Ardtun

[NM 381 248]

Introduction

Ardtun, on the Isle of Mull in the Hebrides, is the only significant Tertiary palaeobotanical site in Scotland. It is the only site in Great Britain to yield Palaeogene plant macrofossils representing the Brito-Arctic Igneous Province. It provides a significant insight into the early Tertiary vegetation of the high northern latitudes and their relationship to the vegetation found further south in Europe.

A full account of the history of research here is given by Boulter and Kva■ek (1989). The fossils were first discovered in the mid-19th century and were briefly described by Forbes in Argyll (1851). Gardner and Ettingshausen (1879–1882) and Gardner (1883–1886a) included material from here in their aborted series of monographs on the 'Eocene' floras of Britain, and Gardner (1887a) also undertook some additional collecting here, using explosives to remove the basalt overlying the plant bed.

The next major period of interest in the Ardtun flora was in the mid-20th century, which resulted in a number of short papers (Seward and Holttum, 1924; Johnson, 1935, 1937), plus an uncompleted monograph by Seward and Edwards. The latter was eventually incorporated into the only published full monograph on the Ardtun flora, which also contained palynological results on the Tertiary sediments exposed here (Boulter and Kva6ek, 1989). In recent years, there has also been work on material from here by Crane (1988), Crane *et al.* (1988) and Jolley (1997).

Description

Stratigraphy

Details of the geology here can be found in Emeleus and Gyopari (1992). A thin succession of sedimentary rock occurs between two layers of basalt (Figure 7.24). The siliciclastics are mainly coarse grained, but there are three beds of silty sandstone and clay, which have yielded the plant fossils.

Palaeobotany

The plant fossils of the Ardtun plant bed are mainly adpressions, occasionally preserving cuticles. Foliage is predominant although some reproductive structures also occur. The following are the major taxa of macrofossils described by Boulter and Kva■ek (1989):

Equisetaceae

Equisetum sp.

Dryopteridaceae

Onoclea hebridica (Forbes) Gardner and Ettingshausen

Ginkgoaceae

Ginkgo gardneri Florin

Taxodiaceae

Metasequoia occidentalis (Newberry) Chaney

Elatocladus campbellii (Forbes) Seward and Holttum

Glyptostrobus dunoyeri (Bally) Boulter and Kva■ek

Cupressaceae

Cupressoconus mathenryi (Baily) Boulter and Kva■ek

Taxaceae

Amentotaxus gladifolia (Ludwig) Ferguson *et al.*

Platanaceae

Platanites hebridicus Forbes

Cercidiphyllales (incertae familiaris)

Trochodendroides antiqua (Gardner) Boulter and Kva■ek

Fagales (*incertae familiaris*)

Corylites hebridicus Seward and Holttum

Fagopsiphyllum groenlandica (Heer) Manchester, 1999, p. 522

Juglandales (incertae familiaris)

Juglandiphyllites ardtunensis Boulter and Kva■ek

J. finlayi (Johnson) Boulter and Kva■ek

Hamamelididae (incertae familiaris)

Camptodromites major (Johnson) Boulter and Kva■ek

C. multinervatus (Johnson) Boulter and Kva■ek

Davidoidea hebridica Johnson

D. hebridica (Seward and Holttum) Boulter and Kva■ek

?**Rhamnales (incertae familiaris)**

Vitiphyllum sewardii Boulter and Kva■ek

Dicotyledonae (incertae ordnis)

Zizyphoides ardtunensis Johnson

Cornophyllum hebridicum (Johnson) Boulter and Kva■ek

Calycites ardtunensis Crane

In addition to these vascular plants, Boulter and Kva■ek (1989) describe some bryophyte remains from here, while Edwards (1922) had described fungal remains.

Boulter and Kva■ek (1989) interpret the lower of the three plant beds (the Black Leaf Bed of Gardner, 1883–1886a, 1887a) as representing non-swampy riparian forest dominated by *Corylites* and *Trochodendroides.* The middle plant bed is, in contrast, dominated by taxodiaceous remains plus *Platanites* and *Camptodromites,* and was interpreted as representing a taxodiaceous swamp forest. No palaeoecological interpretation was given of the top leaf bed.

Interpretation

Ardtun is one of the 'classic' leaf floras from the Palaeocene–Eocene transition interval (Wolfe, 1997). It was formed in the Brito-Arctic Igneous Province (BIP), a belt of Palaeogene igneous rocks and infra-basaltic sediments that extends from Rockall to Spitsbergen, and which resulted from the initiation of the North Atlantic Ocean (Wenk, 1961). Several sites within the province have yielded plant fossils, but Ardtun is in many ways the most important (Boulter and Kva■ek, 1989). It is the only British site to yield this important fossil flora. In Northern Ireland, similar floras are known from County Antrim, most notably Ballypalady and Glenarm (reviewed by Watts, 1970). These Irish sites are particularly important for conifers (especially reproductive structures) but do not yield the diversity of angiosperms as found at Ardtun.

Outside of Britain, plant macrofossils are known from eastern Greenland (Mathiesen, 1932; Seward and Edwards, 1941) and the Faeroes (Rasmussen and Koch, 1963), but these floras are generally poorly preserved and much less diverse than the Ardtun flora. The only known flora that matches that of Ardtun in diversity is from Spitsbergen (Schloemer-Jager, 1958; Schweitzer, 1974, 1980; Budantsev, 1983; Kva■ek and Manum, 1993). Spitsbergen has yielded 13 species of conifers and angiosperms, all but two (*Macclintockia dentata* Heer and *Haemanthophyllum nordenskioldii* (Heer) Boulter and Kva■ek) also occurring at Ardtun (Boulter and Kva■ek, 1989). However, the balance of the Spitsbergen flora is quite different, being dominated by *Metasequoia* and *Trochodendroides* that were growing in swamp forests, and quite different from the mainly riparian vegetation preserved at Mull. Spitsbergen has also yielded more ferns, with five species having been recorded based on macrofossils, three of which are unknown from the other BIP sites (*Osmunda macrophylla* Penhallow, *Coniopteris blomstrandii* (Heer) Kva■ek and Manum, cf. *Dryopteris alaskana* (Hollick) Wolfe), although they are common in other circum-Arctic floras. The ferns from Ardtun, Spitsbergen and the other localities have been recognized as representing a biogeographically distinct Circum-Arctic Palaeocene–Eocene floristic group extending to high northern palaeolatitudes (Collinson, in press a).

The Ardtun flora differs from the similar-aged Reading Formation floras of southern Britain in being dominated by deciduous species of both conifers and the Hamamelidae. This may partly reflect the more northern latitudes of the BIP, and it is notable that most of the families found at Ardtun also occur in the high-latitude Cretaceous and early Tertiary floras of Alaska and northern Canada (Hickey *et al.,* 1983; Spicer *et al.,* 1987). However, these high-latitude floras do not represent cold-climate vegetation, but rather temperate (or even warm-temperate) vegetation, reflecting the generally warmer conditions that prevailed during very early Tertiary times. A more significant factor was probably that the BIP was an area of active volcanicity, producing highly disturbed habitats with poor soils and uneven water supply (Boulter and Kva6ek, 1989).

The BIP and its flora have a crucial role in understanding the early Tertiary floristic development of Europe (Boulter and Kva6ek, 1989; Kva■ek, 1994). It acted as a selective filter to plants between the Boreal and Tethyan Palaeoareas, only allowing through those species that could tolerate its volcanically influenced habitats. Later in the Tertiary, the filter became a more complete barrier as the Atlantic opened up and prevented the spread of most plants with seeds as their disseminules. It is thus clear that the Ardtun flora has a key role in understanding the complex vegetational mosaic in the Tertiary deposits of Europe.

Of the individual species of plant macrofossils, only two have been subjected to detailed morphological description. Crane (1988) investigated some small fruits originally assigned to the living genus *Abelia* by Seward and Edwards in their unpublished manuscript. However, Crane showed that they were unlikely to belong to that genus and instead placed them in the artificial form-genus *Calycites,* of unknown angiospermous affinities.

Crane *et al.* (1988) reconstructed the entire leaf of *Platanites,* including the basal pair of leaflets crucial to the identification of this extinct genus. They also found associated fruits and infructescences. These are very similar to the reproductive organs of one of the living *Platanus* species and provided the first unequivocal evidence of an early member

of the Platanaceae with pinnately compound leaves. This is essential for understanding the early evolution of this family, and of the possible relationship between the Hamamelidae and the Rosidae.

Conclusions

Ardtun is a classic Tertiary palaeobotanical locality, yielding plant fossils representing the warm-temperate vegetation of about 54 Ma ago (transition interval between the Palaeocene Series and Eocene Series). It is unique in Britain. Only in Spitsbergen has a comparable fossil flora been reported, but the Ardtun assemblage is generally more diverse, especially in conifers and flowering plants. It represents mainly deciduous trees growing in a disturbed volcanic terrain, and is crucial for understanding plant migration and the floristic evolution of Europe during early Palaeogene times.

References

(Figure 7.24) Plant bed exposed between beds of basalt at Ardtun (Photo: D.J. Ward.)