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*Supplement of*

## **A brief warming event in the late Albian: evidence from calcareous nannofossils, macrofossils, and isotope geochemistry of the Gault Clay Formation, Folkestone, southeastern England**

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## **Taxonomic List**

A list of all the taxa with taxonomic authorship that are cited in the text, figures and the stratigraphic range chart is given below in alphabetical order.

*Amphizygus brooksii* Bukry, 1969

*Axopodorhabdus albianus* (Black, 1967) Wind & Wise in Wise & Wind, 1977

*Axopodorhabdus dietzmannii* (Reinhardt, 1965) Wind & Wise, 1983

*Biscutum constans* (Górka, 1957) Black in Black and Barnes, 1959

*Biscutum* cf. *B. constans* (Górka, 1957) Black in Black and Barnes, 1959

*Biscutum gaultensis* (Mutterlose, 1992) Bown in Kennedy *et al.*, 2000

*Braarudosphaera africana* Stradner, 1961

*Braarudosphaera hockwoldensis* Black, 1973

*Braarudosphaera* cf. *B. primula* Black, 1973

*Braarudosphaera stenorhetha* Hill, 1976

*Braloweria boletiformis* (Black, 1972) Crux, 1991

*Broinsonia galloisii* (Black, 1973) Bown in Kennedy *et al.*, 2000

*Broinsonia matalosa* (Stover, 1966) Burnett in Gale *et al.*, 1996

*Bukrylithus ambiguous* Black, 1971

*Calciosolenia fossilis* (Deflandre in Deflandre & Fert, 1954) Bown in Kennedy *et al.*, 2000

*Calculites percernis* Jeremiah, 1996

*Ceratolithina bicornuta* Perch-Nielsen, 1988

*Ceratolithina cruxii* Perch-Nielsen, 1988

*Ceratolithina hamata* Martini, 1967

*Chiastozygus* Gartner, 1968

*Chiastozygus bifarius* Bukry, 1969

*Chiastozygus litterarius* (Górka, 1957) Manivit, 1971

*Chiastozygus platyrhethus* Hill, 1976

*Chiastozygus spissus* Bergen in Bralower & Bergen, 1998

*Chiastozygus synquadriperforatus* Bukry, 1969  
*Chiastozygus* cf. *C. amphipons* (Bramlette & Martini, 1964) Gartner, 1968  
*Corollithion madagaskarensis* Perch-Nielsen, 1973  
*Corollithion signum* Stradner, 1963  
*Cretarhabdus conicus* Bramlette & Martini, 1964  
*Cretarhabdus multicavus* Bukry, 1969  
*Cretarhabdus striatus* (Stradner, 1963) Black, 1973  
*Cribrosphaerella eherenbergii* (Arkhangelsky, 1912) Deflandre in Piveteau, 1952  
*Crucicribrum anglicum* Black, 1973  
*Cyclagelosphaera margerelii* Noël, 1965  
*Cyclagelosphaera rotachypeata* Bukry, 1969  
*Discorhabdus ignotus* (Górka, 1957) Perch-Nielsen, 1968  
*Eprolithus apertior* Black, 1973  
*Eprolithus floralis* (Stradner, 1962) Stover, 1966  
*Flabellites oblongus* (Bukry, 1969) Crux in Crux et al., 1992  
*Gaarderella granulifera* Black, 1973  
*Gartnerago* cf. *G. praeobliquum* Jakubowski, 1986  
*Grantarhabdus coronadventis* (Reinhardt, 1966) Grün in Grün and Allemann, 1975  
*Grantarhabdus* cf. *G. coronadventis* (Reinhardt, 1966) Grün in Grün and Allemann, 1975  
*Haqius circumradiatus* (Stover, 1966) Roth, 1978  
*Hayesites albiensis* Manivit, 1971  
*Helenea chiastia* Worsley, 1971  
*Helicolithus compactus* (Bukry, 1969) Varol & Girgis, 1994  
*Helicolithus trabeculatus* (Górka, 1957) Verbeek, 1977  
*Hemipodorhabdus gorkae* (Reinhardt, 1969) Grün in Grün and Allemann, 1975  
*Laguncula dorotheae* Black, 1971  
*Lapideacassis glans* Black, 1971

*Lapideacassis mariae* Black, 1971

*Lapideacassis blackii* Perch-Nielsen in Perch-Nielsen & Franz, 1977

*Lithraphidites carniolensis* Deflandre, 1963

*Loxolithus armilla* (Black in Black & Barnes, 1959) Noël, 1965

*Manivitella pemmatoidea* (Deflandre in Manivit, 1965) Thierstein, 1971

*Manivitella* sp. A

*Nannoconus* Kamptner, 1931

*Octocyclus reinhardtii* (Bukry, 1969) Wind & Wise in Wise & Wind, 1977

*Orastrum perspicuum* Varol in Al-Rifa'iy *et al.*, 1990

*Owenia hilli* Crux, 1991

*Percivalia fenestrata* (Worsley, 1971) Wise, 1983

*Percivalia* cf. *P. hauxtonensis* Black, 1973

*Pickelhaube furtiva* (Roth, 1983) Applegate *et al.* in Covington & Wise, 1987

*Placozygus* cf. *P. fibuliformis* (Reinhardt, 1964) Hoffmann, 1970

*Prediscosphaera columnata* (Stover, 1966) Perch-Nielsen, 1984

*Prediscosphaera* cf. *P. ponticula* (Bukry, 1969) Perch-Nielsen, 1984

*Prediscosphaera spinosa* (Bramlette & Martini, 1964) Gartner, 1968

*Prediscosphaera* cf. *P. spinosa* (Bramlette & Martini, 1964) Gartner, 1968

*Radiolithus planus* Stover, 1966

*Radiolithus* cf. *R. planus* Stover, 1966

*Repagulum parvidentatum* (Deflandre & Fert, 1954) Forchheimer, 1972

*Retecapsa crenulata* (Bramlette & Martini, 1964) Grün in Grün and Allemann, 1975

*Retecapsa surirella* (Deflandre & Fert, 1954) Grün in Grün and Allemann, 1975

*Rhagodiscus achlyostaurion* (Hill, 1976) Doeven, 1983

*Rhagodiscus* cf. *R. achlyostaurion* (Hill, 1976) Doeven, 1983

*Rhagodiscus angustus* (Stradner, 1963) Reinhardt, 1971

*Rhagodiscus asper* (Stradner, 1963) Reinhardt, 1967

*Rhagodiscus gallagheri* Rutledge & Bown, 1996

*Rhagodiscus hamptonii* Bown in Kennedy *et al.*, 2000

*Rhagodiscus reniformis* Perch-Nielsen, 1973

*Rhagodiscus splendens* (Deflandre, 1953) Verbeek, 1977

*Rotelapillus laffittei* (Noël, 1957) Noël, 1973

*Seribiscutum primitivum* (Thierstein, 1974) Filewicz *et al.* in Wise & Wind, 1977

*Staurolithites angustus* (Stover, 1966) Crux, 1991

*Staurolithites gausorhethium* (Hill, 1976) Varol & Girgis, 1994

*Staurolithites glaber* (Jeremiah, 1996) Burnett, 1997

*Staurolithites laffittei* Caratini, 1963

*Staurolithites mutterlosei* Crux, 1989

*Staurolithites* cf. *S. rotatus* Jeremiah, 1996

*Stoverius achylosus* (Stover, 1966) Perch-Nielsen, 1986

*Stoverius protosignum* (Worsley, 1971) Young & Bown, 2014

*Stradnerlithus geometricus* (Górka, 1957) Bown and Cooper, 1989

*Tegumentum stradneri* Thierstein in Roth & Thierstein, 1972

*Tetrapodorhabdus decorus* (Deflandre in Deflandre & Fert, 1954) Wind & Wise in Wise & Wind, 1977

*Tranolithus gabalus* Stover, 1966

*Tranolithus orionatus* (Reinhardt, 1966a) Reinhardt, 1966

*Tranolithus* sp. A

*Tubodiscus burnettiae* Bown in Kennedy *et al.*, 2000

*Watznaueria barnesiae* (Black in Black & Barnes, 1959) Perch-Nielsen, 1968

*Watznaueria biporta* Bukry, 1969

*Watznaueria britannica* (Stradner, 1963) Reinhardt, 1964

*Watznaueria fossacincta* (Black, 1971) Bown in Bown & Cooper, 1989

*Watznaueria manivittiae* Bukry, 1973

*Watznaueria ovata* Bukry, 1969

*Zeugrhabdotus biperforatus* (Gartner, 1968) Burnett, 1997

*Zeugrhabdotus diplogrammus* (Deflandre in Deflandre & Fert, 1954) Burnett in Gale *et al.*, 1996

*Zeugrhabdotus embergeri* (Noël, 1959) Perch-Nielsen, 1984

*Zeugrhabdotus* cf. *Z. embergeri* (Noël, 1959) Perch-Nielsen, 1984

*Zeugrhabdotus howei* Bown in Kennedy *et al.*, 2000

*Zeugrhabdotus* cf. *Z. howei* Bown in Kennedy *et al.*, 2000

*Zeugrhabdotus noeliae* Rood *et al.*, 1971

*Zeugrhabdotus streetiae* Bown in Kennedy *et al.*, 2000

*Zeugrhabdotus xenotus* (Stover, 1966) Burnett in Gale *et al.*, 1996

**Table S1:** Stratigraphic range chart of the Gault Clay, Copt Point section (41 samples)

showing the distribution of nannofossils. Estimation of the semi-quantitative abundance of species was recorded as per the scale; Abundant (A): >10 specimens per field of view (FOV); Common (C): 1–10 specimens per FOV; Frequent (F): at least 1 specimen per 10 FOVs; Rare (R): 1 specimen in > 10 FOVs; Very Rare (VR): only 1 or 2 specimens observed in the sample. An estimate of total nannofossil abundance in a sample was recorded as; High (H): each FOV has > 20–30 nannofossils; Moderate (M): each FOV has 10–20 nannofossils. Preservation of nannofossils was recorded as VG: Very Good; G: Good; and M: Moderate. Full explanation of the preservation categories is given in the text.

**Table S2:** Relative abundance (%) data of the major nannofossil taxa based on 300+ counts performed on 41 samples.

**Table S3:** Percentage distribution of Tethyan ammonites from Beds I–X, Gault Clay (Copt Point).

**Table S4:** Bulk sediment oxygen isotope ( $\delta^{18}\text{O}_{\text{bulk}} \text{‰}$ ), carbon isotope ( $\delta^{13}\text{C}_{\text{bulk}} \text{‰}$ ), carbonate ( $\text{CaCO}_3$ , wt %) and TOC (wt %) data for 44 Gault Clay samples (Copt Point).







<i>Tegumentum stradhieri</i>	<i>Tetrapodorhabdus decorus</i>	<i>Tranolithus gabalus</i>	<i>Tranolithus orionatus</i>	<i>Tranolithus</i> sp. A	<i>Tubodiscus burnetiae</i>	<i>Watznaeria barnesiae</i>	<i>Watznaeria biporta</i>	<i>Watznaeria britannica</i>	<i>Watznaeria fossacincta</i>	<i>Watznaeria manivittae</i>	<i>Watznaeria ovata</i>	<i>Zeughrabdous biperforatus</i>	<i>Zeughrabdous diplogrammus</i>	<i>Zeughrabdous embergeri</i>	<i>Zeughrabdous cf. Z. embergeri (small)</i>	<i>Zeughrabdous howei</i>	<i>Zeughrabdous cf. Z. howei</i>	<i>Zeughrabdous noelhae</i>	<i>Zeughrabdous streetae</i>	<i>Zeughrabdous xenotus</i>	Nannofossil Event	Nannofossil Zone (Brown <i>et al.</i> 1998)	Nannofossil Zone (Jeremiah 1996)	Stage (based on nannofossils)	Sample
F	R		C	R	F	A	F	R	C	C	R		F	R		F	A		R		<i>E. monechiae</i> absent, <i>H. albiensis</i> present			21.4	
F	R		C		F	A	R	VR	F	C	R		F	R		F	A		VR				NAL 9		20.9
F	R		C	F	F	C	R	VR	F	C	R		R	R		F	C		VR						20.4
F	R		C		F	A	F		F	C	R	VR	F	R		R	A		R						19.9
F	VR		C		F	A	F		C	C	R		F	R	R	F	A					<i>FO S. angustus</i>			19.4
F	R		C	R	F	A	R		F	C	F		F			F	A		F						18.9
F	R	R	C		F	A	R		F	C	F	VR	F	VR		F	A	R	F						18.4
F	R		C	R	F	A			F	C	R		R	R	R	F	C	VR	VR						17.8
F	R		F		F	C	F		F	F	R	VR	F				R	C		F					17.2
F	R		C		F	A	F	VR	C	C	F		F	R		F	F	A		F					16.7
F			C	R	F	A	F		C	C	R		F	R	R	F	F	A	R	F					16.1
F	R		C		C	A	F	R	C	C	F	VR	F	F		F	F	A		F					15.6
F	F		F	R	F	C	R		F	F			C	R	R	F	F	A		F					15.1
F	F		F	R	F	A	F		C	C	F		F	F	R	F	F	A		R					14.6
F	R		C		F	A	F		C	F	F		F	R		F	F	A		F					14.3
F			F	R	F	C	R		C	C	R		F	R		F	F	C		R					13.9
F	R		F	R	F	C	R		C	C	R		R	R		F	F	A		R					13.3
F	R		F	R	F	C			C	F	R		F	R		F	F	C		F					12.9
F	R		F		F	A	F	VR	C	C	F		R	R	R	F	F	C		R					12.3
F	F		F	R	F	A	F		C	C	F		F	F		F	F	A		F					11.8
F	R		F	R	F	A	F	VR	C	F	R		F	F		F	F	C		R		<i>FO Gartnerago cf. G. praeobliquum (small)</i>			11.5
F	R		F	VR	F	A	F		C	F	R	R	F	F		F	F	C		R					11.0
C	F		C	R	F	A	F		C	C	F		C	C		C	F	A		R					10.6
F	R		F	R	F	C	F		C	F	R		F	F		F	R	C		F					10.3
C	F		C	R	F	A	F	VR	C	C	F	VR	F	C		C	F	A		R					10.2
F	F		F	R	F	A	F	VR	C	F	R		C	R		C	F	A		F					9.7
F	R		F	R	F	C	R		C	F	R		F	R		F	F	A		R		<i>LO C. bicornuta</i>			9.0
F	R		F		C	C	F		F	F	R		R	R		F	F	A		R					8.1
F	R		C	R	F	C	R		C	C	R		F	R		C	F	A		F					7.4
F	R		F	R	F	C	R		F	F	R		F	R		F	R	C		R					7.1
F	R		C	R	F	C	F		C	C	F	VR	C	R		C	A		F						6.5
F	F		F	R	F	C	R		C	C	F	VR	F	R		F	A		R						6.0
F	VR		F	R	F	C	R		F	C	R		F	F	VR	F	A		F						5.6
F	R		C	R	F	C	R		F	C	F		F	F		F	A		F			<i>FO C. hamata</i>			5.1
F			F	R	F	C			F	F	F		F	R		F	A		F			<i>FO C. bicornuta</i>			4.5
F	R		F	R	F	C	R		F	F	R	VR	F	R		C	C		F						4.0
F	R		F	R	F	C			F	C	R		F	R		F	C		F			<i>FO A. albianus, O. hilli</i>		NAL 5	3.6
F	R		R		R	C	R		F	F	R	VR	C		R		C		F						3.0
F	VR		F	R	R	C	R		F	F	R		C	VR			C		F						2.6
F	VR		F	R	F	C	F		F	C	R		C	VR			A		F			<i>LO B. boletiformis ; FO C. signum</i>		NAL 4	2.0
F	VR		F	R	F	C	F		F	C	R		C				A		F			<i>T. orionatus, C. anglicum</i> present			1.6

Sample height (m)	Bed No (Owen 1971; Young et al. 2010)	% <i>Biscutum constans</i>	% <i>Discothabdas ignotus</i>	% <i>Lithraphidites carniolensis</i>	% <i>Prediscosphaera</i> spp.	% <i>Repagulum parvidentatum</i>	% <i>Retecapsa crenulata</i> + <i>R. surirella</i>	% <i>Rhagodiscus asper</i>	% <i>Serbiscutum primitivum</i>	% <i>Staurolithes laffitei</i>	% <i>Tranolithus orionatus</i>	% <i>W. barnesiae</i> group	% <i>Zeugrhabdotus noeliae</i>	% <i>Zeugrhabdotus diplogrammus</i>	% <i>Zeugrhabdotus howei</i>	Total	Productivity Index
21.4	XI	21	1	5	7	3	1	1	0	5	5	20	26	0	0	95	2.4
20.9		21	1	8	7	3	1	0	0	2	4	17	27	0	0	91	2.8
20.4		15	2	6	7	2	1	1	0	1	2	16	24	0	7	84	2.4
19.9		27	2	6	4	2	1	1	0	2	4	20	20	0	0	89	2.4
19.4		25	2	5	5	3	3	0	0	6	4	27	12	0	0	92	1.4
18.9		26	1	8	4	3	3	0	0	2	4	19	21	0	0	91	2.5
18.4		22	3	5	6	4	1	0	0	1	4	18	22	0	1	87	2.4
17.8		30	0	3	6	2	2	0	0	2	4	23	16	0	1	89	2.0
17.2		26	0	2	4	1	2	0	0	2	3	19	31	0	0	90	3.0
16.7		25	0	1	8	2	1	0	0	2	3	19	30	1	0	92	2.9
16.1		30	0	2	4	2	2	0	0	2	2	17	30	1	0	92	3.5
15.6	24	0	1	5	3	2	1	0	1	2	28	27	0	0	94	1.8	
15.1	X	20	1	8	5	4	1	1	1	4	4	18	24	1	3	95	2.4
14.6		21	0	0	5	5	3	1	0	0	3	21	28	0	0	87	2.3
14.3		16	0	3	7	3	3	0	0	2	3	20	34	0	0	91	2.5
13.9		13	0	2	7	3	2	1	0	1	4	15	40	0	0	88	3.5
13.3	IX	16	0	5	9	1	2	2	0	3	6	13	33	0	0	90	3.8
12.9		17	1	7	5	2	1	0	0	2	2	31	18	0	6	92	1.1
12.3		19	1	3	9	3	2	0	0	1	4	19	31	0	0	92	2.6
11.8		19	1	4	8	5	3	1	0	0	3	11	35	0	0	90	4.9
11.5		18	0	2	6	4	1	0	0	1	3	14	40	0	0	89	4.1
11.0		12	0	2	5	6	3	0	0	1	5	21	35	1	1	92	2.2
10.6		8	2	2	7	8	3	0	0	1	3	18	41	0	0	93	2.7
10.3		11	1	1	4	6	3	1	0	1	6	44	10	2	4	94	0.5
10.2	13	1	2	5	9	3	1	0	1	6	31	21	1	0	94	1.1	
9.7	VIII	11	2	6	1	11	1	0	0	3	3	33	13	3	3	90	0.7
9.0	VII	13	0	1	4	7	2	0	0	2	4	36	26	0	0	95	1.1
8.1		14	0	6	3	9	1	1	0	2	5	25	26	1	0	93	1.6
7.4	VI	22	1	3	4	7	2	0	0	2	4	16	28	1	3	93	3.1
7.1	V	14	2	5	3	6	3	2	0	1	5	17	28	1	2	89	2.5
6.5	IV	13	0	5	10	8	3	0	0	2	4	16	28	1	2	92	2.6
6.0	III	18	1	9	3	12	1	1	0	2	4	22	12	1	6	92	1.4
5.6		14	1	9	2	8	2	2	0	5	3	29	11	0	4	90	0.9
5.1		14	1	7	7	9	2	2	0	4	7	24	11	0	3	91	1.0
4.5	II	11	0	7	4	9	2	2	0	0	1	37	11	2	4	90	0.6
4.0		8	1	8	1	5	2	2	0	4	2	33	21	0	5	92	0.9
3.6		12	1	10	1	5	1	2	0	7	5	31	14	1	3	93	0.8
3.0	I	25	1	3	1	5	2	1	0	10	2	22	23	1	0	96	2.2
2.6		22	3	5	8	2	3	1	0	4	2	22	15	2	0	89	1.7
2.0		21	5	5	8	3	2	0	0	5	6	21	9	0	0	85	1.4
1.6		33	2	7	6	4	1	0	0	5	4	18	9	1	0	90	2.3
Mean		19	1	4.6	5.2	4.9	2	0.7	0	3	3.8	22	23	0.5	1.4	91	2.1

Ammonites	
Bed No.	% Tethyan ammonites
X	70.0
	74.0
IX	68.0
	45.0
	48.0
	49.0
	38.0
	22.0
	3.5
	28.0
VIII	50.0
	9.0
VII	
VI	
V	
IV	4.0
III	
II	
I	4.0

Sample height (m)	Bed No. (Owen 1971; Young <i>et al.</i> 2010)	Oxygen isotope values (‰) bulk	Carbon isotope values (‰) bulk	CaCO <sub>3</sub> (wt.%)	TOC (wt. %)	
21.4	XI	-2.35	2.20	38.4	0.3	
20.9		-2.95	1.80	40.9	0.3	
20.4		-2.40	2.20	37.5	0.2	
19.9		-2.25	1.90	36.2	0.2	
19.4		-3.40	1.70	32.7	0.2	
18.9		-3.15	2.00	37.2	0.2	
18.4		-2.40	1.90	32.7	0.3	
17.8		-3.30	1.60	19.8	0.4	
17.2		-2.65	2.05	28.5	0.4	
16.7		-2.85	1.95	34.4	0.3	
16.1		-2.30	2.65	31.3	0.3	
15.6		-2.00	2.75	34.9	0.3	
15.1		X	-2.90	1.95	38.7	0.3
14.6			-2.15	2.70	33.7	0.5
14.3	-2.70		2.55	35.1	0.5	
13.9	-2.60		2.65	27.6	0.5	
13.3	IX	-2.95	2.40	26.8	0.4	
12.9		-3.25	2.30	31.6	0.5	
12.3		-3.00	2.20	33.7	0.5	
11.8		-2.85	2.75	27.0	0.6	
11.5		-2.60	2.85	29.6	0.7	
11.0		-2.35	2.05	22.6	0.7	
10.6		-4.00	2.50	19.5	1.5	
10.3		-2.95	3.25	9.5	0.7	
10.2	-1.90	2.65	17.7	0.8		
9.7	VIII	-1.25	3.00	19.9	0.9	
9.0	VII	-1.30	2.90	20.1	1.0	
8.1		-1.80	2.70	19.1	0.7	
7.4	VI	-1.70	2.40	18.2	0.3	
7.1	V	-2.65	2.20	19.9	0.6	
6.5	IV	-2.60	2.15	22.0	0.3	
6.0	III	-2.50	2.25	19.7	0.3	
5.6		-2.40	2.20	16.4	0.3	
5.1		-2.10	2.60	18.0	0.2	
4.5	II	-3.05	2.45	11.4	0.3	
4.0		-2.55	1.90	8.6	0.4	
3.6		-2.60	2.30	11.0	0.4	
3.0	I	-1.60	2.85	18.4	0.3	
2.6		-1.65	2.90	17.5	0.4	
2.0		-2.10	3.00	20.6	0.2	
1.6		-1.75	2.90	19.4	0.3	
1.0		-2.10	2.60	14.7	0.2	
0.5		-2.15	2.35	11.1	0.2	
0.1	-2.25	0.70	8.1	0.0		
Mean		-2.46	2.36	24.3	0.4	
Population Standard Deviation		0.566	0.465	9.269	0.265	