Chapter 4 The Jurassic palaeobotany of southern England

C.J. Cleal, B.A. Thomas and D.J. Batten

Introduction

During most of the Jurassic Period, southern England was covered by an area of shallow sea between the islands of Cornubia and Armorica and the Anglo-Brabant landmass (see (Figure 3.2)). The strata of this period thus provide an excellent record of marine faunas, especially invertebrates, but are generally impoverished in plant macrofossils. However, there are a few exceptions, most notably in the Middle Jurassic Stonesfield and Cotswold 'Slate' facies, and in the Upper Jurassic Purbeck facies, and these are the subject of this chapter. Although none of the sites can be compared in preservation or diversity of the floras with those of the Yorkshire Jurassic succession, they reflect rather different types of vegetation and thus provide a valuable complement to the Yorkshire sites.

History of research

Despite their relatively poor preservation, the Jurassic floras of southern England have attracted a considerable amount of scientific attention in the past, especially during the 19th century. This is probably because of their geographical proximity to some of the main centres of palaeobotanical research in those days, most notably London and Oxford.

William Buckland, Professor of Mineralogy at Oxford between 1813 and 1845, generated much of the early interest in the Jurassic palaeobotany of southern England (Andrews, 1980). His direct contribution to the science was on the bennettite stumps preserved on the Isle of Portland (Buckland, 1828, 1836). However, more important was his involvement with a group of palaeobotanists active in the early 19th century, some of whom were permitted to publish descriptions of specimens in his collection. This included some of the leading pioneers of scientific palaeobotany, such as Adolphe Brongniart, Kaspar von Sternberg and John Lindley (for details of these publications, see the Stonesfield GCR site report). As a result, Stonesfield in particular became one of the best-known Jurassic floras in the world.

Buckland's successor at Oxford, John Phillips, continued to study the Mesozoic palaeobotany of southern England, especially in the vicinity of Oxford. He made few novel contributions to the subject, but in 1855 and 1877 he published the first attempts at a monographic treatment of the Stonesfield flora. Also active at this time was William Carruthers of the British Museum (Natural History), who had access to the extensive collections of these floras that by then had been accumulated. He published a number of papers on both the Stonesfield and Portland floras (Carruthers, 1867a,c, 1869, 1870a).

Towards the end of the 19th century and in the early 20th century, Albert Seward was the leading Mesozoic palaeobotanist in Britain. He rarely went into the field himself but, at least for the Middle Jurassic floras of southern England, this was of little consequence because the opportunities to collect had by then all but disappeared. His major contribution was to synthesize the existing collections, most notably those of the British Museum (Natural History). The resulting catalogue is far more than just a list of the species; it is a comprehensive monograph on these floras (Seward, 1904).

Following Seward, relatively little attention was given to these floras. Mabel Kendall (1947, 1948, 1949) published on some conifer remains from various localities in southern England, and Peter Barnard (1968) reviewed a few conifer cones from Stonesfield, but little else seems to have been accomplished. This was partly because collecting from many of these sites had become difficult or impossible, and partly because the fossils could not match the Yorkshire Jurassic floras with their cuticles preserved intact. Recently, however, there has been a resurgence in interest. For the Middle Jurassic material, this has been a direct result of GCR work, since it became evident that a proper assessment of the significance of the floras, such as that from Stonesfield, necessitated a full monographic revision. Cleal and Rees (1998) summarized this work and a full account is now in preparation. For the Upper Jurassic material, recent interest has increased largely through the efforts of J. Francis, who has studied the in-situ fossil forests of the Isle of Portland and the

adjacent parts of the Dorset coast (Francis, 1983, 1984).

Palaeogeographical setting

The general palaeogeographical setting of Britain during the Jurassic Period is summarized in Chapter 3 and need not be repeated here. Much of southern Britain during the Jurassic Period was an area of shallow marine shelf. The geology here thus tends to be dominated by marine clastic and carbonate deposits. Drifted plant remains are known from the Lower Jurassic Series, the middle of the Bathonian Stage and the Oxfordian Stage, the second of these providing the most extensive floras. The Bathonian floras would seem to represent coastal plain and mangrove vegetation from the adjacent lands, probably mainly the Anglo-Brabant landmass. Towards the end of the Jurassic Period, there was a marked marine regression that culminated in the non-marine conditions seen in the Lower Cretaceous Series of southern England. In very late Jurassic times, the seas had shallowed sufficiently for coastal forests to develop periodically. These probably grew on the margins of hypersaline lagoons.

During the Middle Jurassic Epoch, the climate of southern England was probably similar to that of Yorkshire (a humid, subtropical climate). In the Late Jurassic Epoch, however, conditions became more seasonal. A Mediterranean-type climate, with hot, dry summers and cooler, wetter winters prevailed during the latest Jurassic and earliest Cretaceous times.

Stratigraphical background

The Jurassic geology of southern England was summarized by Cope *et al.* (1980a,b). Sediments accumulated in the region (Wessex Basin *sensu lato*) from the Permian Period to the Late Cretaceous Epoch. Today, the marine Jurassic rocks exposed there provide one of the finest sections seen anywhere in the world. During the Jurassic Period, present-day Dorset lay at the western end of a basinal sea covering the Wealden district of south-east England and the English Channel (Callomon and Cope, 1995). The deposits are a mixture of the limestones that dominate to the south and the predominantly siliciclastic sediments that prevail to the north. Ammonites occur from the base of the Lias upwards through much of the section, apart from most of the Bathonian. As a result, biostratigraphical correlation of the Jurassic rocks of the region is generally precise.

Just two parts of the succession are relevant to this chapter. The Great Oolite Group of the Cotswolds is a highly varied interval of mainly shallow marine deposits (Figure 4.1). Most of the plant (and terrestrial vertebrate) fossils occur in a facies known as the Stonesfield 'Slate'. Poor exposure of these beds has always made detailed correlations of these beds difficult and as a result, their position within the stratigraphical column has been somewhat controversial. Until recently, the most widely held view was that the facies comprised a discrete unit within the Sharp's Hill Formation (e.g. Sellwood and McKerrow, 1974). However, boreholes drilled in the Stonesfield area have now proved that it occurs at several levels within the Great Oolite (Boneham and Wyatt, 1993). At Stonesfield itself, the fossiliferous 'slates' are mainly in the Taynton Limestone Formation, whereas further west in Gloucestershire they are in the underlying Charlbury Formation. Both of these formations are in the lower part of the middle Bathonian succession.

The Upper Jurassic succession is well exposed along the cliffs in Dorset enabling changes in facies and thickness to be measured over long distances. Deposition in the area of present-clay Dorset gradually changed. Sea-level rises throughout the Oxfordian led to the widespread mudrocks of the Oxford Clay and the limestones and sands of the Corallian Beds. A series of sedimentary cycles followed, the mudstone clays, bituminous mudstones and limestones of the overlying Kimmeridge Clay representing progressive oxygen depletion leading to complete anoxia at the end of each cycle (Oschmann, 1988). Silt and then carbonate sedimentation in the shallower seas of Portlandian times followed. Continued shallowing of the sea eventually led to the termination of marine sedimentation and the spread of Purbeck facies over the whole area (Wimbledon, 1987). The basin was now smaller and connection to the Bristol Channel area was closed. Even though there was probably connection to the Paris Basin, the rate of evaporation of the shallow water within it was high, and led to intermittently hypersaline conditions. This produced the conditions necessary for fossilizing the coniferous trees that grew around the basin. The forests were rooted in shallow soils that are now preserved as the 'Dirt Beds' in the lower Purbeck Formation (Figure 4.2). Although most of the Purbeck is now regarded as part of the

Lower Cretaceous succession, these basal beds are probably still within the topmost Jurassic Portlandian Stage (Wimbledon in Calloman and Cope, 1995).

Jurassic vegetation in southern England

The Jurassic vegetation of southern England is broadly similar in composition to that of Yorkshire (see Chapter 3). Gymnosperms, in particular bennettites and conifers, dominate the floras. Representatives of other seed plants tend to be rarer (cycads, caytonias, corystosperms, ginkgos) than in Yorkshire or absent altogether (czekanowskias). Clubmosses and horsetails are absent and ferns rare. In the Middle Jurassic Epoch, this may partly be because of their lower preservation potential; the floras are preserved as drifted fragments in marine deposits, in which only the more robust plants would normally survive. However, it may also reflect the fact that the original vegetation of southern England occupied coastal fringes whereas in Yorkshire it clothed a delta.

A notable addition to the Middle Jurassic floras here, by comparison with Yorkshire, is the enigmatic plant that bore leaves known as *Pelourdea.* When originally found, they were interpreted as large, deciduous leaflets from bennettite or cycad fronds (*Zamites*), even though no other bennettite or cycad was known to have them. However, more complete material from the Triassic strata of North America (Ash, 1987), has since demonstrated that the leaflets are in fact complete leaves and that the plant probably had a habit similar to that of the living angiosperm *Dracaena,* which is not much more than half a metre high (Figure 4.3). The affinities of this plant remain an enigma, although the American examples were associated with gnetalean 'flowers' (Cornet, 1995).

Another enigmatic plant from these Middle Jurassic deposits is represented by a single leaf (part and counterpart) known as *Phyllites,* reported from Stonesfield by Seward (1904). Despite its rarity, it has attracted attention because it looks so remarkably angiospermous. However, there is no other good evidence of angiosperms in rocks of this age, the oldest known macrofossil being from deposits of supposed Late Jurassic age in China (Sun *et al.,* 1998). The attribution of such an isolated leaf must therefore remain questionable.

The conifers in these floras are represented mainly by cheirolepidiacean and, to a lesser extent, araucariacean remains. Our knowledge of the habit of the cheirolepidiacean conifers has benefited considerably from the work of Francis (1983, 1984) on the Upper Jurassic fossil forests of the Purbeck Dirt Beds of Portland (Figure 4.4).

Palaeobotanical sites in the Jurassic of southern Rngland

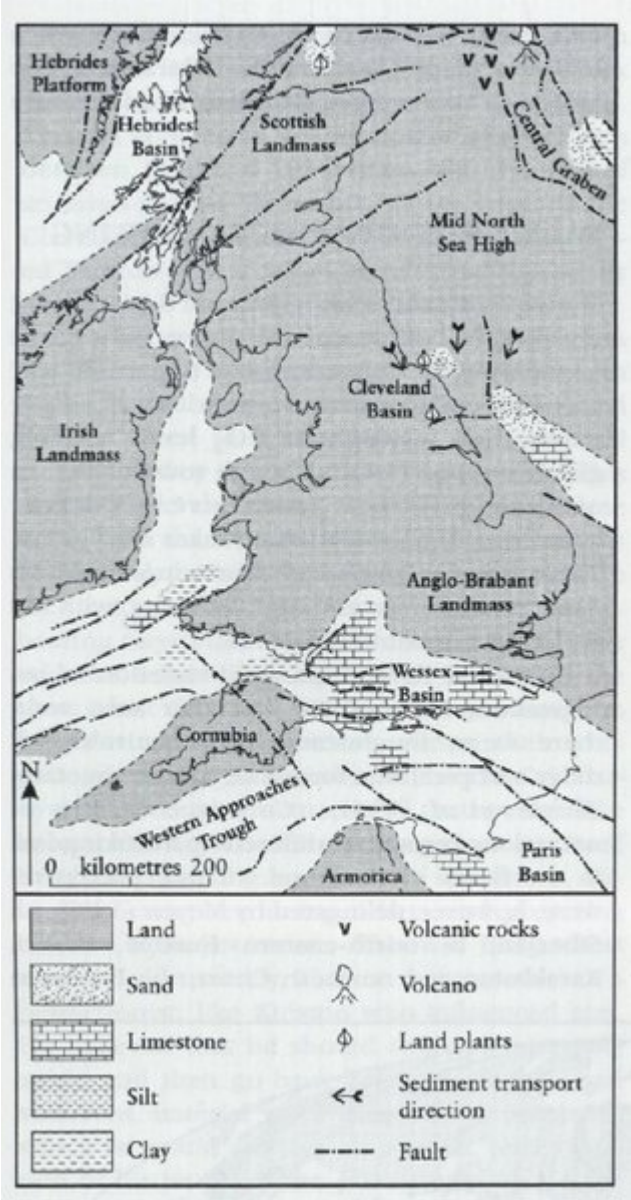
Except for the stratigraphically highest rocks, plant fossils in the Jurassic rocks of southern England are mainly drifted, poorly preserved fragments. The Lower Lias around Lyme Regis has over the years yielded some better-preserved material including cuticles (De la Beche, 1824; Woodward, 1893; Seward, 1904; Kendall, 1948), but they are so rare that it has been decided not to select this as a GCR Mesozoic palaeobotany site. Kendall (1948) also reported conifers from the Lower Lias of Warwickshire, but these were from museum specimens and the localities no longer exist.

As noted earlier, Middle Jurassic plant macrofossils are mainly restricted to the tilestones known as the Stonesfield and Cotswold 'Slates'. The classic site for such floras is Stonesfield, which has yielded by far the most diverse assemblage. However, the exposures are underground, in mines from which it is now difficult to collect. The Huntsman's Quarry at Eyford, Gloucestershire, has, therefore, also been selected, because the 'slates' crop out at the surface here. Plant fragments have been reported from other Middle Jurassic sites, most notably in the Forest Marble Formation (upper Bathonian) of Oxfordshire, which has yielded coniferous remains (Kendall, 1952), but the fossils are rare and usually poorly preserved. As a result, none of these localities merits selection for the GCR.

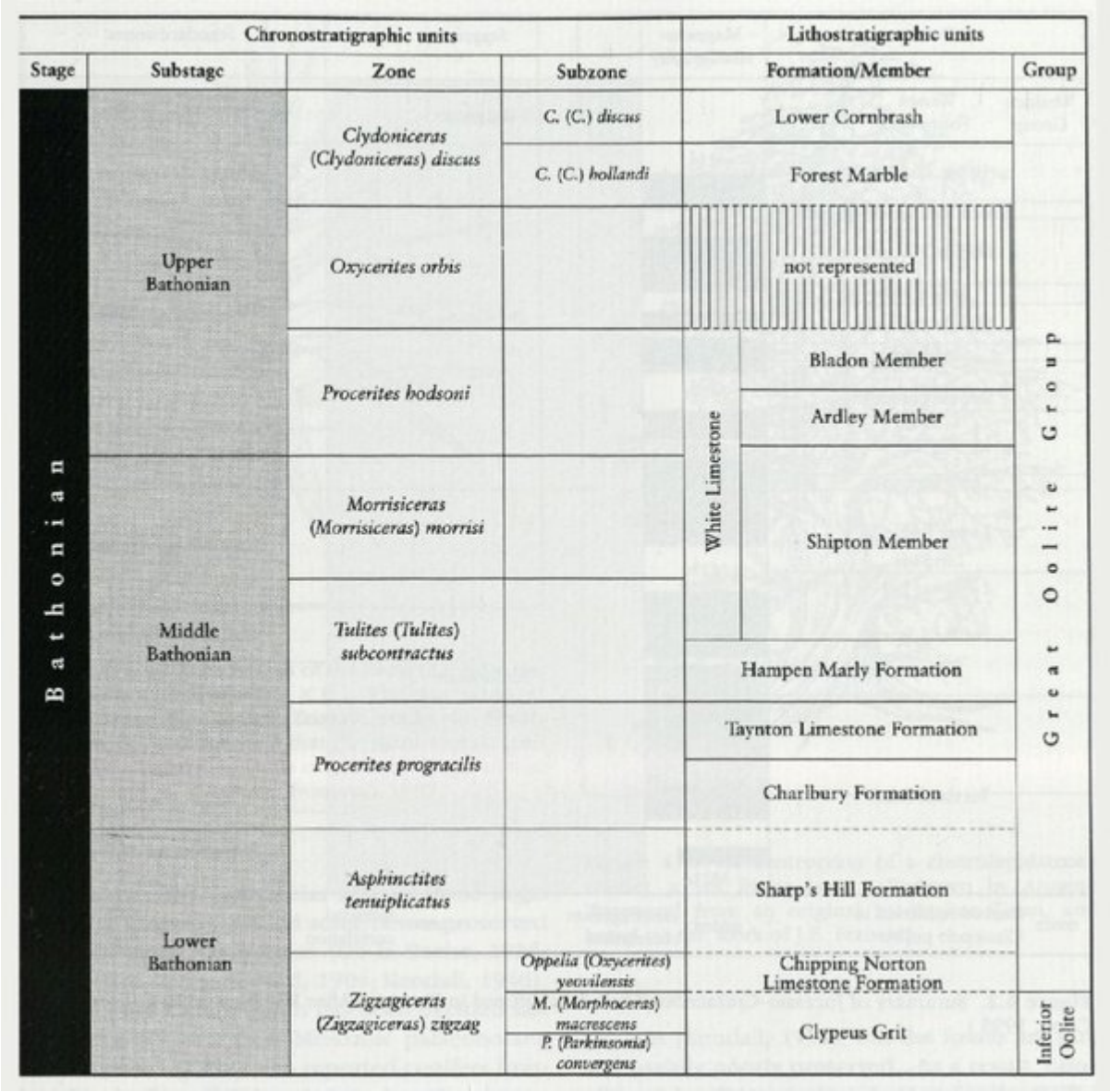
Mainly coniferous remains have been reported from the Upper Jurassic Oxford Clay, most notably from Christian Malford in Wiltshire (Carruthers, 1869; Kendall, 1947), but the exposure no longer exists. There is also a record of rare plant remains from the Kimmeridge Clay near Weymouth (Carruthers, 1869). The only significant palaeobotanical sites in the Upper Jurassic rocks of southern England that still exist are the 'fossil forest' localities in the Dirt Beds of the Purbeck Limestone Formation. These can be seen in several places, one of the best sites being in Lulworth Cove. However, it is

on the Isle of Portland where they can be best studied, and it is here that the representative GCR site has been identified.

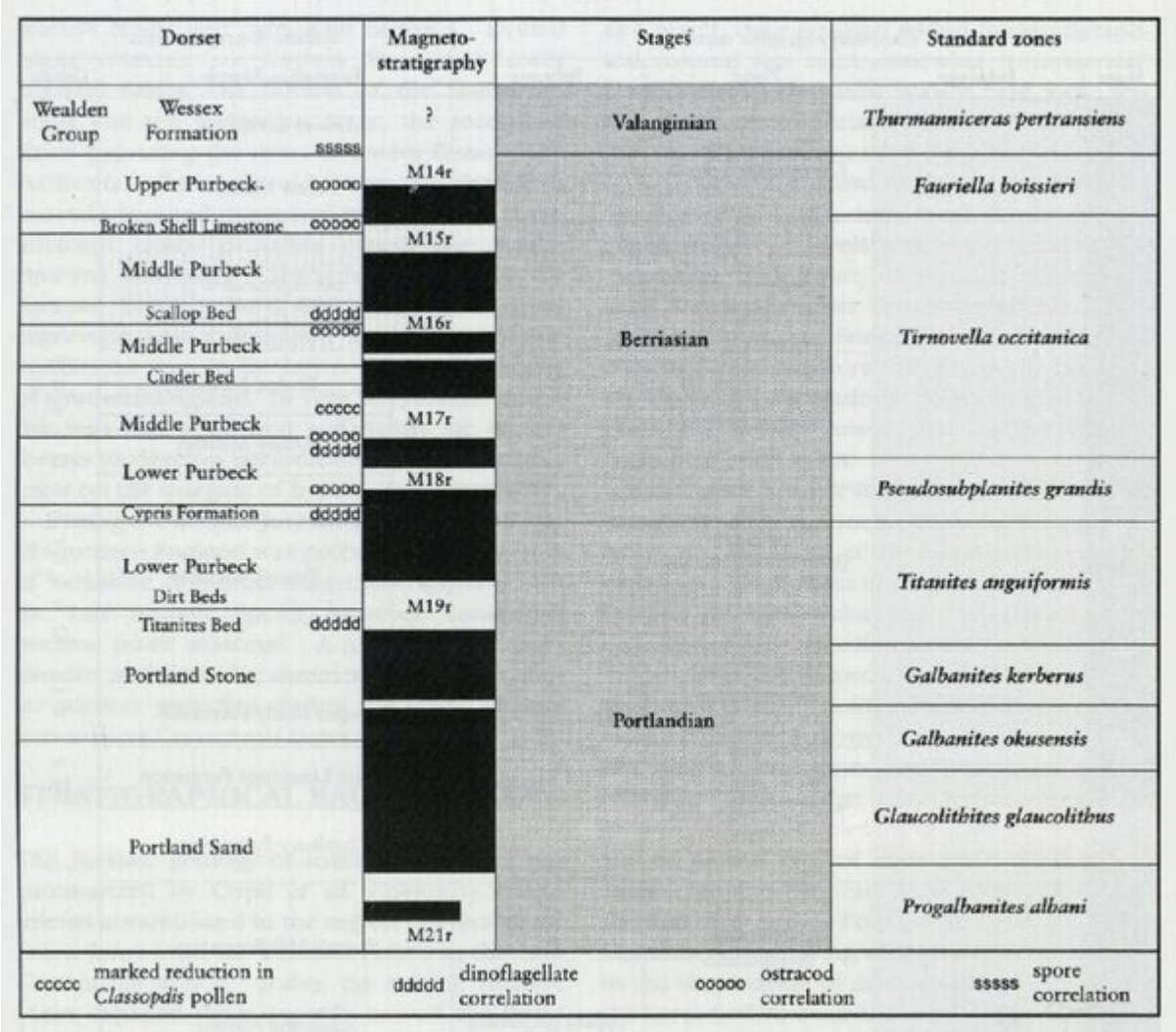
References



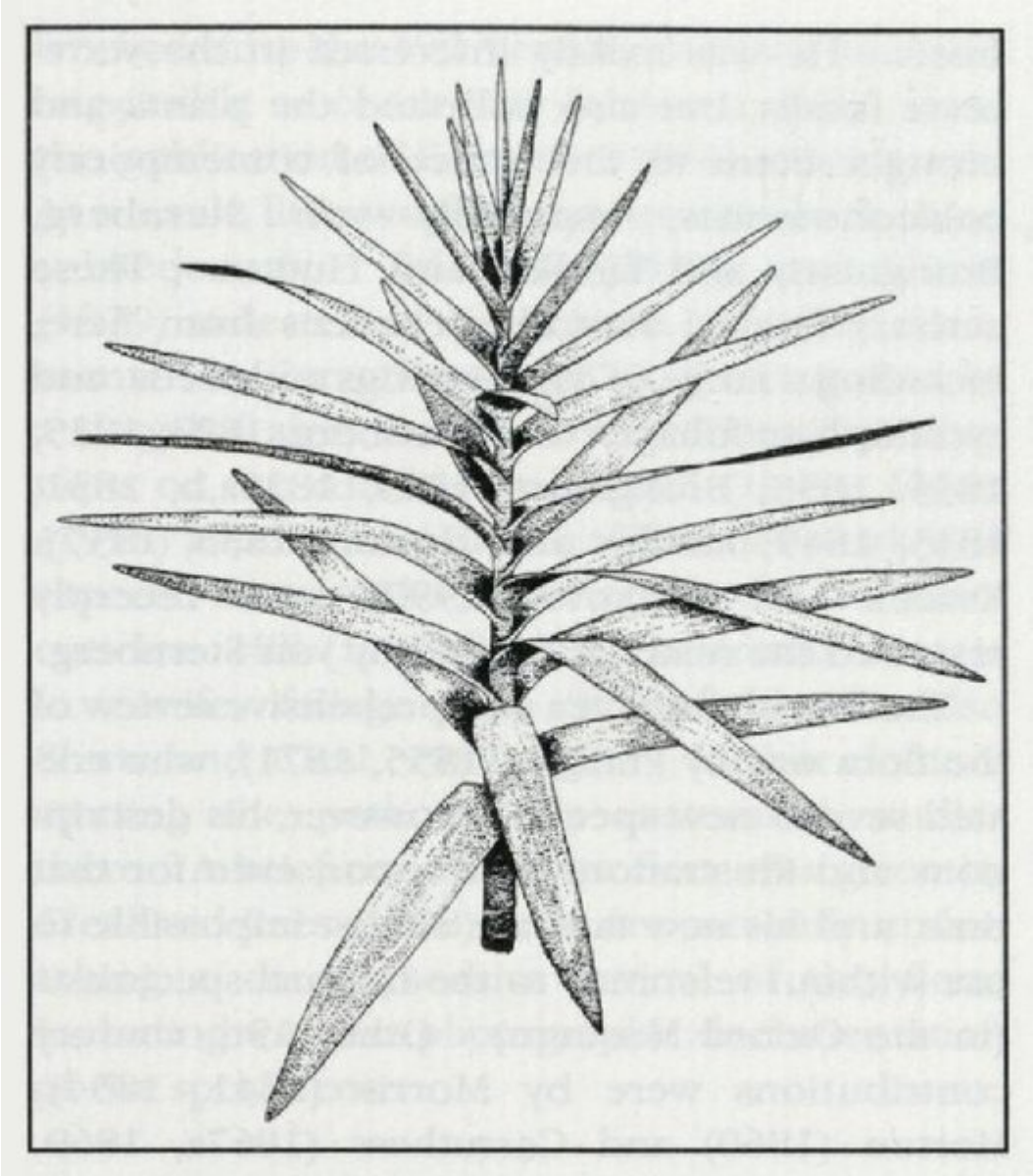
(Figure 3.2) The British Isles during the Middle Jurassic Epoch, showing the general distribution of land and sea. (After Hesselbo and Jenkins, 1995.)



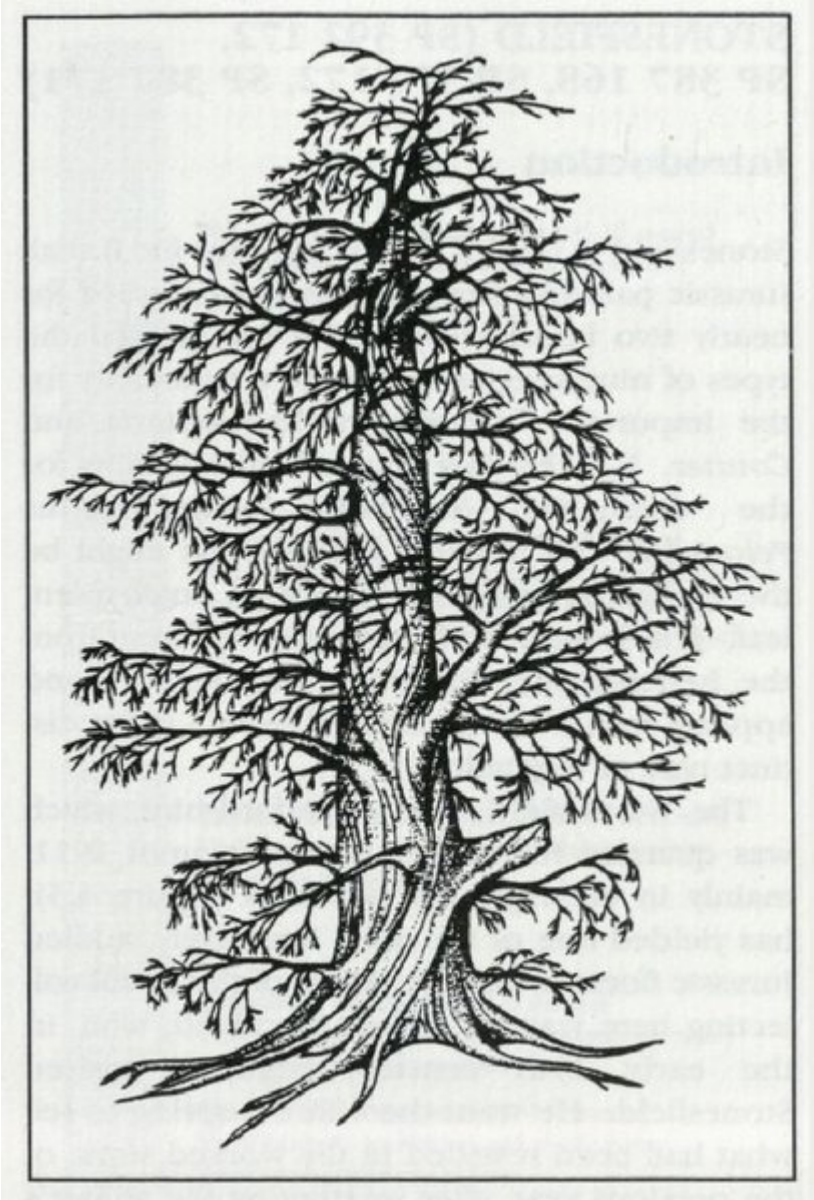
(Figure 4.1) Summary of the stratigraphical divisions in the Great Oolite Group of the Cotswolds. (After Boneham and Wyatt, 1993.)



(Figure 4.2) Summary of Jurassic–Cretaceous boundary interval in Dorset. (After Wimbledon in Calloman and Cope, 1995.)



(Figure 4.3) Reconstruction of the plant that bore the leaves known as Pelourdea, × 0.1. This was based on fossils from the Upper Triassic rocks of North America, but it is assumed that the plant represented in the Middle Jurassic floras of southern England was broadly similar. (Redrawn from Ash, 1987.)



(Figure 4.4) Reconstruction of a cheirolepidiacean conifer, a tall forest tree. (Redrawn by Annette Townsend from an original by Pauline Dean, and based on the work of J.E. Francis.)