
Highcliffe

[SZ 195 927]–[SZ 199 928]

Introduction

Highcliffe (also sometimes known as 'Friars Cliff, Mudeford') is the type section for the Boscombe Sand Formation, which is an arenaceous deposit immediately below the Barton Clay. This is the only site known to yield abundant plant macrofossils from the Eocene Boscombe Sand Formation. Over 50 species have been reported and it is the type locality for 14 of them. For 11 species and 3 genera, this is the only known British locality. The flora includes a mixture of wetland and paratropical rain forest plants, and represents a transitional phase in the history of European Palaeogene vegetation.

Plant fossils here were noted first by Prestwich (1849), but for many years they remained unstudied, at least partly due to the difficulties of collecting significant quantities of fresh material. During the 1930s, however, the direction of outflow of the River Run changed, causing the cliff to be eroded at its base (Burton, 1931). For two years, the resulting cliff-falls allowed considerable quantities of material to be collected, but in 1935 another change in the river flow caused this to cease and since then collecting has been difficult. Most of what we know about this site comes from Chandler's (1963b) descriptions of the fossils collected then.

Description

Stratigraphy

Daley (in Daley and Balson, 1999) discusses details of the geology of this site. The exposed sequence consists of about 14 m mainly of sands, which have been interpreted as being prograding mouth-bars at the seaward end of a tidal channel (Plint, 1988). Dinoflagellate biostratigraphy (Costa *et al.*, 1976) suggests that the Boscombe Sands are the same age as the upper Selsey Formation further east, and are thus late Lutetian in age (see also Collinson, 1996b).

Palaeobotany

Chandler (1963b) gives details of the plant fossils that were found here. These include ferns, principally *Lygodium kaulfussii* Heer (Schizaeaceae), and the conifers *Pinus* sp., *Sequoia couttsiae* Heer (see footnote to (Table 8.2)) and *Cupressistrobus gardneri* Chandler. There are also conifer shoots originally described as '*Araucarites*' *sternbergii* Goppert but which may belong to *Sequoiadendron fordii* Chandler, 1978 (Chandler, 1978, p.36–40; see comments on *Araucarites*' in the Bracklesham GCR site report). However, the angiosperms were by far the most diverse components; those included are listed in (Table 9.1). The plant remains are mostly preserved as delicate compression fossils. Compared with some of the other Tertiary fruit and seed sites in southern England, the fossils here are sparse.

Interpretation

The Boscombe Sand flora belongs to the 'Late Middle Eocene floras' of Collinson and Hooker (1987), which they state to be poorly known. Highcliffe is the only known locality to have yielded abundant plant remains from these deposits. Lignites in the Boscombe Sands at Bournemouth have yielded some plant remains but they are poorly preserved (Chandler, 1963b). The flora is probably coeval with the basal Hengistbury Head assemblage (Chandler, 1960) and the upper Selsey Formation exposed at Bracklesham Bay (Collinson, 1996b), but these have not yielded anywhere near as diverse assemblages as Highcliffe.

Although not abundant, the plant fossils from Highcliffe are of considerable interest as they throw some light on the vegetational changes taking place in Europe during middle Palaeogene times. They represent the stratigraphically highest occurrence of several taxa of angiosperm, including *Rutaspermum rugosum*, *Toddaliospermum ornatum*, *Oncoba rugosa*, *Thymelaeaspermum bournense* and *Nysoidea eocenica*. On the other hand, it yields the oldest known remains

of *Cladiocarya foveolata*, ?*Gordonia truncata*, *Microdiptera parva* and *Epacridicarpum mudense*. Ten species have not been reported from other localities in the British Tertiary: *Scleriocarya tribracteata*, *Toddalia excavata*, *Grewia minima*, *Eurya mudense*, *Clethra hantonense*, *Sambucus mudensis*, *Cucurbitospermum mudense* and three species of *Carpolithus*.

Two genera are unique as fossils to Highcliffe. *Scleriocarya* was established for fruits similar to those of the living razor-sedge (*Scleria*), but which differed in details of shape and surface from any living species. The record of *Grewia* was based on a single endocarp that is very similar to those of the fruits of the mainly tropical living genus of that name. Highcliffe is also the only British site to yield fossils of *Clethra*, although it has been recorded from Polish amber (Conwentz, 1886) and Danish Miocene deposits (Friis, 1985). Friis (1985) considered the inclusion of the Highcliffe species in *Clethra* as uncertain.

Chandler (1963b) regarded the assemblage as having more in common with the Ypresian, para-tropical rain forest vegetation than of the later Eocene and Oligocene floras. Some of the families found at Highcliffe (e.g. dogwood, flacourtia, moonseed and tea families) indeed suggest the surrounding vegetation had a tropical aspect. However, neither the mangrove palm *Nypa*, which forms such a characteristic element of the Ypresian fossil floras, nor '*Scirpus*' *lakensis* occur at Highcliffe (Collinson, 2000a). Also absent are many of the characteristic families of the Ypresian paratropical forests, such as the sumac, custard apple, dogbane, frankincense, icacina, laurel and soapberry families. The presence of some sedges, pondweeds, water lilies and frog's bits indicates that freshwater wetlands were already starting to become a dominant habitat in southern England. It would seem that the Highcliffe flora represents a transition between the Ypresian paratropical mangroves and rain forests, and the late Eocene wetlands, but with, on the whole, more in common with the latter.

Conclusions

Highcliffe is the only site known to yield a significant number of fossil fruits and seeds from the Boscombe Sand Formation, about 42 Ma old. The flora includes 11 species and 3 genera that are unique in the British Tertiary deposits. It reflects the transition between the paratropical rain forests of early Eocene times and the wetlands of late Eocene times, and is thus important for understanding the vegetational and climatic changes that were occurring in Britain during that time.

(Table 9.1). Composition of the angiosperm flora from the Boscombe Sand Formation, Highcliffe. Species are described in Chandler (1963b) unless otherwise referenced. Some are also discussed by Mai and Walther (1978, 1985) and Mai (2000). The family classification listed here is summarized in Chapter 1 of the present volume.

Family	Species
Actinidiaceae	<i>Actinidia eocenica</i> Chandler
	<i>Saurauia crassisperma</i> (Chandler) Mai ¹
Arecaceae	<i>Calamus daemonorops</i> (Unger) Chandler
Betulaceae	<i>Carpinus boveyanus</i> (Heer) Chandler
Boraginaceae	Genus? (?Ehretioideae)
Caprifoliaceae	<i>Sambucus mudensis</i> Chandler
Caryophyllaceae	<i>Hantsia pulchra</i> (Chandler) Chandler
Clethraceae	<i>Clethra hantonensis</i> Chandler
	<i>Dunstaniana glandulosa</i> (Chandler) Chandler, 1961c (see also Chandler, 1963b) ²
Cornaceae (including Mastixiaceae)	<i>Eomastixia rugosa</i> (Zenker) Chandler
	<i>Mastixia? glandulosa</i> Chandler
	<i>Mastixicarpum crassum</i> Chandler
Cucurbitaceae	<i>Cucurbitospermum mudense</i> Chandler
	<i>Caricoidea obscura</i> Chandler
Cyperaceae	<i>Scleriocarya tribrachteata</i> Chandler
	<i>Cladiocarya foveolata</i> Reid and Chandler

Cyrillaceae ³	<i>Epacridicarpum headonense</i> Chandler
Epacridaceae	<i>E. mudense</i> Chandler
Flacourtiaceae	? <i>Leucopogon</i> sp.
Hydrocharitaceae	<i>Oncoba rugosa</i> Chandler
Lythraceae	<i>Stratiotes hantorzensis</i> Chandler
	<i>Microdiptera parva</i> Chandler
	<i>Palaeolythrum bournense</i> Chandler
Menispermaceae	<i>Palaeosinomenium</i> spp.
Nymphaeaceae	<i>Sabrenia chandlerae</i> Collinson
Nyssaceae	<i>Nyssonidea eocenica</i> Chandler
	<i>Potamogeton pygmaeus</i> Chandler (see Collinson, 1983a)
Potamogetonaceae	<i>Limnocatpus forbesii</i> (Heer) Chandler <i>emend.</i> Collinson 1982a
Rosaceae	<i>Rubus acutiformis</i> Chandler
	<i>Rutaspermum rugosum</i> Chandler
Rutaceae	<i>Toddalia excavata</i> (Chandler) Gregor ⁴
	<i>Toddaliospermum ornatum</i> Chandler
Solanaceae	<i>Solanispermum reniforme</i> Chandler
Symplocaceae?	Genus? ? <i>Cleyera</i> sp.
	<i>Eurya dubia</i> (Chandler) Mai ⁵
Theaceae	<i>Eurya stigmosa</i> (Ludwig) Mai ⁶
	<i>Eurya mudensis</i> Chandler
	? <i>Gordonia truncata</i> Chandler ⁷
Thymelaeaceae	<i>Thymelaeaspermum bournense</i> Chandler
Tiliaceae	<i>Grewia minima</i> Chandler
Vitaceae	<i>Vitis</i> sp.
	<i>Carpolithus echinatus</i> Chandler
	<i>C. ornatus</i> Chandler
	<i>C. mudense</i> Chandler
<i>Incertae sedis</i>	<i>Dicotylophyllum pinnatifidum</i> Reid and Chandler
	<i>Rhamnospermum bilobatum</i> Chandler
	<i>Wessexia fibrosa</i> (Chandler) Chandler
	¹ Formerly <i>Hordwellia crassisperma</i> (Chandler) Chandler (see Mai and Walther, 1985).
	² See Footnote 4 to (Table 8.1).
	³ See comment on <i>Epacridicarpum</i> in the Barton GCR site report.
	⁴ Formerly <i>Toddaliospermum excavatum</i> Chandler (see Mai and Walther, 1978).
	⁵ Formerly <i>Cleyera? lentiformis</i> Chandler (see Mai and Walther, 1985).
	⁶ Formerly <i>Cleyera? stigmosa</i> (Ludwig) Chandler (see Mai and Walther, 1978, 1985).
	⁷ <i>Gordonia truncata</i> = <i>Polyspora truncata</i> (Chandler) Gregor (see Mai and Walther, 1985). <i>Gordonia</i> and <i>Polyspora</i> are both modern genera, which are considered synonyms by some authors.

References

Family	Species	Lake	Arne	Studland	Family	Species	Lake	Arne	Studland
Peridaceae	<i>Acrostichum lanzaeanum</i> (Visini) Chandler		x	x	Icacinaceae	<i>Josier acutiformis</i> Chandler	x	x	
Schizaceae	<i>Lygodium hamifolium</i> Heer emend. Gardner and Etinghausen			x	<i>Natriatum socranicum</i> Chandler ¹¹	x			
	<i>L. podosum</i> Chandler	x			<i>Palaepolytocremis foreolata</i> Reid and Chandler	x			
	<i>Ascentia poolensis</i> Chandler	x	x		<i>Leuciscarya inornata</i> Chandler	x	x		
	<i>Rafinesquina subreticulata</i> (Nappeta) Barthel, 1976 ⁵	x	x		Lauraceae	<i>Lauricapsum</i> spp.	x		
Taxodiaceae	<i>Taxodium labensis</i> Chandler	x	x		Lythraceae	<i>Amorimia labensis</i> Chandler	x		
	<i>Sagaria costatae</i> Heer ²			x	<i>Alataspermum labense</i> Chandler	x			
Actinidiaceae	<i>Saxatula crassispina</i> (Chandler) Mai ³	x			Menispermaceae	<i>Timogera arvensis</i> Chandler	x	x	
	<i>S. poolensis</i> (Chandler) Mai, 1970 ²	x			<i>Palaeooculus labensis</i> Chandler	x	x		
Anacardiaceae	<i>Dracocorymbus glandulosa</i> Chandler	x			<i>Wardensheppeya poolensis</i> (Chandler) Eyde, 1970		x		
	<i>Rhus</i> spp.	x			Moraceae	<i>Ficus lucida</i> Chandler (see Collinson, 1989)	x		
	<i>R. sp.</i>	x			<i>F. sp.</i>			x	
Apocynaceae	<i>Apocynospermum acutiforme</i> Chandler ⁴	x			†Moraceae	<i>Ovicarpum reticulatum</i> Chandler (see Collinson, 1989)		x	
	<i>A. labense</i> Chandler ⁵	x			Nymphaeaceae	<i>Palaeonymphaea eocenica</i> Chandler (see Collinson 1980a)	x		
Araceae	<i>Galium dalemonorops</i> (Unger) Chandler	x			Nyssaceae	<i>Nyssidia eocenica</i> Chandler	x	x	
	<i>Sabal</i> sp.		x		Rosaceae	<i>Rubus arctiformis</i> Chandler			x
Boraginaceae	<i>Eberia labensis</i> Chandler	x			Rutaceae	<i>Phellodendron costatum</i> Chandler		x	
Burseraceae	<i>Palaeobursera labensis</i> Chandler	x			<i>Radiospermum eocenicum</i> Chandler		x		
Capparidaceae	<i>Burtonella emarginata</i> Chandler	x	x	x	<i>R. glabrum</i> Chandler	x			
	<i>Palaeocleome labensis</i> Chandler	x			<i>R. magnificum</i> Chandler		x		
	<i>Capparioidespermum eocenicum</i> Chandler	x			<i>R. striatum</i> Chandler	x			
Caprifoliaceae	<i>Sambucus parvula</i> Chandler	x			Sabiaceae	<i>Meliosma shapperyensis</i> Reid and Chandler	x		
Cornaceae (including Mastixiaceae)	<i>Dumetia labensis</i> Chandler ⁶	x			Sapotaceae	<i>Sapotocarpum</i> sp.		x	
	<i>Dumetia rigosa</i> (Zemke) Chandler (see Mai, 1993)	x	x		Solanaceae	<i>Solanum arvense</i> Chandler			x
	<i>E. arceolata</i> Chandler	x			<i>Solanum permianum</i> resiforme Chandler			x	
	<i>Mastixia canaliculata</i> Reid and Chandler ⁷		x		Syracaceae	<i>Syrax elegans</i> Chandler	x		
	<i>Mastixocarpum crassum</i> Chandler (see Mai, 1993)	x			Symplocaceae	<i>Symplocos beaufortensis</i> Chandler		x	
	<i>Sarcia quadriflorata</i> (Chandler) Mai, 1999 ⁸	x			<i>S. labensis</i> Chandler	x	x		
Cucurbitaceae	<i>Cucurbitospermum labense</i> Chandler	x			Thraceae	<i>Clypeus obliquus</i> Chandler	x		
	<i>C. obliquum</i> Chandler	x			†Cordoniaceae	<i>Cordonia</i> sp.	x		
Cyperaceae	<i>Scirpus labensis</i> Chandler	x	x		Thymelaeaceae	<i>Thymelaeospermum labense</i> Chandler	x	x	
	<i>Scirpus</i> sp.	x			<i>T. multatum</i> Chandler	x			
	<i>Carpocolea arsei</i> Chandler		x		Vitaceae	<i>Vitis ambigua</i> Chandler	x		
	<i>C. obtusata</i> Chandler	x			<i>V. arvensis</i> Chandler			x	
	<i>Carpocolea</i> sp.	x			<i>V. cuneata</i> Chandler	x			
	<i>Cladocorys minima</i> (Chandler) Mai in Mai and Walther, 1978 ⁹		x		<i>V. arvensis</i> Chandler	x			
Ebenaceae	<i>Diospyros beaufortensis</i> Chandler	x			<i>V. labensis</i> Chandler	x			
Euphorbiaceae	<i>Euphorbia labensis</i> Chandler	x			<i>V. junatica</i> Czeconi and Skingello ¹²	x	x		
	<i>E. platysperma</i> Chandler	x			<i>V. platysperma</i> Chandler	x	x		
	<i>E. tuberculata</i> Chandler	x			<i>V. poolensis</i> Chandler	x			
	<i>E. aligata</i> Chandler	x			<i>V. pygmaea</i> Chandler	x	x		
	<i>Euphorbioglossum fasciatum</i> Chandler	x			<i>V. goodhartii</i> Chandler	x	x		
	<i>Wittweilla cuspidata</i> Bowerbank		x		<i>V. symmetrica</i> Chandler	x			
Flacourtiaceae	<i>Oncoba rigosa</i> Chandler		x		<i>V. triangulata</i> Chandler			x	
Hamamelidaceae	<i>Strobilanera subglobosa</i> Presl ¹⁰	x			<i>Tetrafolium acuminata</i> Chandler			x	
					<i>T. lobata</i> Chandler	x			
					Zingiberaceae	<i>Alpinia arvensis</i> (Chandler) Mai in Mai and Walther, 1985 ¹³		x	
					†Cercitaceae	<i>Rhamnospermum Miobatum</i> Chandler	x	x	
					<i>Carpobibus arvensis</i> Chandler			x	

(Table 8.2) Composition of floras from the Dorset Pipe Clays, Hampshire Basin. Species descriptions, or references to them, can be found in Chandler (1962), unless otherwise referenced. Discussions on some of these species can also be found in Manchester (1994), Mai and Walther (1978, 1985), Mai (2000) and Collinson (1996b, in press a). The family classification used here is summarized in Chapter 1 of the present volume

Family	Species
Actinidiaceae	<i>Actinidia eocenica</i> Chandler <i>Saurauia crassisperma</i> (Chandler) Mai ¹
Arecaceae	<i>Calamus daemonorops</i> (Unger) Chandler
Betulaceae	<i>Carpinus boreyanus</i> (Heer) Chandler
Boraginaceae	Genus? (Pihretioideae)
Caprifoliaceae	<i>Sambucus mudensis</i> Chandler
Caryophyllaceae	<i>Hantsia pulchra</i> (Chandler) Chandler
Clethraceae	<i>Clethra bantonensis</i> Chandler
Cornaceae (including Mastixiaceae)	<i>Dunstania glandulosa</i> (Chandler) Chandler, 1961c (see also Chandler, 1965b) ² <i>Eomastixia rugosa</i> (Zenker) Chandler <i>Mastixia? glandulosa</i> Chandler <i>Mastixicarpum crassum</i> Chandler
Cucurbitaceae	<i>Cucurbitospermum mudense</i> Chandler
Cyperaceae	<i>Caricoidea obscura</i> Chandler <i>Sclerocarya tribracteata</i> Chandler <i>Cladocarya foveolata</i> Reid and Chandler
Cyrtaceae ³	<i>Epacridicarpum beatonense</i> Chandler <i>E. mudense</i> Chandler
Epacridaceae	? <i>Leucopogon</i> sp.
Flacourtiaceae	<i>Oncoba rugosa</i> Chandler
Hydrocharitaceae	<i>Stratiotes bantonensis</i> Chandler
Lythraceae	<i>Microdiptera parva</i> Chandler <i>Palaeolythrum bourmense</i> Chandler
Menispermaceae	<i>Palaeosinomenium</i> spp.
Nymphaeaceae	<i>Sabrenia chandlerae</i> Collinson
Nyssaceae	<i>Nyssonidea eocenica</i> Chandler
Potamogetonaceae	<i>Potamogeton pygmaeus</i> Chandler (see Collinson, 1983a) <i>Limnocarpus forbesii</i> (Heer) Chandler <i>emend.</i> Collinson 1982a
Rosaceae	<i>Rubus acutiformis</i> Chandler
Rutaceae	<i>Rutaspermum rugosum</i> Chandler <i>Toddalia excavata</i> (Chandler) Gregor ⁴ <i>Toddaliospermum ornatum</i> Chandler
Solanaceae	<i>Solanispermum reniforme</i> Chandler
Symplocaceae?	Genus?
Theaceae	? <i>Cleyera</i> sp. <i>Eurya dubia</i> (Chandler) Mai ⁵ <i>Eurya stigmosa</i> (Ludwig) Mai ⁶ <i>Eurya mudensis</i> Chandler ? <i>Gordonia truncata</i> Chandler ⁷
Thymelaeaceae	<i>Thymelaeaspermum bourmense</i> Chandler
Tiliaceae	<i>Grewia minima</i> Chandler
Vitaceae	<i>Vitis</i> sp.
<i>Incertae sedis</i>	<i>Carpolithus echinatus</i> Chandler <i>C. ornatus</i> Chandler <i>C. mudense</i> Chandler <i>Dicotylophyllum pinnatifidum</i> Reid and Chandler <i>Rhamnospermum bilobatum</i> Chandler <i>Wessexia fibrosa</i> (Chandler) Chandler

¹ Formerly *Hordwellia crassisperma* (Chandler) Chandler (see Mai and Walther, 1985).

² See Footnote 4 to Table 8.1.

³ See comment on *Epacridicarpum* in the Barton GCR site report.

⁴ Formerly *Toddaliospermum excavatum* Chandler (see Mai and Walther, 1978).

⁵ Formerly *Cleyera? lentiformis* Chandler (see Mai and Walther, 1985).

⁶ Formerly *Cleyera? stigmosa* (Ludwig) Chandler (see Mai and Walther, 1978, 1985).

⁷ *Gordonia truncata* = *Polyspora truncata* (Chandler) Gregor (see Mai and Walther, 1985).

Gordonia and *Polyspora* are both modern genera, which are considered synonyms by some authors.

(Table 9.1) Composition of the angiosperm flora from the Boscombe Sand Formation, Highcliffe. Species are described in Chandler (1963b) unless otherwise referenced. Some are also discussed by Mai and Walther (1978, 1985) and Mai (2000). The family classification listed here is summarized in Chapter 1 of the present volume.

Family	Species	Strain No.	Reid	Chandler	Family	Species	Strain No.	Reid	Chandler	Family	Species	Strain No.	Reid	Chandler	
Rosaceae	<i>Amelanchier canadensis</i> (Mill.) B.S.P.				Rosaceae	<i>Amelanchier canadensis</i> (Mill.) B.S.P.				Rosaceae	<i>Amelanchier canadensis</i> (Mill.) B.S.P.				
	<i>Amelanchier canadensis</i> (Mill.) B.S.P.					<i>Amelanchier canadensis</i> (Mill.) B.S.P.					<i>Amelanchier canadensis</i> (Mill.) B.S.P.				
	<i>Amelanchier canadensis</i> (Mill.) B.S.P.					<i>Amelanchier canadensis</i> (Mill.) B.S.P.					<i>Amelanchier canadensis</i> (Mill.) B.S.P.				
	<i>Amelanchier canadensis</i> (Mill.) B.S.P.					<i>Amelanchier canadensis</i> (Mill.) B.S.P.					<i>Amelanchier canadensis</i> (Mill.) B.S.P.				
	<i>Amelanchier canadensis</i> (Mill.) B.S.P.					<i>Amelanchier canadensis</i> (Mill.) B.S.P.					<i>Amelanchier canadensis</i> (Mill.) B.S.P.				
	<i>Amelanchier canadensis</i> (Mill.) B.S.P.					<i>Amelanchier canadensis</i> (Mill.) B.S.P.					<i>Amelanchier canadensis</i> (Mill.) B.S.P.				
	<i>Amelanchier canadensis</i> (Mill.) B.S.P.					<i>Amelanchier canadensis</i> (Mill.) B.S.P.					<i>Amelanchier canadensis</i> (Mill.) B.S.P.				
	<i>Amelanchier canadensis</i> (Mill.) B.S.P.					<i>Amelanchier canadensis</i> (Mill.) B.S.P.					<i>Amelanchier canadensis</i> (Mill.) B.S.P.				
	<i>Amelanchier canadensis</i> (Mill.) B.S.P.					<i>Amelanchier canadensis</i> (Mill.) B.S.P.					<i>Amelanchier canadensis</i> (Mill.) B.S.P.				
	<i>Amelanchier canadensis</i> (Mill.) B.S.P.					<i>Amelanchier canadensis</i> (Mill.) B.S.P.					<i>Amelanchier canadensis</i> (Mill.) B.S.P.				
<i>Amelanchier canadensis</i> (Mill.) B.S.P.				<i>Amelanchier canadensis</i> (Mill.) B.S.P.				<i>Amelanchier canadensis</i> (Mill.) B.S.P.							

(Table 8.1) Angiosperm fruit, seed, wood and twig fossils from the Eocene London Clay GCR sites. Species and details from Reid and Chandler (1933) and Chandler (1961a), unless otherwise referenced. The family classification used here is summarized in Chapter 1 of the present volume.