Wardie Shore

Highlights

Wardie Shore is the best available site for plant fossils from the Visean Wardie Shales (Figure 5.43). It is the type locality for the lycopsid stem *Bothrodendron wardiense* Crookall and the equisete strobilus *Pothocites grantoni* Paterson.

Introduction

Records of Visean plant fossils from this shoreline Oil Shale exposure east of Granton Harbour, on the Firth of Forth [NT 245 771], date back to the mid-nineteenth century, the earliest being that of Paterson (1841). Subsequent records include those by Kidston (1883b, c, 1889b, c), but the most comprehensive accounts of the fossils are in the monographs by Kidston (1923b, 1924) and Crookall (1964, 1969). There has been no recent work on the palaeobotany of this site.

Description

Stratigraphy

The geology of this site is described by Peach and Horne (1910). The exposed sequence (Figure 5.44) belongs to the Wardie Shales Formation in the Lower Oil Shale Group. According to Carruthers (1927), these shales were probably laid down under alternating lagoonal and estuarine conditions. Scott (1985) regards them as probably late Holkerian in age.

Palaeobotany

The plant fossils found here are mainly compressions, which are readily separated from the matrix. Their appearance suggests that cuticles should be preserved but, in practice, they have proved impossible to separate from the bituminous carbonized tissue (C.H. Shute, pers. comm., 1989). The following species have been described to date:

Lycopsida:

Lepidodendron veltheimianum Sternberg

Bothrodendron wardiense Crookall

Equisetopsida:

Archaeocalamites radiatus (Brongniart) Stur

Pothocites grantoni Paterson

Lagenostomopsida:

Sphenopteris affine Lindley and Hutton

Spathulopteris dunsii Kidston

Interpretation

Crookall (1964, pl. 64, fig. 1, pl. 71, fig. 1) shows a large specimen of *Lepidodendron veltheimianum* with a row of so-called 'ulodendroid-scars'. Such scars are thought to be the result of branch abscission, and occur commonly in many arborescent lycopsids (Jonker, 1976). A similar specimen from the Burdiehouse Limestone, identified by Carruthers (1870) as *Ulodendron ovale* Carruthers, was transferred to *L veltheimianum* by Kidston (1885b). *Ulodendron* has been

used by many authors as an artificial form-genus for lycopsid axes with such abscission scars; Thomas (1967b) has shown that it in fact represents leafy lycopsid twigs with a distinctive epidermal structure.

This is the only known locality for another species of lycopsid stem, *Bothrodendron wardiense.* It was originally described by Kidston (1889b, c) as *Bothrodendron wiikianum* Heer, but he later recognized that the ligule pit aperture is more distantly placed above the leaf scar (see also Crookall (1964) and Thomas (1980)). Although he proposed an alternative name in manuscript, it was not validly published until after his death, by Crookall (1932). According to Thomas (1980), *Bothrodendron* differs from *Eskdalia,* another lycopsid stem frequently found in the Visean of Britain, in having a clearly marked parichnos mark in the leaf scar; and the Wardie Shore specimen indeed seems to show such a mark. Thomas also notes differences in the epidermal structure, but such information is unavailable at present for *B. wardiense.*

This is also the type locality for the equisete strobilus *Pothocites grantoni* (Paterson, 1841; Kidston, 1883b, c). Unfortunately, however, the type specimens are reported by Chaphekar (1965) as lost, and her re-assessment of the species had therefore to be based on material from Loch Humphrey Burn and Glencartholm (both sites discussed elsewhere in this chapter). Stur (1875) reported similar strobili attached to *Archaeo-calamites* stems (see also Chaphekar, 1963), and so it is not surprising to find this type of stem associated with *Pothocites* at Wardie Shore.

Spathulopteris dunsii has only been reported to date from the Oil Shale Group of Scotland (Kidston, 1923b). Kidston lists it as occurring at Wardie Shore, but no specimens from here were illustrated. It is similar to another spathulopterid from the Oil Shale Group of Scotland, *S. decomposita* Kidston, 1923b, but the latter has more closely spaced pinnae and larger pinnules.

Clearly, however, it is possible that they are just small and large fronds of a single biological species. The affinities of *Spathulopteris* are at present unproved, but may be with the Calamopityales, one of the two main orders of seed plants found in the Lower Carboniferous.

Kidston (1924) figured a number of specimens of the lagenostomalean frond *Sphenopteris affine* from the Oil Shale Group of Scotland. He mentions Wardie Shore as one of the many sites to yield the species, although none of the figured specimens originated from here. Kidston assigned the species to the form-genus *Telangium,* since he was able to show that the fronds bore *Telangium* fructifications. However, such fructifications are only rarely found attached to such fronds, and it is unwise to use a fructification form-genus for fronds which are normally found in a sterile condition (compare comments by Cleal, 1986b on the combination of form-genera representing different organs of a plant). Since *S. affine* has an essentially similar frond architecture and bore the same fructifications as the type-species of *Sphenopteris* (*Sphenopteris elegans* (Brongniart) Sternberg; synonym *Diplothmema adiantoides* (Schlotheim) Gothan — see Kidston, 1923c), it is best if it is retained in that form-genus.

The Oil Shale Group of Scotland has yielded some of the best preserved Visean plant compressions in Britain. The Burdiehouse Limestone was for many years one of the best stratigraphical horizons for such fossils (e.g. Lindley and Hutton, 1831–37; Miller, 1857), but there are now no suitable exposures of this bed. The oil shales themselves, however, particularly the Wardie Shales, have also produced some remarkably well-preserved specimens. When the matrix dries, the fossil sometimes peels off more or less intact (Kidston, 1923b, c, 1924), and almost has the appearance of a compressed piece of modern plant, albeit blackened (some excellent examples of such isolated fossils are figured by Kidston, 1924, p1. 101 figs 7–10). Plant fossils have been recorded from a number of exposures of the Wardie Shales in Edinburgh and environs, in particular Hailes Quarry and at a number of localities along the Water of Leith (Kidston, 1923a, 1925), but only Wardie Shore now still yields them. The site has only so far yielded the limited assemblage listed above, but this may just reflect the limited amount of collecting that has been done here, especially in recent years. Kidston also lists from other nearby exposures of the Wardie Shales the following taxa, which may also eventually prove to be present at Wardie Shore:

Sphenopteris cuneolata Lindley and Hutton

Sphenopteridium pachyrrachis (Göppert) Potonié

S. crassum (Lindley and Hutton) Kidston

S. speciosum Kidston

Spathulopteris obovata (Lindley and Hutton) Kidston

S. decomposita Kidston

Rbacopteris lindsaeformis (Bunbury) Kidston

R. inaequilaterata (Göppert) Stur

R. geikiei Kidston

Schuetzia bennteana Kidston

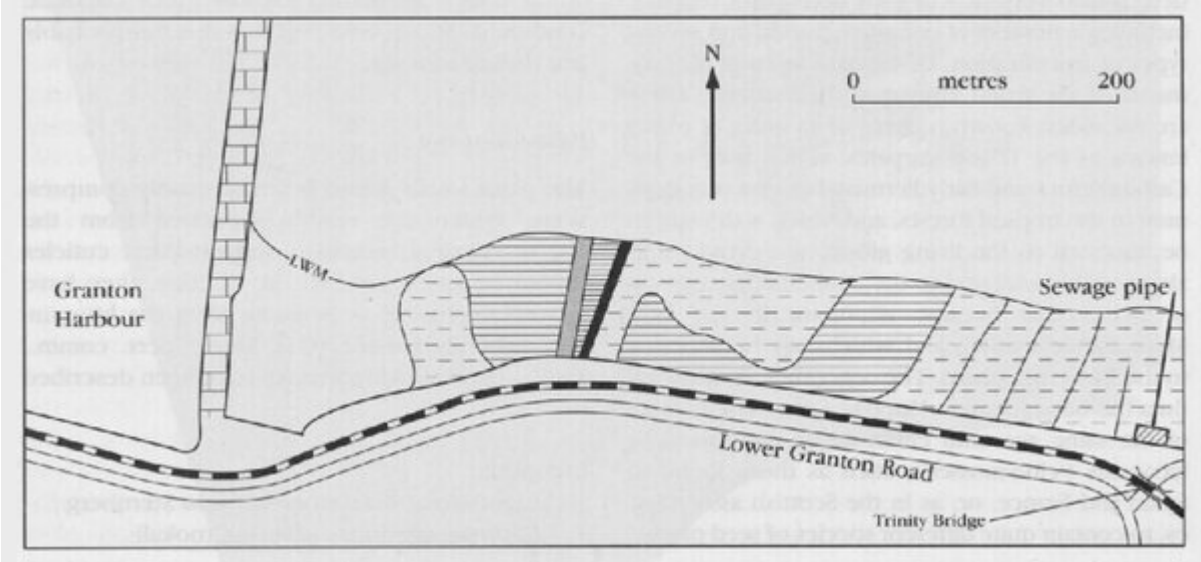
Similar British assemblages to that found in the Wardie Shales have been reported from Glencartholm and to a lesser extent Teilia Quarry (see comments elsewhere in this chapter on these sites for details of the comparison). Outside Britain, comparable assemblages are known from Upper Silesia (Patteisky, 1929; Hartung and Patteisky, 1960). Most other Visean assemblages from Europe differ from that of the Wardie Shales in both overall balance and species composition (Hirmer, 1939; Vakhrameev *et al,* 1978). In particular, the Wardie assemblage has a much higher proportion of lycopsids and equisetes, suggesting a wetter, more swampy environment. According to Raymond and Parrish (1985), a rain-shadow caused by newly formed mountains to the west resulted in much of western Europe having a relatively dry climate during the Early Carboniferous. However, the Scottish sites such as Wardie seem to have avoided its influence, perhaps due to local topographic factors.

Conclusion

Wardie Shore is the only site that still yields abundant plant fossils from the Scottish Oil Shale Group, about 335 million years old. These shales were once a famous source of plant fossils. However, as the shales are no longer a commercial hydrocarbon source, there are now no quarries or mines from which the fossils can be collected. This particular site has yielded a number of club-mosses and early seed plants. One of its main interests, though, is as the type locality for a cone known as *Pothocites grantoni,* which is now known to be an early type of horsetail fructification, and has proved important for establishing the early evolutionary history of this extant class of plants. The general balance of the assemblage, with its predominance of club-mosses and horsetails, suggests a much wetter environment than is represented by the vegetation of this age found elsewhere in Europe.

References

(Figure 5.43) Wardie Shore. Foreshore exposures of the upper Holkerian Wardie Shales Formation. (Photo: C.J. Cleal.)



(Figure 5.44) Map showing the main lithologies exposed at Wardie Shore. Based on McAdam and Clarkson (1986, Map 7).