Because of the critical importance of the Sikora *et al*. (2004) conclusions for the basal Coniacian boundary definition and basal boundary stratotype selection, on the one hand, and the serious methodological deficiencies of their study, on the other, additional studies of the Wagon Mound–Springer succession were undertaken and are briefly reported below. This is the companion paper to our 2010 paper in which we proposed the combined Salzgitter-Salder–Słupia Nadbrzeżna (central Poland) section as a candidate composite GSSP for the base of the Coniacian Stage (Walaszczyk *et al.* 2010).

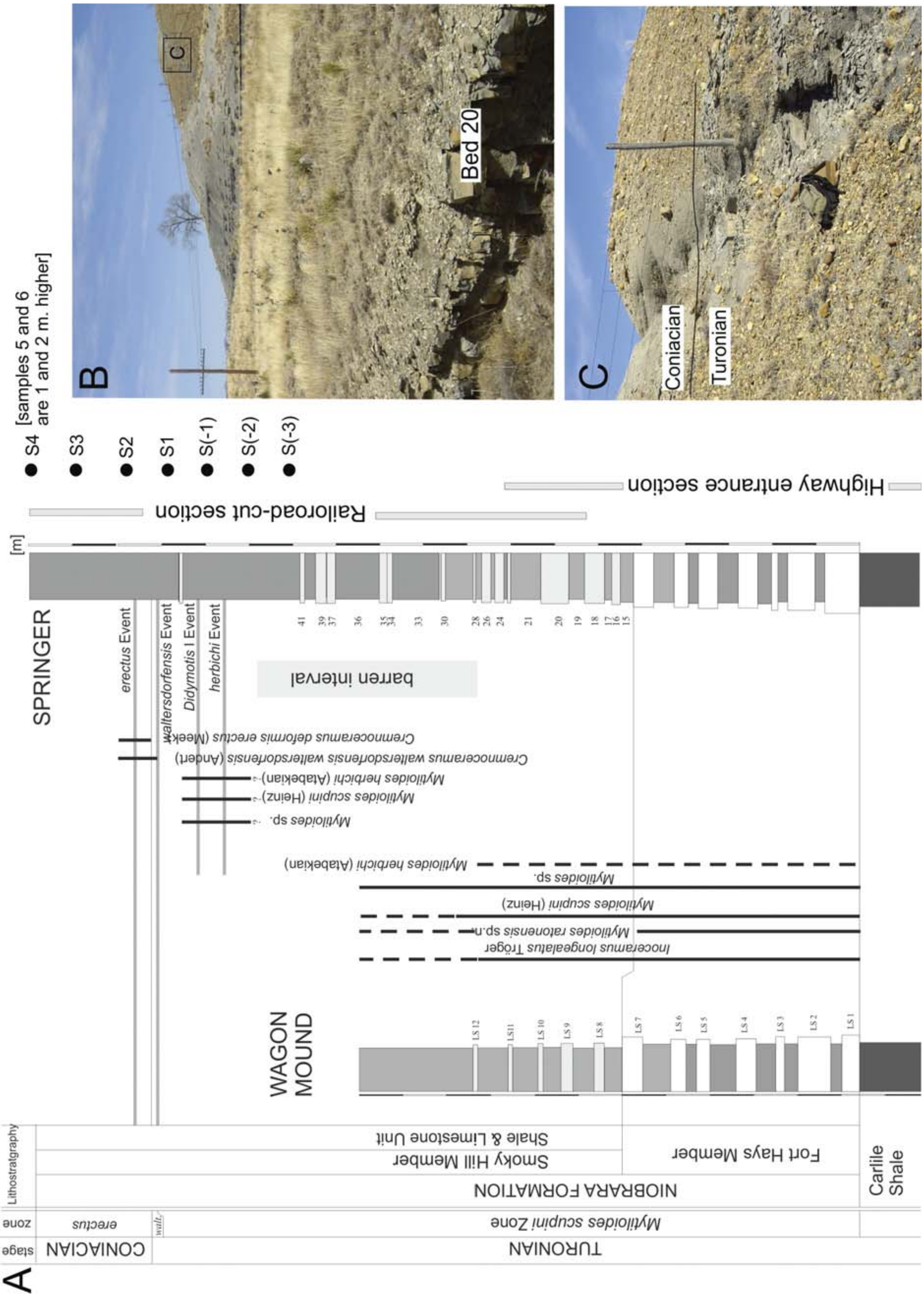
THE SUCCESSION AND MACROFOSSIL RECORD

In inoceramid bivalve terms, the Wagon Mound section ranges to a level within the *Mytiloides scupini* Zone, and a corresponding horizon is indicated by ammonites (*Prionocyclus germari* Zone) (Walaszczyk and Cobban 1998, 2000). The higher part of the succession, ranging up to the *Cremnoceramus deformis erectus* Zone, is not exposed in Wagon Mound, but is readily accessible in the

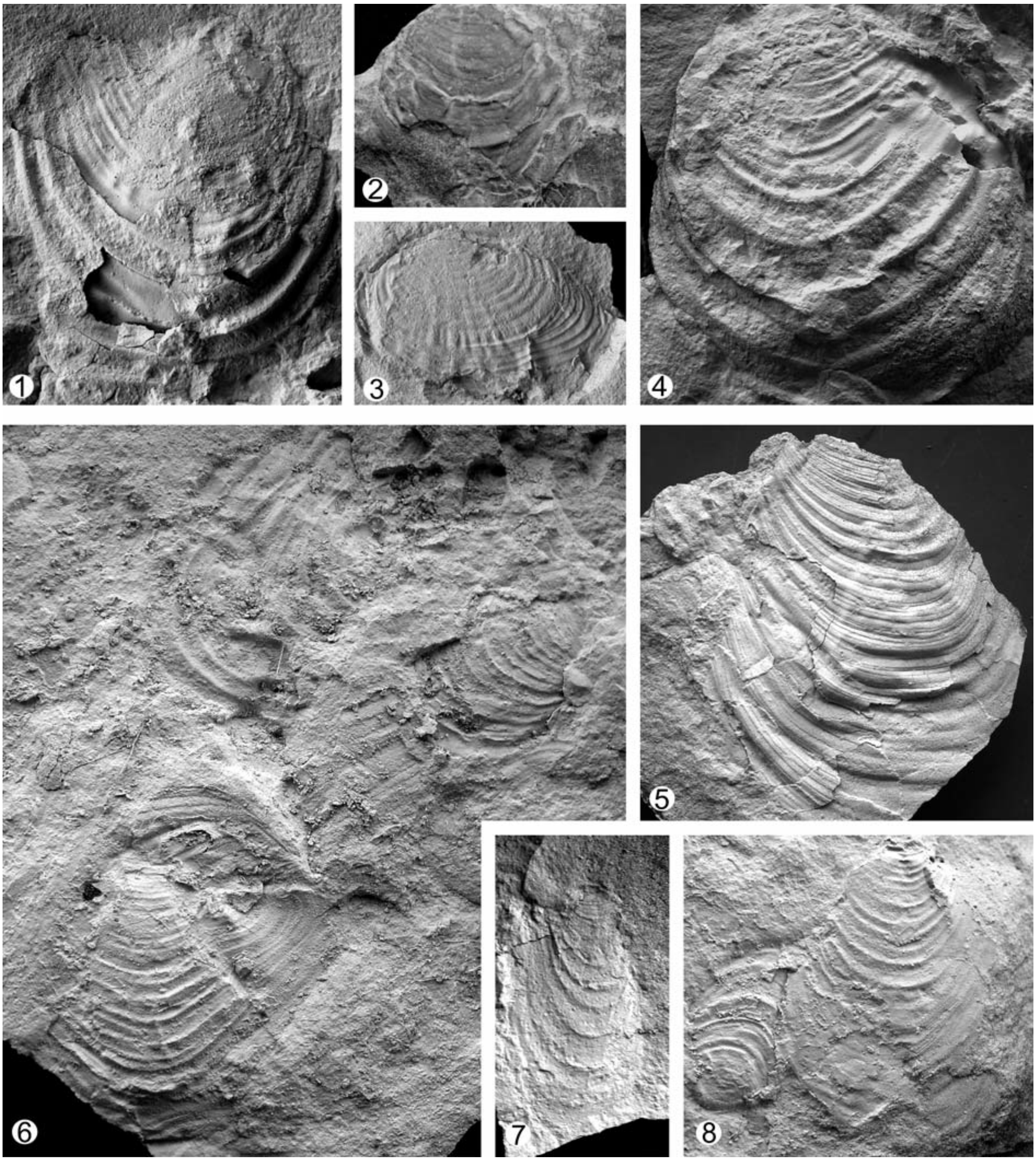




Text-fig. 1. Geographical location of the Wagon Mound–Springer composite section in the USA (A) and in the Wagon Mound – Springer area (B)



Text-fig. 2. A – Stratigraphical succession and vertical distribution of inoceramid species of the Wagon Mound–Springer composite section; S(-1) through S4 at the upper right of the Springer log are microfossil samples (samples S5 and S6 are 1 and 2 m higher but not shown on the graph); the vertical ranges of the railway-cutting and highway-entrance sections are shown to the right of the Springer log; B – general view of the railway-cutting section of the topmost Turonian–basal Coniacian succession as exposed south of Springer; C – close-up view of the Turonian–Coniacian boundary interval and location of microfossil samples and boundary events nearby section in Springer, about 25 miles [=40 km] to the north (Text-fig. 1). Because the upper part of the succession exposed in Wagon Mound is also well exposed in Springer, the correlation between the two sections is straightforward (see Text-figs 1, 2; see also Scott *et al.* 1986; Walaszczyk and Cobban 1998). Macrofaunally, the basal Coniacian boundary in the Springer section is well documented by the inoceramid bivalve succession and confirmed additionally by the record of the thin-shelled bivalve *Didymotis*, which is characteristic of the Turonian–Coniacian boundary interval (Text-figs 2, 3; see Wood *et al.* 1984, 2004; Kauffman *et al.* 1996). It also contains the record of the sequence of events, known from the entire Euramerican biogeographic region



Text-fig. 3. Inoceramids and *Didymotis* bivalves of the topmost Turonian and basal Coniacian part of the Springer section. 1, 4 – *Cremnoceramus deformis erectus* (Meek, 1877), 1 – USNM 544534, 4 – USNM 544533; 2 – *Cremnoceramus waltersdorfensis waltersdorfensis* (Andert, 1911), USNM 544527, *waltersdorfensis* Event; 3 – *Didymotis* sp., USNM 544532, *Didymotis* I Event; 5, 6, 8 – *Mytiloides* sp., 5 – USNM 544531, 6 – USNM 544530, 8 – USNM 544529; *herbichi* Event; 7 – *Mytiloides scupini* (Heinz 1929), USNM 544528, *herbichi* Event; all specimens are natural size

(Wood *et al*. 1984, 2004; Walaszczyk 2000), that spans the Turonian–Coniacian boundary (Text-fig. 2): *Mytiloides herbichi* Event; *Didymotis* I Event; *Cremnoceramus waltersdorfensis waltersdorfensis* and *Didymotis* II events; *Cremnoceramus erectus* I Event.

Sikora *et al*. (2004) analysed only the Wagon Mound section and compared it with the *C. deformis erectus* interval in Salzgitter-Salder. Why, aiming to demonstrate the diachroneity of the FO of *C. deformis erectus* they did not sample the *C. deformis erectus* interval, which is well exposed in Springer, remains unclear. To check the microfossil vs. macrofossil record between Salzgitter-Salder and the US Western Interior, and to confirm or disprove the Sikora *et al*. (2004) conclusions about the diachroneity of the inoceramid bivalve marker for the base of the Coniacian, we sampled the topmost Turonian and the *C. deformis erectus* interval in the Springer section in order to study its planktonic foraminiferal and nannofossil record.

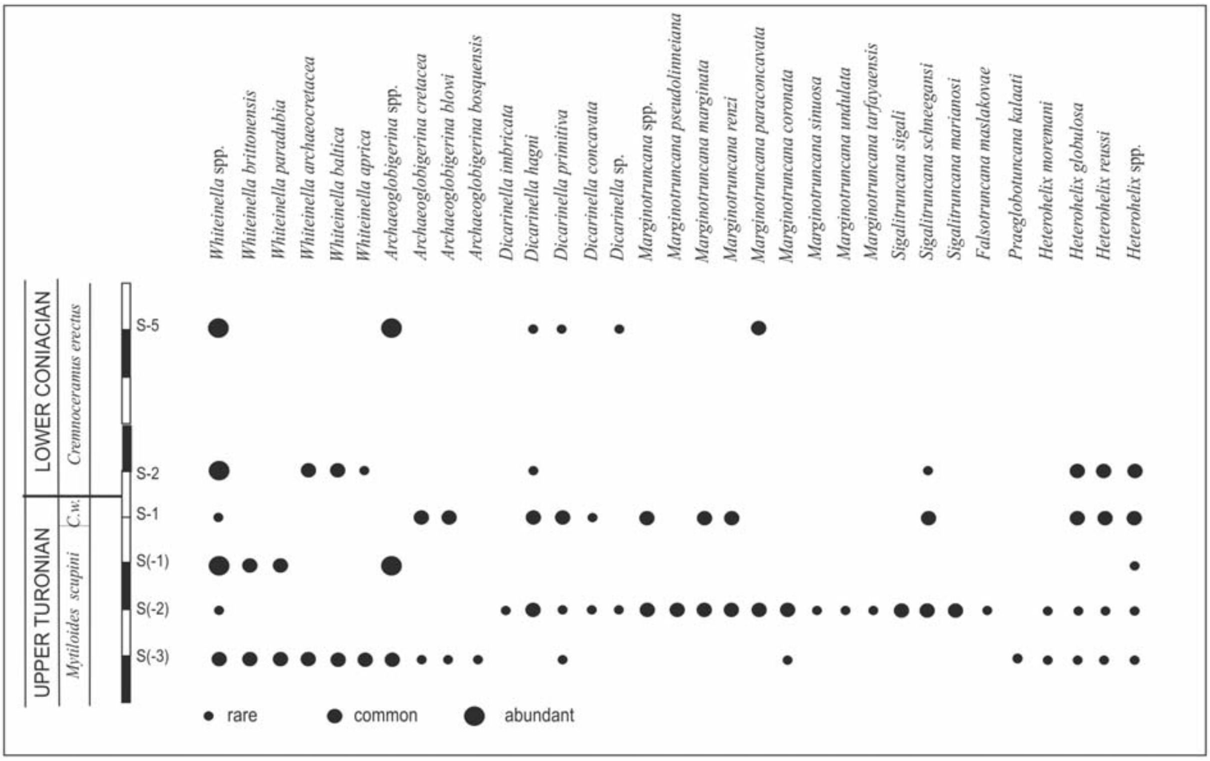
The microfossils were studied from an 8-m thick interval spanning the uppermost Turonian and lowermost Coniacian (as defined by inoceramid bivalves) strata exposed in the railway-cutting east of Highway 25, just south of the town of Springer (Text-fig. 1; see also Scott *et al*. 1986, fig. 7; the Springer section in Walaszczyk and Cobban 1998, 2000). The Turonian–Coniacian boundary, defined by the first appearance of *C. deformis erectus*, is located in the middle part of the interval studied, slightly above sample 1 (Text-fig. 2).

MICROFOSSIL RECORD

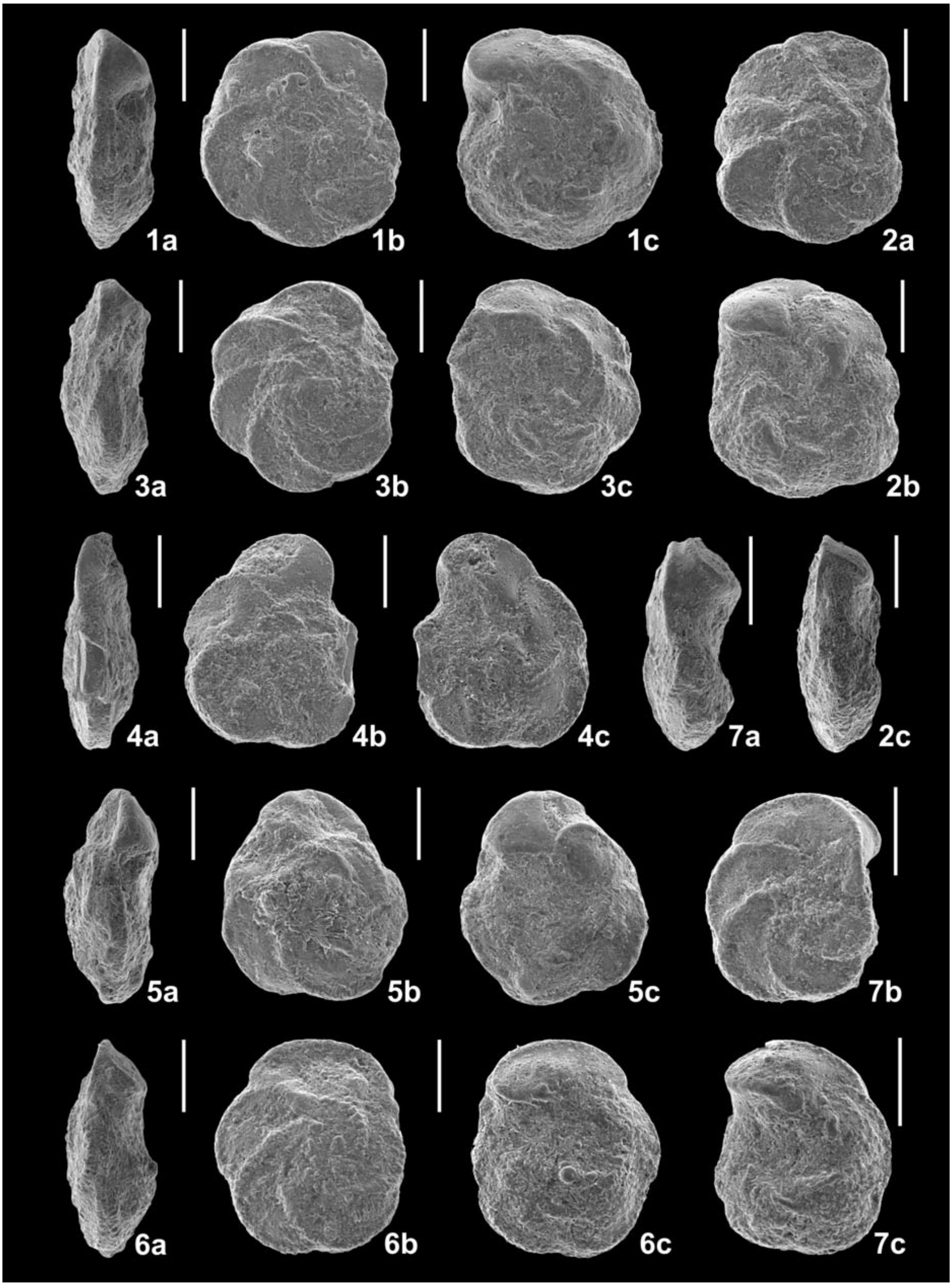
Planktonic foraminifera (D. Peryt)

The samples yield abundant, moderately to highly diverse, poorly preserved planktonic foraminifera (Text-figs 4–9). They form 95–98% of the foraminiferal assemblages. The very low contribution of benthic foraminifers may be due to the oxygen-depleted bottom waters.

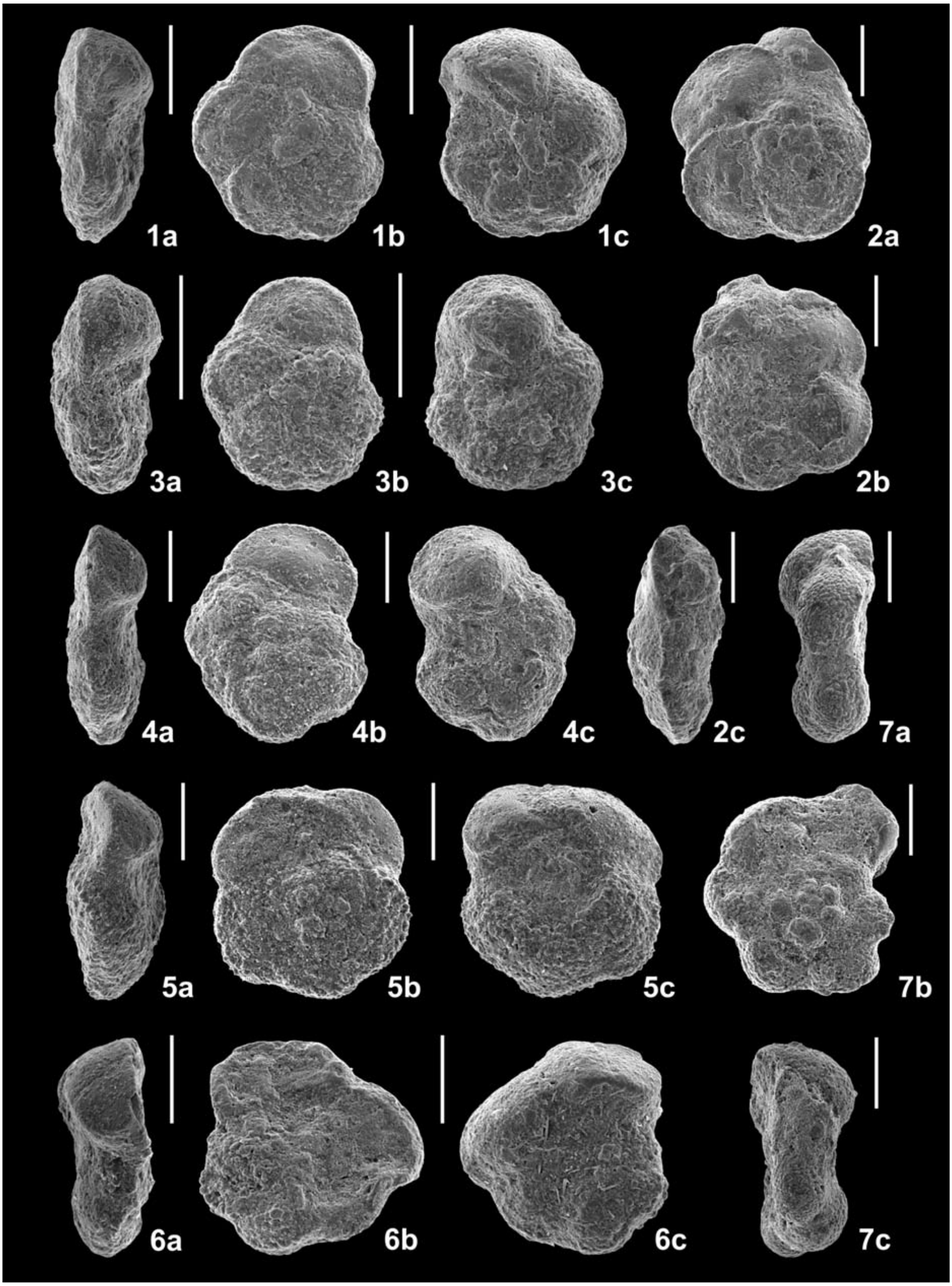
The lowest sample [S(–3)] is dominated by whiteinellids and common small-sized heterohelicids. Representatives of double-keeled *Marginotruncana* and *Dicarinella* are very rare. The most diverse assemblage appears one sample higher [S(-2)], which is dominated by *M. coronata* (Bolli), *M. pseudolinneiana* Pessagno, *M. marginata* (Reuss), *M. renzi* (Gandolfi), *M. paraconcavata* Porthault, *M. undulata* (Lehmann) and *M. sinuosa* Porthault. Also common are biconvex dicarinellids: *Dicarinella hagni* (Scheibnerova), *D. imbricata* (Mornod) and *Dicarinella* sp. Single-keeled *Sigalitruncana sigali* (Reichel), *S. marianosi* (Douglas) and *S. schneegansi* (Sigal), as well as *Praeglobotruncana kalaati* Gonzales-



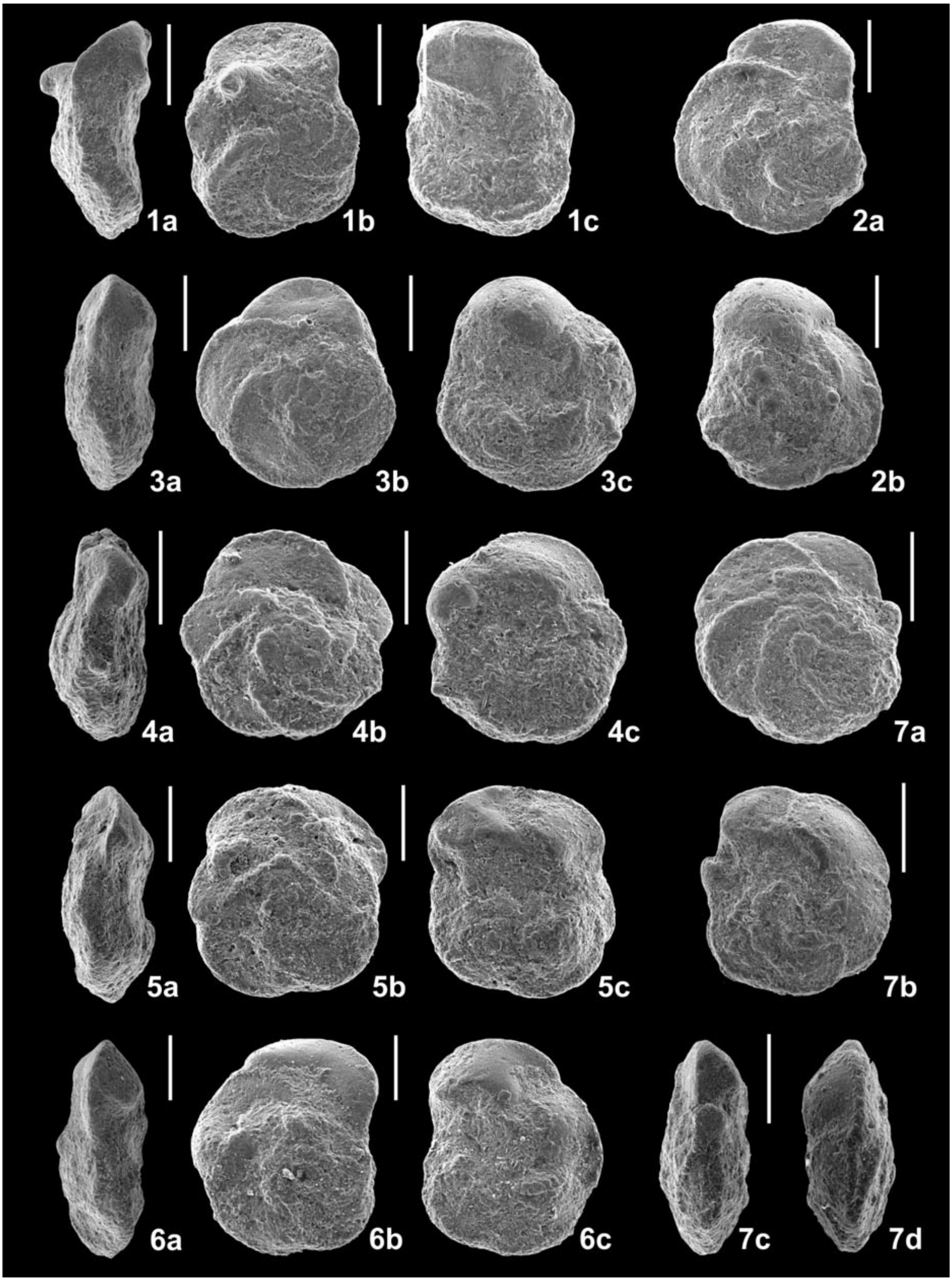
Text-fig. 4. Stratigraphical distribution of planktonic foraminifera in the Upper Turonian – lowermost Coniacian boundary interval in the Springer section; *C.w. – Cremnoceramus waltersdorfensis waltersdorfensis* Zone



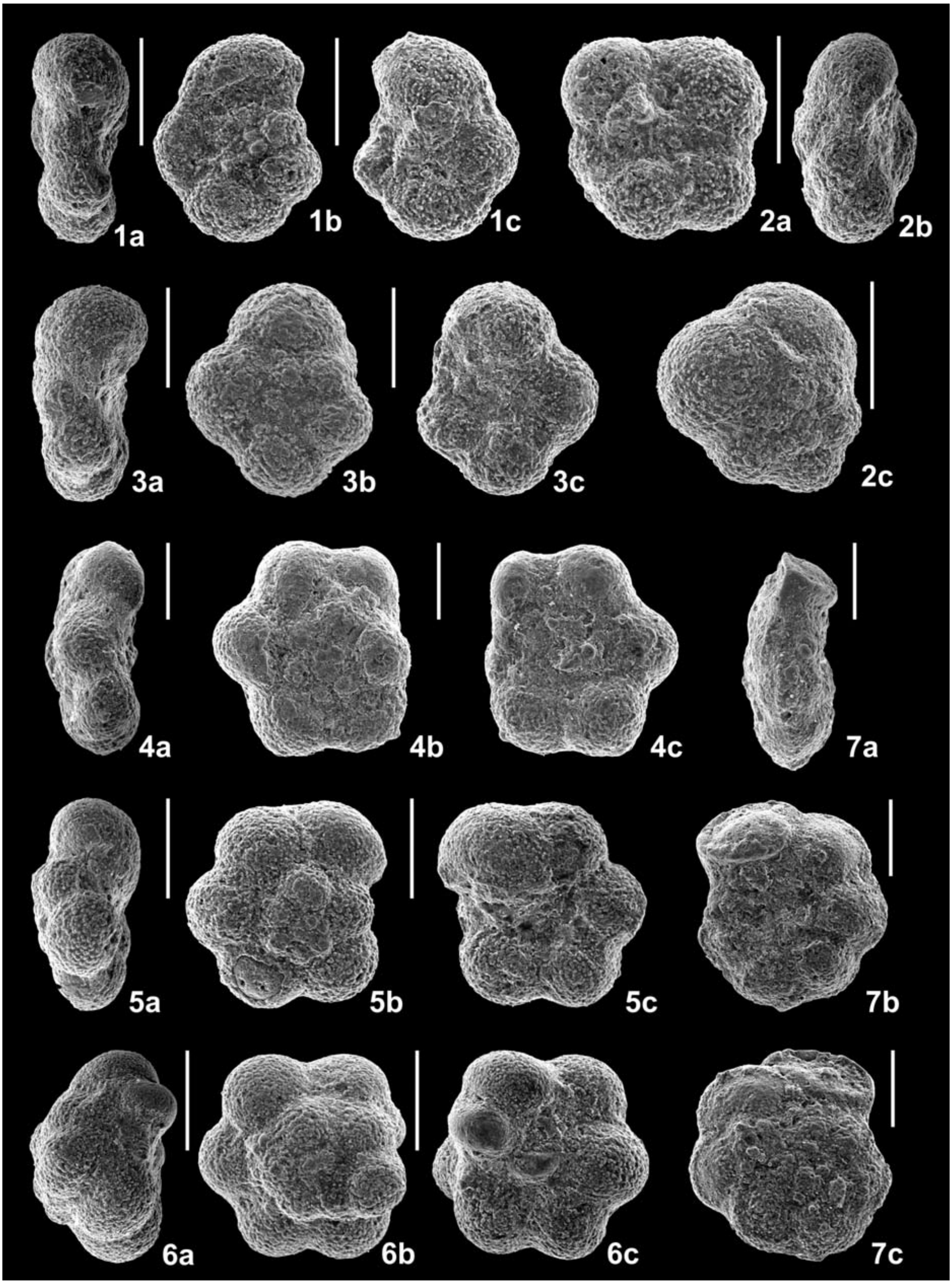
Text-fig. 5. 1a-c – *Marginotruncana paraconcavata* Porthault, 1970, sample Spr-2; 2a-c – *Sigalitruncana marianosi* (Douglas, 1969), sample Spr-2; 3a-c – *Marginotruncana coronata* (Bolli, 1945), sample Spr-2; 4a-c – *Marginotruncana pseudolinneiana* Pessagno, 1967, sample Spr-2; 5a-c – *Marginotruncana tarfayaensis* (Lehmann, 1963), sample Spr-2; 6a-c – *Marginotruncana renzi* (Gandolfi, 1942), sample Spr-2; 7a-c – *Marginotruncana sinuosa* Porthault, 1970, sample Spr-2. Scale bar = 200 µm



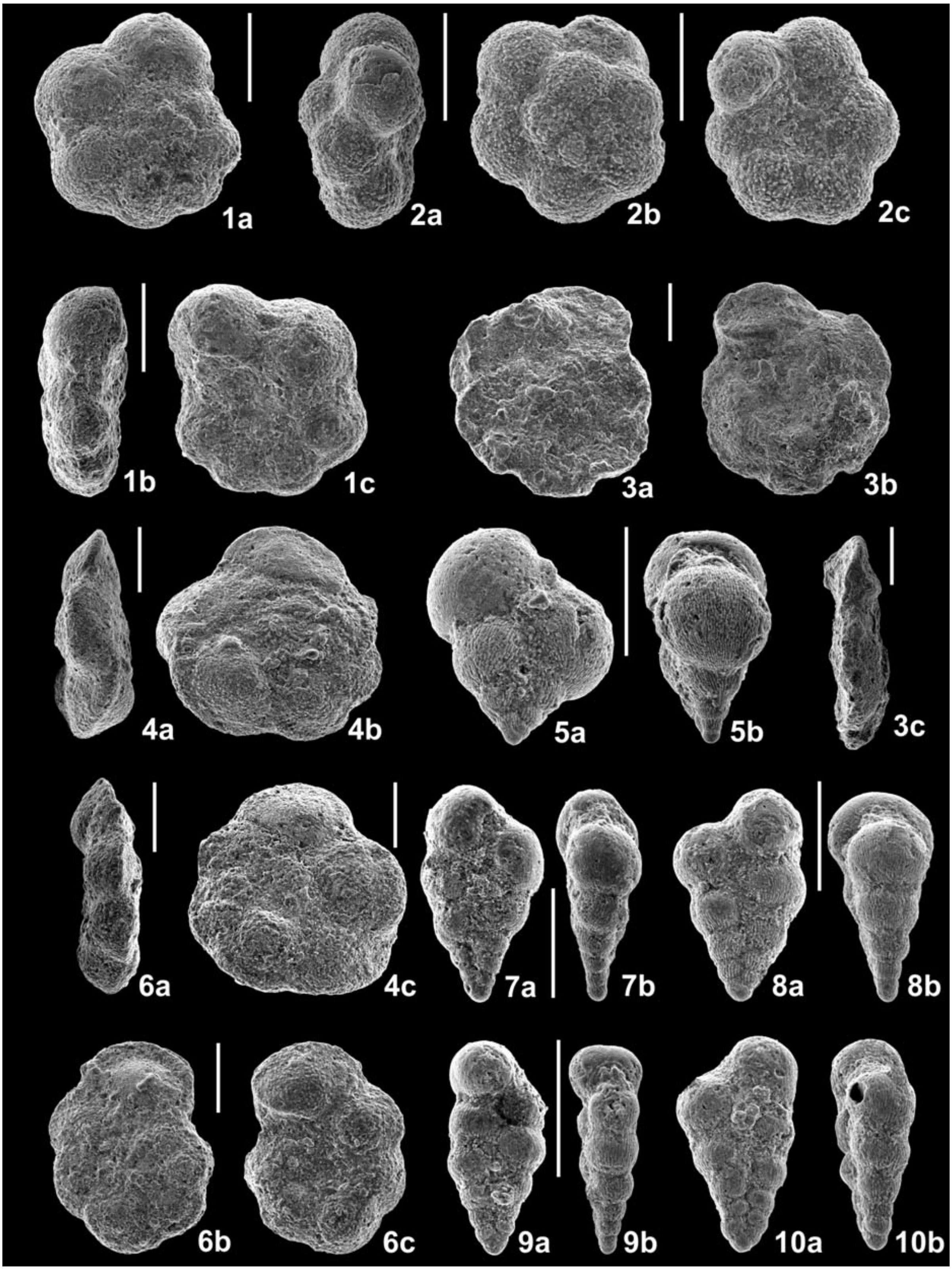
Text-fig. 6. 1a-c – *Dicarinella hagni* (Scheibnerova, 1962), sample Spr-2; 2a-b – *Dicarinella imbricata* (Mornod, 1970), sample Spr-2; 3a-c – *Dicarinella hagni* (Scheibnerova, 1962), sample Spr-2; 4a-c – *Marginotruncana undulata* (Lehmann, 1963), sample Spr-2; 5a-c – *Dicarinella concavata* (Brotzen, 1934), sample Spr-2; 6a-c – *Dicarinella concavata* (Brotzen, 1934), sample Spr-2; 7a-c – *?Dicarinella concavata (Brotzen, 1934)*, sample Spr-2. Scale bar = 200 µm



Text-fig. 7. 1a-c – *Falsotruncana maslakovae* Caron, 1981, sample Spr-2; a-c – *Marginotruncana sinuosa* Porthault, 1970, sample Spr-2; 3a-c – *Marginotruncana renzi* (Gandolfi, 1942), sample Spr-2; 4a-c – *Marginotruncana sinuosa* Porthault, 1970, sample Spr-2; 5a-c – *Marginotruncana undulata* (Lehmann, 1963), sample Spr-2; 6a-b – *Marginotruncana sinuosa* Porthault, 1970, sample Spr-2; 7a-c – *Marginotruncana renzi* (Gandolfi, 1942), sample Spr-2. Scale bar = 200 µm



Text-fig. 8. 1a-b – *Whiteinella archaeocretacea* Pessagno, 1967, sample Spr-3; 2a-b – *Wheiteinella baltica* Douglas and Rankin, 1969, sample Spr-3; 3a-c – *Archaeoglobigerina blowi* Pessagno, 1967, sample Spr-3; 4a-b – *Whiteinella aprica* (Loeblich and Tappan, 1961), sample Spr-3; 5a-c – *Wheiteinella brittonensis* (Loeblich and Tappan, 1961), sample Spr-3; 6a-c – *Whiteinella paradubia* (Sigal, 1952), sample Spr-3; 7a-c – *Marginotruncana marginata (Reuss, 1845)*, sample Spr1. Scale bar = 200 µm



Text-fig. 9. 1a-b – *Archaeoglobigerina cretacea (d'Orbigny, 1840)*, sample Spr-3; 2a-b – *Wheiteinella brittonensis* (Loeblich and Tappan, 1961), sample Spr5; 3a-c – ?*Sigalitruncanaa schneegansi* (Sigal, 1952), sample Spr-2; 4a-b – *Praeglobotruncana kalaati* Gonzalez Donoso and Linares, 1990, sample Spr1; 5a-c – *Heterohelix reussi*, sample Spr-3; 6a-c –?*Dicarinella* sp., sample Spr1; 7a-c – *Heterohelix globulosa* (Ehrenberg, 1840), sample Spr2; 8a-c. *Heterohelix globulosa* (Ehrenberg, 1848), sample Spr-3; 9a-b – *Heterohelix moremani* (Cushman, 1938), sample Spr1; 10a-b – *Heterohelix moremani* (Cushman, 1938), sample Spr2. Scale bar = 200 μm

Donoso and Linares are rare, as are plano-convex *Dicarinella*. *Falsotruncana maslakovae* Caron is recorded only in this level. Whiteinellids and small-sized heterohelicids are minor components of the assemblage.

In the next samples, the assemblages change from those dominated by non-keeled globular (*Whiteinella*) and weakly double-keeled (*Archaeoglobigerina*) forms, to assemblages dominated by double-keeled forms. It is worth noting that in the topmost sample *Dicarinella hagni*, *D. imbricata*, *Dicarinella* sp. and *Dicarinella primitiva* (Dalbiez) are still present.

The interval studied represents the lower part of the *Dicarinella concavata* Zone.

The correlation potential of none of the three main planktonic foraminiferal datums that formed the basis of the Sikora *et al.* (2004) correlation of part of the Wagon Mound section with the *Cremnoceramus deformis erectus* interval of the Salzgitter-Salder section was confirmed in the present study (see discussion below).

(1) the FO of *Archaeoglobigerina blowi*: it is first noted in the middle Fort Hays Member in the Wagon Mound section, in the *Mytiloides scupini* inoceramid bivalve Zone; it also appears in the same zone in the Salzgitter-Salder section, albeit distinctly lower than reported by Sikora *et al.* (2004), i.e., in bed 40 instead of bed 52 (Lower Coniacian).
(2) the LO of *Dicarinella hagni*: in contrast to Sikora *et al*. (2004), who reported this datum from the upper Fort Hays Member in the Wagon Mound section, the species is still present together with *C. deformis erectus* in the Springer section.
(3) the FO of *Dicarinella concavata* at the base of the Smoky Hill Member: the correlation potential of this datum cannot be tested as no convincing specimen of *Dicarinella concavata* is known from the Salzgitter-Salder section.

Besides these three main datums, the results of our study call into question some of the other arguments used by Sikora *et al*. (2004) in support of their correlation. Among those are:

(1) the reported presence of *Hastigerinoides subdigitata* (Carman) in Bed 43 and *Marginotruncana marianosi* (Douglas) in Bed 41 in the Salzgitter-Salder section could not be confirmed;
(2) *Dicarinella* cf. *primitiva* (Dalbiez), one of the other datums taken by Sikora *et al*. (2004) and claimed to start right at the boundary (bed 45) in the Salzgitter-Salder section, was shown to start markedly lower (Bed 38), still within the *M. scupini* Zone;
(3) *Whiteinella aprica* (Loeblich and Tappan), which was claimed to have its LO in the middle Smoky Hill Member as exposed in the Wagon Mound section, actually ranges higher and is still present in the Springer section.

Nannofossils (Jackie Lees)

The nannofossils in the Springer section (Text-fig. 10) are not so well preserved as in the Salzgitter-Salder section, but it was possible to identify the essential marker, *Broinsonia parca expansa* Wise and Watkins, 1983, which places the base of the Coniacian Stage, as defined by the FO of the inoceramid bivalve *Cremnoceramus deformis erectus*, in Nannofossil Subzone UC9c (where it should be, according to Lees 2008). The one potentially complicating factor is the presence in sample S-1 of a *Micula* that looked more like a *M. staurophora* (Gardet, 1955) than a *M. adumbrata* (Burnett, 1998), which would place the Lower Coniacian below the basal boundary. However, I found only a single specimen and *M. staurophora* preserves well, so if it was *M. staurophora*, I would have expected to see more specimens in the sample.

In contrast to Sikora *et al*. (2004), the nannofossil assemblages in the Salzgitter-Salder section appear to be quite variable and sufficiently well preserved (see Lees 2008) to allow recognition of the critical taxa and establish a reliable biostratigraphy. As shown by Lees (2008), the base of the Coniacian, as defined by the FO of *C. deformis erectus*, falls in Nannofossil Subzone UC9c, the base of which is defined by the FO of *B. parca expansa* and its top by the FO of *M. staurophora* (= base Nannofossil Zone UC10).

CONCLUSIONS

Summing up, it may be stated that there is no macrofaunal, microfaunal or calcareous nannofossil evidence to support the suggestion by Sikora *et al*. (2004) that the succession exposed in the Wagon Mound section ranges up to the base of the Coniacian; it is entirely Upper Turonian. Moreover, there is no discrepancy between the macrofaunal and microfossil biostratigraphies of the Wagon Mound section and the *Cremnoceramus deformis erectus* interval of the Salzgitter-Salder section; the former is simply stratigraphically older. Both the planktonic foraminiferal and calcareous nannofossil data in the Wagon Mound section are in accord with the inoceramid bivalve data and show that the base of the Coniacian is located higher in the succession, as can be demonstrated in the nearby Springer section. The erroneous biostratigraphic datings and correlations of Sikora *et al*. (2004) result partly from the incomplete recogni-

Nannofossil data, Springer section, USA

Vertical grey blocking denotes stratigraphically-useful taxa; C = common, F = few, R = rare, ? = questionable identification
Jackie Lees/Irek Walaszczyk 6.08

STAGE after Walaszczyk (pers. comm., 2007)	**SAMPLE**	**PRESERVATION**	**ABUNDANCE**	**SPECIES RICHNESS**	**TAXA**	*Biscutum* cf. *B. ellipticum*	*Biscutum ellipticum*	*Broinsonia enormis*	*Broinsonia furtiva*	*Broinsonia matalosa*	***Broinsonia parca expansa***	*Broinsonia signata*	*Calculites additus*	*Chiastozygus bifarius*	*Chiastozygus platyrhethus*	*Corollithion madagaskarensis*	*Cribrosphaerella ehrenbergii* thin-rimmed, elliptical form	*Cylindralithus nudus*	*Discorhabdus ignotus*	*Eiffellithus eximius*	*Eiffellithus gorkae*	*Eiffellithus turriseiffelii*	*Eprolithus apertior*	*Eprolithus floralis*	*Gartnerago coxalliae*	*Gartnerago segmentatum*	*Gorkaea pseudanthophorus*	*Helicolithus anceps*	*Helicolithus compactus*	*Helicolithus trabeculatus*	*Helicolithus trabeculatus* large form	*Kamptnerius magnificus*	*Lithastrinus septenarius*	*Loxolithus armilla*	*Lucianorhabdus maleformis* long form	*Lucianorhabdus maleformis* short form	*Manivitella pemmatoidea*	*Marthasterites crassus*	*Marthasterites furcatus*	***Micula adumbrata* ?**	*Placozygus fibuliformis*	*Prediscosphaera columnata*	*Prediscosphaera cretacea*
CONIACIAN	S-6	VP-M	M	29			R			F	**R**			F		R	R			F		R	R	F		R	R			R		F	R			F	R	R	F		R		F
	S-5	VP-M	L-M	19							**R**			R						F		R		F	R	F						F				R		R	F				
TURONIAN	S-2	VP-M	M	30			R	R		F	**R**			F			R	R		R		R		R	R	R			R		R	R		R	R			R	R				
	S-1	VP-M	L-M	31/32			R			R				F			R			F	R	R			R		R	R	R			R	R	R	R		R			R	R	R	
	S(-1)	VP-M	M	32		R	R			R				F	R		F		R	F	R	R		F	R	F		R			R	R			F	R	R						
	S(-2)	VP-M	M	28/29					R		**R**	R	R	F			F			F		F		R		R	R	R			R	R		R			R		R				
	S(-3)	VP-M	M	34					F	F	**R**			F			F			F	R	R		R	R	F				R		F	R	R	F	F		R	F		R	R	R

Text-fig. 10a. Nannofossil distribution and zonation of the Turonian/Coniacian boundary interval of the Springer section

STAGE after Lees (2008)	LR. CON.?				TUR./CON.		
NANNOFOSSIL ZONE after Burnett (1998)	UC9c						
AGE-DIAGNOSTIC NANNOFOSSIL EVENTS	*Micula staurophora ?, Lithastrinus grillii* abs			?FO *M. adumbrata*			*B. parca expansa* present
Prediscosphaera ponticula	F		F	R	F	F	F
Radiolithus planus						?	
Reinhardtites anthophorus				R	R	R	R
Retecapsa angustiforata			R	R			R
Retecapsa crenulata	F		F	R	R		R
Retecapsa surirella			R	R			R
Staurolithites crux					R		
Staurolithites cf. *S. dorfii*				R			
Staurolithites ellipticus					R		
Staurolithites halfanii						R	
Staurolithites laffittei		R			R		
Tranolithus minimus				?			
Tranolithus orionatus	C	F	C	C	C	C	C
Watznaueria barnesiae	C	A	C	C	C	C	A
Watznaueria bayackii		R					
Watznaueria fossacincta							R
Watznaueria manivitiae s.l.	C	F	C	C	C	R	C
Zeugrhabdotus bicrescenticus	F	F	F		R	F	R
Zeugrhabdotus biperforatus	R						
Zeugrhabdotus cf. *Z. diplogrammus*						R	
Zeugrhabdotus diplogrammus		R	F	R	R	R	F
Zeugrhabdotus noeliae			R		R		
Zeugrhabdotus scutula	R	R	R	R		R	
Zeugrhabdotus sp.							
Zeugrhabdotus cf. *Z. trivectis*				R	F	R	F

Text-fig. 10b. Nannofossil distribution and zonation of the Turonian/Coniacian boundary interval of the Springer section

tion of the actual ranges of particular taxa and partly are effects of comparisons based on partial ranges. As a result, all of their reservations concerning the stratigraphic potential of the macrofauna can be rejected. Consequently, their whole subsequent discussion of the apparent discrepancy between the macrofaunal and microfossil biostratigraphy, as well as the diachroneity of the basal boundary biomarker, *C. deformis erectus,* has no factual basis and should be treated as a purely hypothetical assumption.

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REFERENCES

Bailey, H.W. and Hart, M.B. 1979. The Correlation of the Early Senonian in Western Europe using Foraminiferida. In: J. Wiedmann (Ed.), Aspekte der Kreide Europas, *International Union of Geological Sciences*, **A6**, 159–170.

Caron, M. 1985. Cretaceous planktonic foraminifera. In: H.M. Bolli, J.B. Saunders and K. Perch-Nielsen (Eds), Plankton stratigraphy, pp. 17–86. Cambridge University Press; Cambridge.

Gonzales-Donoso, J.-M. and Linares, D. 1990. The planktonic foraminifera. In: F. Robaszynski, M. Caron, C. Dupuis, F. Amédro, J.-M. Gonzales-Donoso. Linares, J. Hardenbol, S. Gartner, F. Calandra and R. Deloffre (Eds), A tentative integrated stratigraphy in the Turonian of Central Tunisia: formations, zones and sequential stratigraphy in the Kalaat Senan area. *Bulletin des Centres de Recherches Exploration-Production Elf-Aquitaine*, **14**, 281–361.

Hart, M.B., Bailey, H.W., Crittenden, S., Fletcher, B.N. and Swiecicki, A. 1989. Cretaceous. In: D.G. Jenkins, J.W. Murray (Eds), Stratigraphical Atlas of Fossil Foraminifera, second edition. *British Micropalaeontological Society Series*. pp. 273–371. Ellis Horwood Limited; Chichester.

Jenkyns, H.C., Gale, A.S. and Corfield, R.M. 1994. Carbon- and oxygen-isotope stratigraphy of the English Chalk and Italian Scaglia and its palaeoclimatic significance. *Geological Magazine*, **131,** 1–34.

Kauffman, E.G., Kennedy, W.J. and Wood, C.J. 1996. The Coniacian stage and substage boundaries. *Bulletin de l'Institut Royal Science Naturelle Belgique (Science de la Terre)*, **66** (Supplement), 81–94.

Kennedy, W.J. and Walaszczyk, I. 2004. *Forresteria* (*Harleites*) *petrocoriensis* (Coquand, 1859) from the Upper Turonian *Mytiloides scupini* Zone of Słupia Nadbrzeżna, Poland. *Acta Geologica Polonica,* **54**, 55–59.

Lees, J.A. 2008. The calcareous nannofossil record across the Late Cretaceous Turonian/Coniacian boundary, including new data from Germany, Poland, the Czech Republic and England. *Cretaceous Research*, **29**, 40–64.

Loeblich, A.R. and Tappan, H.N. 1987. Foraminiferal genera and their classification. 970 pp. Van Nostrand Reinhold Company; New York.

Pessagno, E.A. Jr. 1967. Upper Cretaceous planktonic foraminifera from the Western Gulf Coastal Plain. *Palaeontographica Americana,* **5**, 259–441.

Pożaryska, K. and Peryt, D. 1979. The Late Cretaceous and Early Paleocene Foraminiferal "Transitional Province" in Poland. In: J. Wiedmann (Ed.), Aspekte der Kreide Europas, *International Union of Geological Sciences*, **A6**, 293–304.

Premoli Silva, I. and Sliter, W.V. 1995. Cretaceous planktonic foraminiferal biostratigraphy and evolutionary trends from the Bottaccione section, Gubbio, Italy. *Paleontographia Italica*, **82** (1994), 1–89.

Premoli Silva, I. and Verga, D. 2004. Practical Manual of Cretaceous Planktonic Foraminifera. D. Verga and R. Rettori (Eds), International School on Planktonic Foraminifera, 3^0 Course: Cretaceous. 283 pp. Universities of Perugia and Milan, Tipografia Pontefelcino; Perugia.

Robaszynski, F., Caron, M., Dupuis, C., Amédro, F., Gonzales-Donoso, J. M., Linares, D., Hardenbol, J., Gartner, S., Calandra, F. and Deloffre, R. 1990. A tentative integrated stratigraphy in the Turonian of Central Tunisia: Formations, zones and sequential stratigraphy in the Kalaat Senan area. *Bulletin des Centres de Recherches Exploration-Production Elf-Aquitaine*, **14**, 213–384.

Robaszynski, F., Caron, M. (Eds) and European Working Group on Planktonic Foraminifera. 1979. Atlas de foraminiferès planctoniques du Crétacé moyen (mer boreale et Téthys). *Cahiers de Micropaléontologie*, **1-2**, 1–366.

Sikora, P.J., Howe, R.W., Gale, A.S. and Stein, J.A. 2004. Chronostratigraphy of proposed Turonian–Coniacian (Upper Cretaceous) stage boundary stratotypes: Salzgitter-Salder, Germany, and Wagon Mound, New Mexico, USA. In: A.B. Beaudoin and M.J. Head (Eds), The Palynology and Micropalaeontology of Boundaries. *Geological Society, London, Special Publications*, **230**, 207–242.

Walaszczyk, I. and Peryt, D. 1998. Inoceramid-foraminiferal biostratigraphy of the Turonian through Santonian deposits of the Middle Vistula Section, Central Poland. *Zentralblatt für Geologie und Paläontologie* **I, 11/12**, 1501–1513.

Walaszczyk, I. and Cobban, W.A. 1999. The Turonian – Coniacian boundary in the United States Western Interior. *Acta Geologica Polonica*, **48** (4), 495–507.

Walaszczyk, I. and Cobban, W.A. 2000. Inoceramid faunas and biostratigraphy of the Upper Turonian–Lower Coniacian of the Western Interior of the United States. *Special Papers in Palaeontology*, **64**, 1–118.

Walaszczyk, I. and Wood, C.J. 1999. Inoceramids and biostratigraphy at the Turonian/Coniacian boundary; based on the Salzgitter-Salder quarry, Lower Saxony, Germany, and the Słupia Nadbrzeżna section, central Poland. *Acta Geologica Polonica*, **48**, 395–434.

Walaszczyk, I., Wood. C.J., Lees, J.A., Peryt, D., Voigt, S.

and Wiese, F. 2010. The Salgitter-Salder Quarry (Lower Saxony, Germany) and Słupia Nadbrzeżna river cliff section (Central Poland): a proposed candidate composite Global Boundary Stratotype Section and Point for the base of the Coniacian Stage (Upper Cretaceous). *Acta Geologica Polonica*, **60**, 445–477.

Wood, C.J., Walaszczyk, I., Mortimore, R.N. and Woods, M.A. 2004. New observations on the inoceramid biostratigraphy of the higher part of the Upper Turonian and the Turonian – Coniacian boundary transition in Poland, Germany and the UK. *Acta Geologica Polonica,* **54**, 541–549.

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