Cold Ash

[SU 500 714]

Introduction

The Reading Formation at Cold Ash has yielded a diverse flora from the Palaeocene–Eocene transition. It is important because it includes foliage, fruits and seeds (of mainly angiosperms), which have allowed the partial reconstruction of several species. It also represents a flora from a different facies to that found at Felpham (see GCR site report, this volume).

There is a long history of records of plant fossils from the Reading Formation, mostly from temporary exposures in Berkshire (Chandler, 1961a). Cold Ash seems to have been first identified as a major source of palaeobotanical material in the mid-1970s by Roland Goldring and Peter Crane, when the site was undergoing expansion as a source of sand. These workings finished in 1980 and most of the pit has been infilled. However, one of the pockets of plant-bearing mudstones has been conserved by English Nature and provides for the continuing interest in the site (Crane and Goldring, 1991). Most of the published palaeobotanical work on the site has been by Crane and his colleagues (Crane, 1978, 1981, 1984, 1989a; Collinson and Crane, 1978; Smith and Crane, 1979; Crane and Jarzembowski, 1980; Crane and Manchester, 1982; Collinson *et al.,* 1985; Crane and Stockey, 1986; Manchester, 1987; Jarzembowski, 1989; Herendeen and Crane, 1992). Collinson (1978a) also included some specimens from the site in an unpublished thesis.

Description

Stratigraphy

An outline plan and stratigraphical sequence for when the site was at its maximum extent is shown in (Figure 7.11). The bulk of the section consisted of poorly consolidated cross-bedded sands of the Reading Formation, which is in the transition interval between the Palaeocene and the Eocene series (see 'Stratigraphical Background' earlier in this chapter). The underlying Upnor Formation and the Chalk were sometimes revealed during commercial extraction of the sands, but were never as well exposed as at Pincent's Kiln. The plant fossils occur in lenticular bodies of silty clay within the Reading Formation and are thought to be abandoned channel fills or mud deposits in channels during low water (Crane and Goldring, 1991). Crane (1978) and Crane and Goldring (1991) reported plants from five lenses, one of which is conserved. However, the following account deals with all of the plant fossils found at Cold Ash.

Palaeobotany

The plant fossils at Cold Ash are adpressions. The leaf fossils in particular are mostly impressions preserving no cellular detail. However, compressions have occasionally been found and these sometimes yielded cuticles. The katsura-tree, plane-tree and walnut families dominate the flora. The following is the list of taxa reported to date:

Betulaceae

Palaeocarpinus laciniata Crane (fruit) (Figure 7.12) and (Figure 7.13)

Craspedodromophyllum acutum Crane (foliage) (Figure 7.14)

Cercidiphyllaceae

Nyssidium arcticum (Heer) lljinskaja (fruit)

Trochodendroides prestwichii (De la Harpe) Crane (foliage)

Ericaceae

Rhododendron newburyanum Collinson and Crane (seeds) (Figure 7.15)

Cf. *Vaccinium* sp. (seeds)

Juglandaceae

Casholdia microptera Crane and Manchester (fruit)

Dicotylophyllum sp. (foliage)

Lauraceae

Lauraceaephyllum stenolobatus Koch (foliage)

'**Legumes**'

Leguminocarpon gardneri (Chandler)

Herendeen and Crane (fruit)

Platanaceae

Platanus schimperi (Heer) Saporta and Marion (foliage) (Figure 7.16)

Theaceae

Cf. *Cleyera* sp. (seeds)

Incertae sedis

Rhamnospermum bilobatum Chandler

In addition to these taxa that have been reported in the published literature, there are probably at least another 35 form-species, including 7 of foliage and 11 of reproductive organs (unpublished report prepared by Peter Crane for the GCR Unit of the former Nature Conservancy Council). Collinson (1978a) also described several types of isolated anther from here, one of which included pollen of a type associated with the *Casholdia* plant (Manchester, 1987, 1989).

Interpretation

Cold Ash has yielded a diverse assemblage of plant fossils from the Palaeocene–Eocene transition beds (Reading Formation) in southern England. Much of the flora in fact is still to be fully described, although specimens are available for study in the Natural History Museum in London. It has nevertheless already proved to be a site of international importance for Palaeogene palaeobotany. This is at least partly because it has enabled partial reconstructions to be made of a number of early angiosperms, which has thrown an important new light not just on these individual plants, but on early Tertiary angiosperm evolution as a whole. In particular, it has emphasized the importance of studying reconstructed whole plants wherever possible, to obtain the maximum information on the relationship of the early angiosperms to living genera.

The most abundant fossil plants at Cold Ash are the leaves *Trochodendroides prestwichii,* which are closely associated with the fruits *Nyssidium arcticum.* Largely as a result of Crane's (1984) study on the Cold Ash fossils, this became one of the best-understood early Palaeogene dicotyledons, which is widely known as the '*Cercidiphyllum*-like plant' (see also Crane and Stockey, 1985, 1986). It was evidently a woody plant with large rounded leaves and rigid axes bearing paired female fruits (the male structures are unknown), and shares many features with the extant *Cercidiphyllum.* Today, the katsura-tree family (Cercidiphyllaceae) consists of just one genus with two species, found only in Japan and China. However, in Palaeogene times, a *Cercidiphyllum*-likeplant was one of the commonest constituents of the middle and high latitudes floras of the Northern Hemisphere (Crane, 1989a; Friis and Crane, 1989). In Britain, it is not only found in the Reading Formation (Chandler, 1961a, 1964; Crane, 1984), but is also known (under the name *Jenkinsella apocynoides* Reid and Chandler in older publications) from the Oldhaven Beds and London Clay (Chandler, 1961a; Cooper, 1977; George and Vincent, 1977; Crane, 1984) and the lower Headon Formation (Crane, 1984). In the Palaeocene deposits of North America there is a very similar genus, *Joffrea,* which is distinguished from *Nyssidium* mainly on the inflorescences of the former having been borne on short shoots.

Also based on evidence of association, Crane (1981) argued that *Palaeocarpinus laciniata* (Figure 7.13) was the fruit of the plant that bore the leaves *Craspedodromophyllum acutum* (Figure 7.14). This was the first partial reconstruction of an angiosperm from Cold Ash and was at the time one of the best-known early Palaeogene dicotyledons. The leaves are of a type that has been normally assigned to the birch family, although Crane (1981) pointed out that there are other families that have this type of foliage. The fruit is more clearly diagnostic of the birches, in particular of the tribe Coryleae (including the hazels and hornbeams). However, Crane (1981) pointed out that the winged nut is most comparable to *Carpinus* (hornbeam), while the arrangement of the involucral bracts is more similar to *Corylus* (hazel). Hence, although the nuts or the bracts may on their own suggest affinities with living genera, the combination of characters (especially when taken with the foliage) dearly separates the Cold Ash plant from anything living today. This combination of characters fits in well with the predictions of a cladistic analysis of extant birch family by Crane (1989b).

There have subsequently been many other *Palaeocarpinus* plants described. These have shown that the genus had a circum-boreal occurrence in the Palaeocene and Palaeocene–Eocene transition, occurring in Britain, France, China and North America. In the Eocene Epoch, it persisted in North America and eastern Asia (Manchester, 1999). The Cold Ash flora thus contains the type material upon which a global palaeobiogeography has been built. *Palaeocarpinus* is also important because of its diversity and because it is the earliest known member of the tribe Coryleae, which subsequently became specialized for animal dispersal (Collinson and Hooker, 1987; Manchester, 1987; Collinson, 1999).

Crane and Manchester (1982) described an unusual fruit of the walnut family as *Casholdia microptera* (see also Manchester, 1987). It is the oldest known fruit from this family from Eurasia, and is only marginally younger. than *Polyptera manningii* Manchester and Dilcher from Wyoming. Unlike most other fossil walnut fruits, *Casholdia* cannot be assigned definitely to one of the extant tribes of that family, but on the whole it has more in common with the Engelhardieae. However, there is associated foliage that shows closer similarities to the Juglandeae, while associated pollen suggests the Platycaryeae. While the connection between the fruit, foliage and pollen has not been proven, the Cold Ash fossils seem to represent a primitive member of the walnut family, sharing characters of more than one of the extant tribes.

Cold Ash is the best locality for the legume fruits *Leguminocarpon gardneri* (Herendeen and Crane, 1992). They clearly show affinities with the subfamily Caesalpinioideae (sometimes regarded as a distinct family) and are the oldest reliable evidence of this subfamily in the fossil record. However, in the absence of evidence of other parts of the plant, it is difficult to be certain if it can be assigned to an extant genus, hence Herendeen and Crane placed it in a form-genus for isolated legume fruits. Isolated leaflets of legume-like compound leaves have been found at Cold Ash, but descriptions have not been published.

Collinson and Crane (1978) described numerous isolated *Rhododendron* seeds with very distinctive dissected terminal wings, which they made the basis of a new species, *Rhododendron newburyanum* (Figure 7.15). They are very similar to those of many living rhododendrons, especially those that grow as trees and shrubs in lowland forests. Associated with the seeds are leaves with a similar outline to some extant *Rhododendron* species but the venation is too poorly preserved to confirm their identity. Collinson and Crane suggested that the seeds may have been transported some distance from their parent plant. They appear to be the only recorded examples of Palaeogene *Rhododendron* from anywhere in the world.

Other common leaf fossils at Cold Ash are *Platanus schimperi* (Figure 7.16) and *Lauraceaephyllum stenolobatus.* Although not described in detail in the published literature, Crane (1989a, fig. 12A) figured a drawing of what was claimed to be a fruitlet associated with the *Platanus* leaves. However, no evidence has been found here of the *Platanus*-like fruit-cluster *Liquidambar paleocenica* Chandler described from other localities in the Reading Beds (Chandler, 1961a).

Crane and Jarzembowski (1980) and Jarzembowski (1989) have described leaf mines from here. Although leaf mines and galls have been described from the Branskome Sand Formation at Bournemouth Cliffs (Scott *et al.,* 1994; Lang *et al.,* 1995) these were based only on museum collections, the sites having long been obscured by amenity and sea-defence work. Cold Ash is therefore the only available site at which insect and plant co-evolution can be documented from leaf trace fossils in the British Tertiary record.

Much work clearly remains to be done at Cold Ash, with only about a third of the flora having been described in detail. There is also potential for wider palaeoecological studies, building on the work on fungi (Smith and Crane, 1979) and leaf taphonomy (Crane and Jarzembowski, 1980). However, it is already clear that the flora is of great significance.

The Cold Ash flora is similar to the assemblages from other Reading Formation localities around Reading described by Chandler (1961a). However, except for Felpham (see GCR site report, this volume), this is the only place where there is still at least the potential to collect fur ther material; the Pincent's Kiln exposures are unlikely to yield any quantities of new specimens. There is a some similarity at the family level with the Palaeocene–Eocene transitional interval floras of the Brito-Arctic Igneous Province, such as from Ardtun, although there are no species in common and the latter tends to have a greater diversity of ferns and conifers. This similarity may be partly a function of both the Cold Ash and Ardtun floras including a large proportion of riparian elements. However, it also holds true for many other circum-arctic floras of this age and so the similarity in the fossils may reflect a more fundamental similarity in the original vegetation.

The Eocene Thames Group, such as the London Clay at Sheppey (see GCR site report, this volume), yields quite a different flora to that at Cold Ash, including the remains of trees and shrubs of a more obvious tropical character. Significantly, there is no evidence in the Palaeocene–Eocene transitional floras of the mangroves that dominated the Ypresian vegetation of southern England (Collinson, 2000a). This difference cannot be explained merely by the London Clay being a marine deposit, whereas the Reading Formation is non-marine; the Poole Formation, which is a non-marine equivalent of the London Clay, also yields a markedly different flora from that found at Cold Ash (or Felpham). There appears to have been a real difference between the Reading Formation and London Clay vegetation in southern England, the latter being of a significantly more tropical aspect. There is evidence of a short-lived increase in atmospheric CO_2 at the Palaeocene–Eocene boundary, which may have elevated temperatures (Beerling and Jolley, 1998). This may have favoured the change from mixed-mesophytic to paratropical vegetation, with a distinctive flora characterizing the transitional interval (Collinson, 2000a).

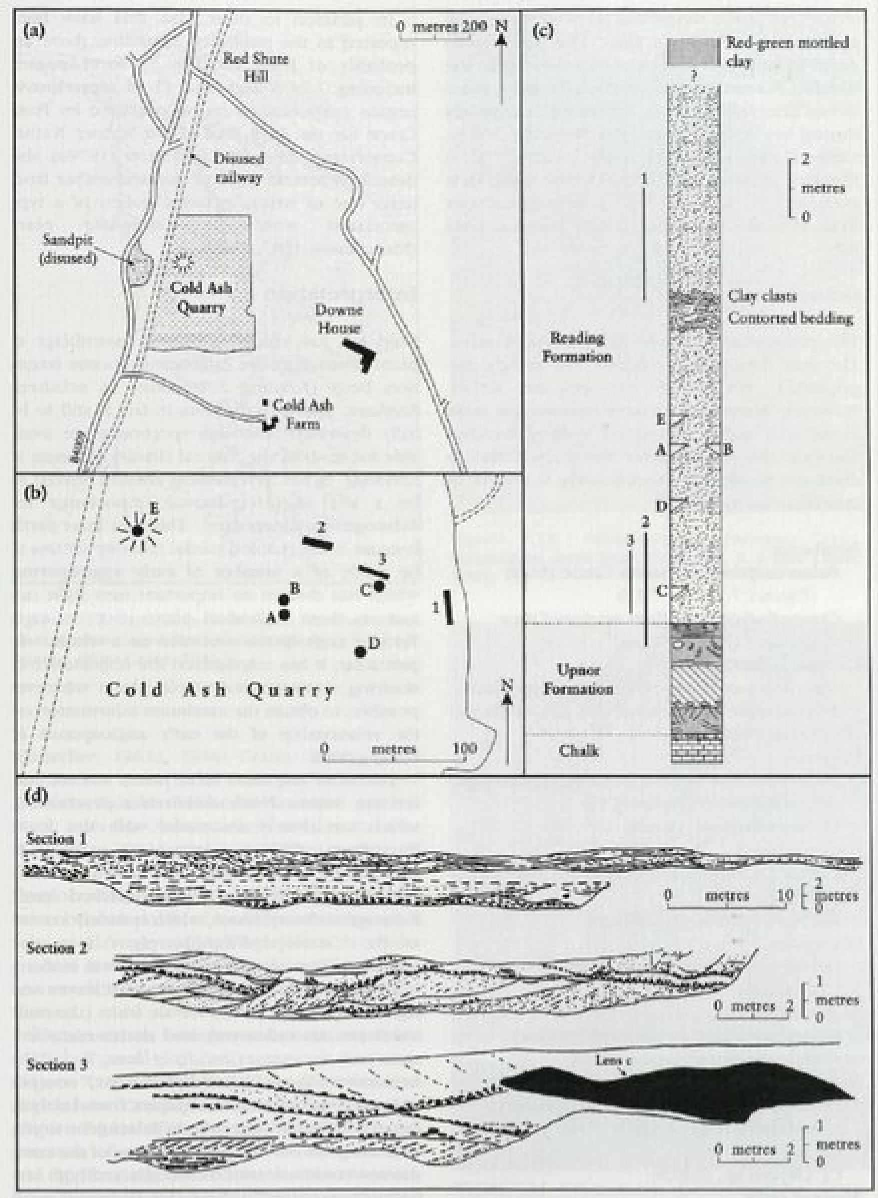
Outside of Britain, the closest comparison with Cold Ash seems to be with sites in continental Europe such as Menat in France (Piton, 1940), which yield the remains of similar para-tropical vegetation. As pointed out by Kva■ek (1994), however, there are also elements (e.g. *Lauraceaephyllum*) that allow a comparison with the Tertiary floras of higher latitudes.

According to Kva■ek, the Reading Formation and Brito-Arctic Igneous Province floras are reflecting the migration of high-latitude elements into the paratropical forests of central Europe and are thus crucial for developing our understanding of the Tertiary vegetational history of Europe.

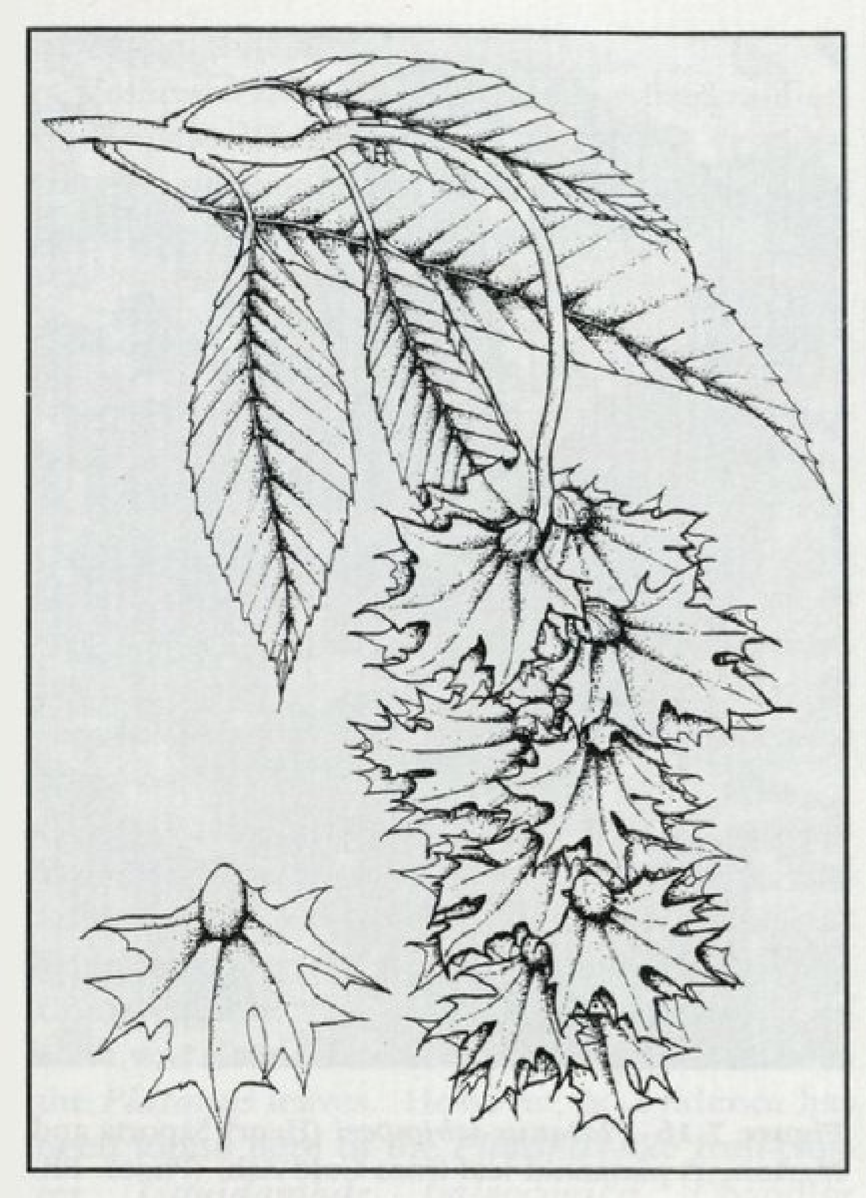
Conclusions

Cold Ash has yielded an internationally significant fossil flora from the Palaeocene–Eocene transition beds (Reading Formation) of southern Britain, dominated by plants related to the planes, caesalpinias, hazels, rhododendrons and walnuts, as well as the now rare katsura-tree family. It provides important insights into the vegetation that flourished here about 54 Ma ago and which seems to be less 'tropical' in nature than the succeeding London Clay vegetation, such as preserved at Sheppey. It is one of the few sites in Europe where it has proved possible to partly reconstruct some of the early Tertiary angiosperms and has provided important evidence as to the early evolution of flowering plants.

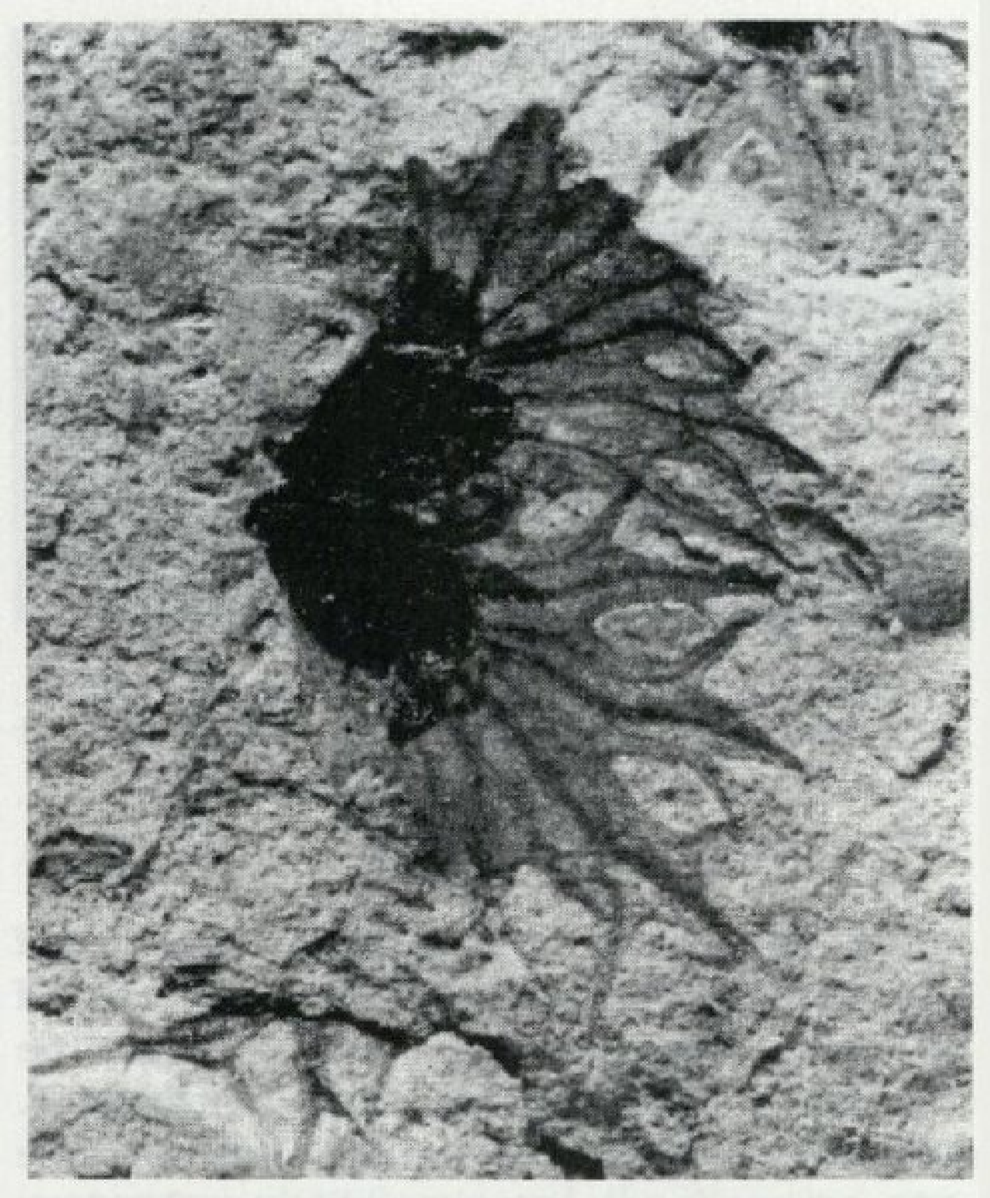
References



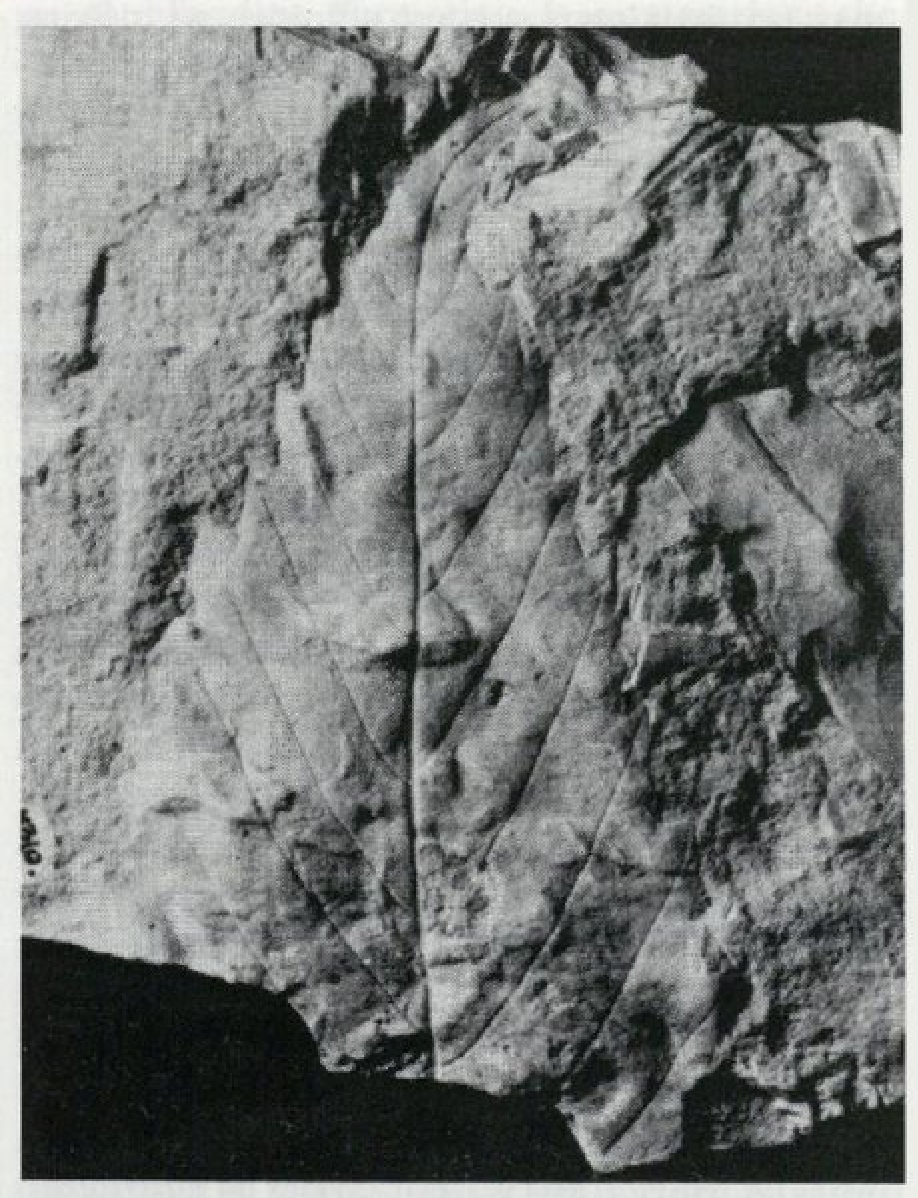
(Figure 7.11) Cold Ash Quarry in the early 1980s; (a) and (b) show plans of the site and include the location of the sections 1–3 represented in (d). Also shown are the locations of the main plant-bearing lenses (A–E); (c) is a composite stratigraphical section for the site. (After Crane and Goldring, 1991.)



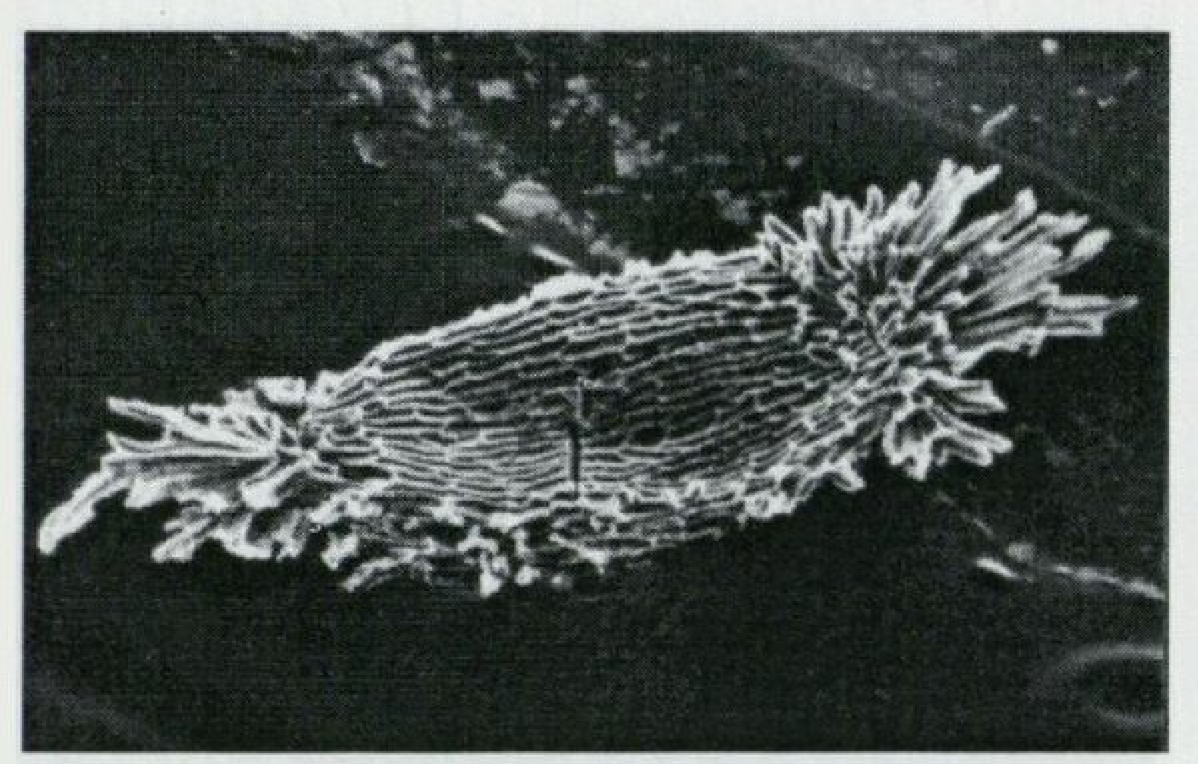
(Figure 7.12) Part of the Palaeogene Palaeocarpinus plant, reconstructed from plant fossils from Cold Ash Quarry (After Crane, 1981.)



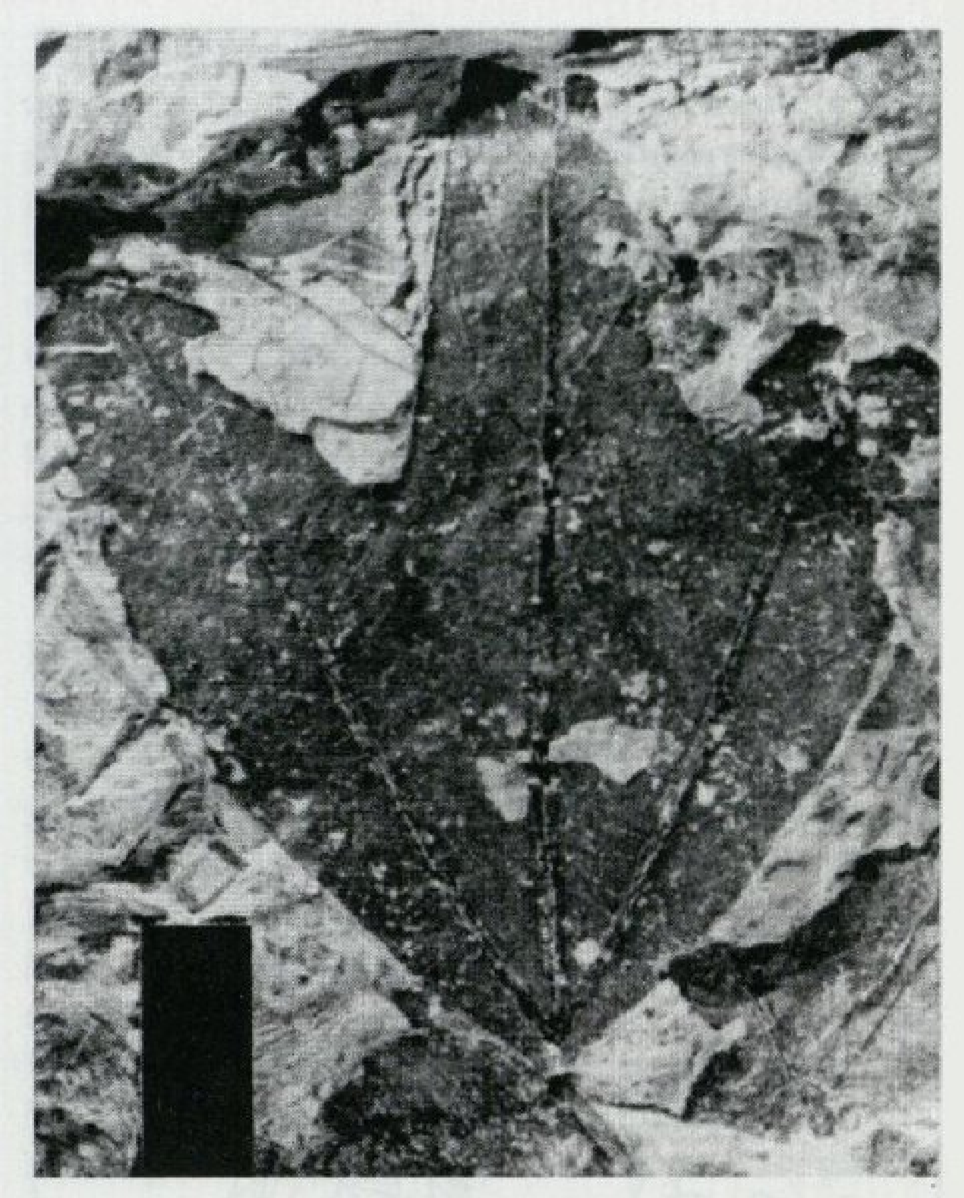
(Figure 7.13) Palaeocarpinus laciniata Crane. Betulaceous fruits from Cold Ash, × 4 (see Crane, 1981).



(Figure 7.14) Craspedodromophyllum acutum Crane. The apical portion of a leaf attributed to the Palaeocarpinus plant from Cold Ash × 1.2 (see Crane, 1981).



(Figure 7.15) Seeds of Rhododendron newburyanum, × 50 (see Collinson and Crane, 1978), from the Cold Ash GCR site. (Photo: M.E. Collinson.)



(Figure 7.16) Platanus schimperi (Heer) Saporta and Marion. A platanoid leaf from Cold Ash. (Photo: P.R. Crane.)