Supporting Information

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SI Text

SI Materials and Methods. ***Collection of macrofossils at Astartekløft.*** Each plant bed was census-collected for a total of 48 hours by excavating four small quarries spaced two to five metres apart laterally as constrained by the nature of the outcrop (1). Plant beds 1.5 and 6 were census-collected for a total of eight hours each (1). Macrofossils were collected from each quarry by an individual worker (1) and occurrences of macrofossils within each quarry are shown in Dataset S1.

NMDS ordination on relative abundance data. Ordination of the sporomorph samples using relative abundance data (with singletons removed) results in the same grouping of samples as "Wisconsin" standardized data (Fig. S1). The grouping is statistically significant using a Kruskal–Wallis test: NMDS Coordinate 1 ($KW = 26.98_{24,9,3,4}$ $p < 0.0001$); NMDS Coordinate 2 ($KW = 12.67_{24,9,3,4}$ $p = 0.0054$). Ordination on relative abundance data is likely to be sensitive to the most abundant taxa. In this respect, plant bed 5 differs from plant beds 1 to 4 by a two-fold rise in the relative abundance of *Baculatisporites comaumensis* (~35%), an increase in the frequency of *Uvaesporites reissingerii* (~15%), and a decrease in the frequency of *Riccisporites tuberculatus* (~8%).

Details of plant groups at Astartekløft. (*i*) Ferns, comprising all representatives of the class Filicopsida (Tables S2 and S3); (*ii*) Conifers and Corystosperms, comprising all representatives of the class Coniferopsida and the order Corystospermales (Tables S2 and S3). This order of seed-ferns has been included owing to the dubious botanical affinities of *Alisporites* and grains of the *Pinuspollenites* morphotype (Table S3 and ref. 2); (*iii*) Monosulcate Producers, comprising all representatives of the classes Cycadopsida, Ginkgopsida, Bennettitopsida, and the order Peltaspermales (Tables S2 and S3). This group contains many clades because the parent plants produced simple monosulcate pollen grains of the *Monosulcites*/*Cycadopites* and *Chasmatosporites* morphotypes (Table S3 and ref. 3). Mosses, liverworts, and lycopods are absent from census-collected macrofossils from Astartekløft (1) and horsetails constituted <6% of the total flora in both the macrofossil and sporomorph records (Table S1). These groups were not included in the analysis of agreement. Sporomorphs of unknown botanical affinities at the class level account for less than 7% of the total assemblage in each plant bed (Table S1).

Other Supporting Information Files

Dataset S1

Data matrix showing occurrences of macrofossil genera in each plant bed at Astartekløft. The total number of macrofossils recorded rom each plant bed is shown, and these occurrences are broken into collections from each plant bed made by individual collectors during census collection (see ref. 1 for a detailed description of macrofossil collection techniques). Where a macrofossil could not be assigned to an individual collector, the occurrence is shown in the column labeled C/U (Collector Unknown).

Dataset S2 (XLS)

Data matrix showing occurrences of sporomorphs from samples from each plant bed at Astartekløft analyzed in this study.

1. McElwain JC, Popa ME, Hesselbo SP, Haworth M, Surlyk F (2007) Macroecological responses of terrestrial vegetation to climatic and atmospheric change across the Triassic/Jurassic boundary in East Greenland. *Paleobiology* 33:547–573.
2. Leslie AB (2008) Interpreting the function of saccate pollen in ancient conifers and other seed plants. *Int J Plant Sci* 169:1038–1045.
3. Balme BE (1995) Fossil in situ spores and pollen grains: An annotated catalogue. *Rev Palaeobot Palyno* 87:81–323.

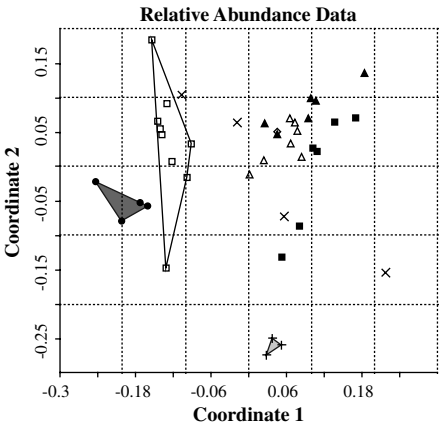

Fig. S1. Nonmetric multidimensional scaling plot of relative abundance sporormorph data. Samples from plant bed 5 represented by open squares and enclosed within an unshaded envelope. Samples from plant bed 6 represented by vertical crosses and enclosed within a pale gray envelope, and samples from plant bed 7 represented by closed circles and enclosed within a dark gray envelope.

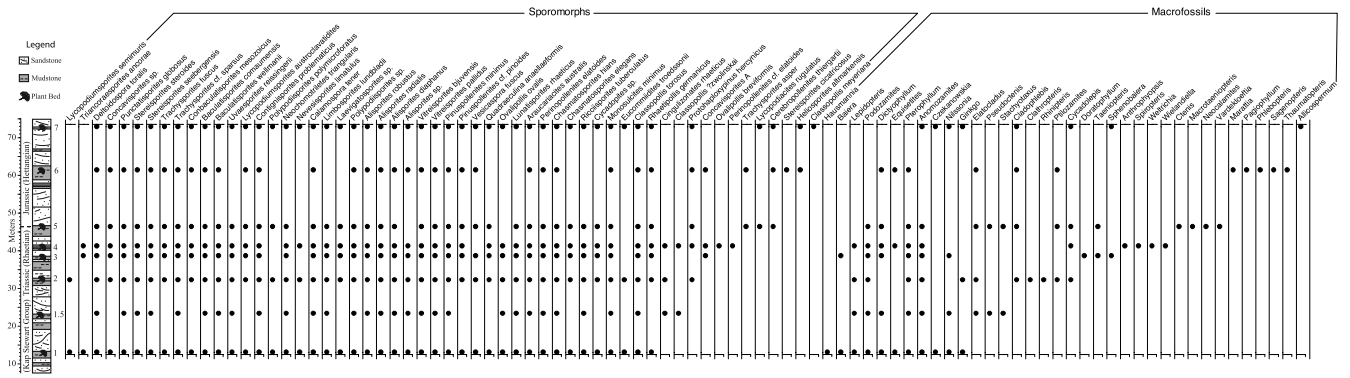

Fig. S2. Range chart of Sporomorphs and Macrofossils at Astartekløft. Occurrences are shown binned at "bed level."

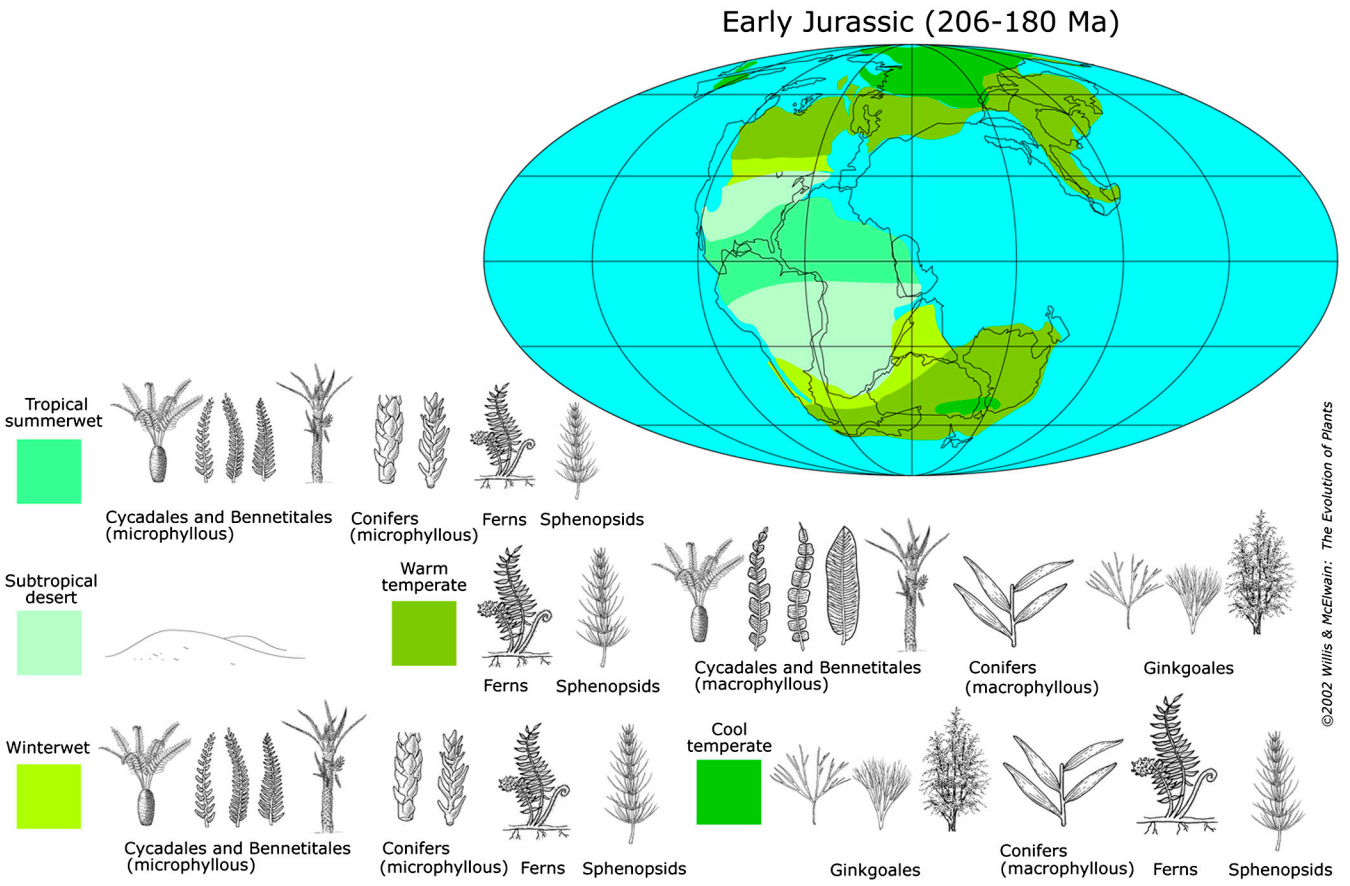

Fig. S3. Biome map of the Early Jurassic world (from ref. 1).

Willis KJ, McElwain JC (2002) *The Evolution of Plants* (Oxford University Press, Oxford), pp 378.

Table S1. Number of individuals and percentages of each plant group in the macrofossil and sporomorph records from each plant bed at Astarteklø ft

	Plant Group	Individuals (*n*) and percentage	Plant bed							
			7	6	5	4	3	2	1.5	1
Macrofossils	Ferns	*n*	*22*	*98*	*4*	*63*	*1*	*41*	*20*	*4*
		%	2.66	77.78	1.07	11.45	0.18	16.53	33.33	2.56
	Conifers	*n*	*0*	*18*	*316*	*3*	*490*	*37*	*6*	*29*
		%	0.00	14.29	84.49	0.55	87.97	14.92	10.00	18.59
	Monosulcate producers	*n*	*797*	*5*	*39*	*477*	*62*	*169*	*34*	*116*
		%	96.37	3.97	10.43	86.73	11.13	68.15	56.67	74.36
	Other seed-ferns	*n*	*0*	*3*	*10*	*0*	*0*	*1*	*0*	*0*
		%	0.00	2.38	2.67	0	0.00	0.40	0.00	0.00
	Horsetails	*n*	*0*	*2*	*2*	*5*	*0*	*0*	*0*	*7*
		%	0.00	1.59	0.53	0.91	0.00	0.00	0.00	4.49
	Incertae Sedis	*n*	*8*	*0*	*3*	*2*	*4*	*0*	*0*	*0*
		%	0.97	0.00	0.80	0.36	0.72	0.00	0.00	0.00
Sporomorphs	Ferns	*n*	*858*	*936*	*1444*	*730*	*503*	*697*	*80*	*330*
		%	60.94	86.43	45.04	34.13	34.10	27.57	22.16	13.87
	Conifers and Corystosperms	*n*	*312*	*85*	*669*	*359*	*170*	*478*	*74*	*444*
		%	22.16	7.85	20.87	16.78	11.53	18.91	20.50	18.66
	Monosulcate producers	*n*	*53*	*4*	*41*	*26*	*27*	*50*	*5*	*48*
		%	3.76	0.37	1.28	1.22	1.83	1.98	1.39	2.02
	Other seed-ferns	*n*	*29*	*10*	*29*	*60*	*15*	*69*	*4*	*67*
		%	2.06	0.92	0.90	2.81	1.02	2.73	1.11	2.82
	Horsetails	*n*	*15*	*21*	*133*	*13*	*10*	*18*	*16*	*32*
		%	1.07	1.94	4.15	0.61	0.68	0.71	4.43	1.35
	Mosses	*n*	*22*	*9*	*32*	*10*	*3*	*29*	*7*	*16*
		%	1.56	0.83	1.00	0.47	0.20	1.15	1.94	0.67
	Lycopods	*n*	*22*	*2*	*590*	*101*	*468*	*234*	*48*	*195*
		%	1.56	0.18	18.40	4.72	31.73	9.26	13.30	8.20
	?Gnetales	*n*	*2*	*0*	*0*	*0*	*0*	*1*	*0*	*1*
		%	0.14	0.00	0.00	0.00	0.00	0.04	0.00	0.04
	Ricciisporites tuberculatus	*n*	*1*	*0*	*239*	*801*	*220*	*865*	*118*	*1189*
		%	0.07	0.00	7.45	37.45	14.92	34.22	32.69	49.98
	Incertae Sedis	*n*	*94*	*16*	*29*	*39*	*59*	*87*	*9*	*57*
		%	6.68	1.48	0.90	1.82	4.00	3.44	2.49	2.40

Table S2. Higher classification of the plant macrofossils analyzed in this present paper

Genus	Order	Class
Allicospermum	—	*Incertae sedis*
Anomozamites	Bennettitales	Bennetitopsida
Anthrophyopsis	—	*Incertae sedis*
Baiera	Ginkgoales	Ginkgopsida
Cladophlebis	Filicales	Filicopsida
Clathropteris	Filicales	Filicopsida
Ctenis	Cycadales	Cycadopsida
Cycadolepis	Bennettitales	Bennetitopsida
Czekanowskia	Czekanowskiales	Ginkgopsida
Dictyophyllum	Filicales	Filicopsida
Doratophyllum	Cycadales	Cycadopsida
Elatocladus	Coniferales	Coniferopsida
Equisetites	Equisetales	Sphenopsida
Ginkgo	Ginkgoales	Ginkgopsida
Hausmannia	Filicales	Filicopsida
Lepidopteris	Peltaspermales	Pteridospermopsida
Macrotaeniopteris	—	*Incertae sedis*
Marattia	Marattiales	Filicopsida
Neocalamites	Equisetales	Sphenopsida
Nilssonia	Nilssoniales	Cycadopsida
Pagiophyllum	Coniferales	Coniferopsida
Phlebopteris	Filicales	Filicopsida
Podozamites	Coniferales	Coniferopsida
Pseudoctenis	Cycadales	Cycadopsida
Pterophyllum	Bennettitales	Bennetitopsida
Ptilozamites	*Incertae sedis*	Pteridospermopsida
Rhinipteris	Marattiales	Filicopsida
Sagenopteris	Caytonales	Pteridospermopsida
Sphenobaiera	Ginkgoales	Ginkgopsida
Spiropteris	Filicales	Filicopsida
Stachyotaxus	Coniferales	Coniferopsida
Taeniopteris	—	*Incertae sedis*
Thaumatopteris	Filicales	Filicopsida
Vardekloeftia	Bennettitales	Bennetitopsida
Weltrichia	Bennettitales	Bennetitopsida
Wielandiella	Bennettitales	Bennetitopsida

Table S3. Botanical affinities of the sporomorph taxa analyzed in this present paper

Sporomorph taxon	Order	Class
Alisporites diaphanus	Coniferales; Corystospermales	Coniferopsida; Pteridospermopsida
Alisporites radialis	Coniferales; Corystospermales	Coniferopsida; Pteridospermopsida
Alisporites robustus	Coniferales; Corystospermales	Coniferopsida; Pteridospermopsida
Alisporites sp.	Coniferales; Corystospermales	Coniferopsida; Pteridospermopsida
Araucariacites australis	Coniferales	Coniferopsida
Baculatisporites comaumensis	Filicales	Filicopsida
Baculatisporites wellmanii	Filicales	Filicopsida
Calamospora tener	Equisetales	Sphenopsida
Cerebropollenites thiergartii	Coniferales	Coniferopsida
Chasmatosporites elegans	Cycadales; Ginkgoales	Cycadopsida; Ginkgopsida
Chasmatosporites hians	Cycadales; Ginkgoales	Cycadopsida; Ginkgopsida
Cingulizonates rhaeticus	—	Lycopsida
Classopollis? *zwolinskai*	Coniferales	Coniferopsida
Classopollis meyeriana	Coniferales	Coniferopsida
Classopollis torosus	Coniferales	Coniferopsida
Conbaculatisporites mesozoicus	Filicales	Filicopsida
Concavisporites A	Filicales	Filicopsida
Concavisporites sp.	Filicales	Filicopsida
Contignisporites problematicus	—	*Incertae sedis*
Cycadopites sp.	Cycadales; Ginkgoales; Peltaspermales; Bennettitales	Cycadopsida; Ginkopsida; Pteridospermopsida; Bennetitopsida
Deltoidospora toralis	Filicales	Filicopsida
Eucommiidites troedssonii	Erdtmanithecales	*Incertae sedis*
Heliosporites altmarkensis	—	Lycopsida
Laevigatosporites sp.	Marattiales	Filicopsida
Limbosporites lundbladii	—	Lycopsida
Lunatisporites rhaeticus	Coniferales; Corystospermales	Coniferopsida; Pteridospermopsida
Lycopodiacidites rugulatus	—	Filicopsida
Lycopodiumsporites austroclavatidites	—	Lycopsida
Lycopodiumsporites semimuris	—	Lycopsida
Monosulcites minimus	Bennettitales	Bennetitopsida
Neochomotriletes triangularis	—	*Incertae sedis*
Nevesisporites limatulus	—	*Incertae sedis*
Ovalipollis breviformis	—	*Incertae sedis*
Ovalipollis ovalis	—	*Incertae sedis*
Perinopollenites cf. *elatoides*	Coniferales	Coniferopsida
Perinopollenites elatoides	Coniferales	Coniferopsida
Pinuspollenites cf. *pinoides*	?Coniferales	Coniferopsida; Pteridospermopsida
Pinuspollenites minimus	?Coniferales	Coniferopsida; Pteridospermopsida
Polypodiisporites polymicroforatus	Filicales	Filicopsida
Polypodiisporites sp.	Filicales	Filicopsida
Protohaploxypinus hercynicus	Coniferales; Glossopteridales	Coniferopsida; Pteridospermopsida
Punctatisporites globosus	Filicales; Marattiales	Filicopsida
Quadraeculina anaellaeformis	Coniferales	Coniferopsida
Rhaetipollis germanicus	—	*Incertae sedis*
Ricciisporites tuberculatus	?Marchantiales	?Marchantiopsida
Stereisporites cicatricosus	Sphagnales	Sphagnopsida
Stereisporites seebergensis	Sphagnales	Sphagnopsida
Stereisporites stereoides	Sphagnales	Sphagnopsida
Trachysporites asper	—	Filicopsida
Trachysporites cf. *sparsus*	—	Filicopsida
Trachysporites fuscus	—	Filicopsida
Triancoraesporites ancorae	—	Lycopsida
Uvaesporites reissingerii	Selaginellales	Lycopsida
Vesicaspora fuscus	—	Pteridospermopsida
Vitreisporites bjuvensis	Caytonales	Pteridospermopsida
Vitreisporites pallidus	Caytonales	Pteridospermopsida