Teilia Quarry

Highlights

Teilia Quarry is the only locality to yield plant fossils from the Gronant Group of North Wales, and includes a number of endemic taxa. It is particularly important for the putative progymnosperm *Rhacopteris,* yielding the only known British example with fructifications. It has also yielded some of the best known examples of lagenostomalean fronds from Britain, including *Diplopteridium* and *Sphenopteridium,* and what may be the earliest evidence of the order Trigonocarpales. It is a site of outstanding palaeobotanical significance.

Introduction

Lower Carboniferous plant fossils were first collected from this disused quarry north-east of Gwaenysgor, near Prestatyn, North Wales [SJ 080 814], by the amateur geologist J.B. Shone, during the mid-nineteenth century. Morton (1886) published the earliest species list based on Shone's material, although many of his identifications were wrong. The first reliable account of the assemblage was by Kidston (1889a), who also later included a number of Teilia specimens in his classic monograph on Carboniferous plant fossils (Kidston, 1923–1925). Further material was collected during the 1920s, and resulted in a revision of the assemblage by Walton (1926, 1928, 1931); Walton's identifications were also quoted by Neaverson (1930), Crookall (1932) and Hirmer (1939). Most recently, Benson (1935a, b) has given brief accounts on fructifications.

Description

Stratigraphy

Morton (1886) and Walton (1931) have provided accounts of the geology at Teilia. The sequence exposed consists of about 8 metres of thinly-bedded, dark grey limestones belonging to the Gronant Group (previously the Upper Black Limestone Group). In these sedimentary rocks, land-plant fossils are closely associated with fossils of marine animals, and Walton regarded this as evidence that the strata were lagoonal or shallow marine. The fauna mentioned by Morton (1886), Hind and Stobbs (1906), Jackson *in* Walton (1928) and Neaverson (1930) all clearly point to an early Brigantian age (George *et al.,* 1976).

Palaeobotany

The plant fossils are preserved here mainly as adpressions, but no evidence of cuticles has so far been reported. The following taxa have been described:

Lycopsida:

cf. *Lepidodendron* spp.

Equisetopsida:

Archaeocalamites radiatus (Brongniart) Stur

Filicopsida(?):

cf. *Rhodeopteridium tenue* (Gothan)

Purkynova

Progymnospermopsida(?):

Rhacopteris circularis Walton

R. robusta Kidston

R. petiolata (Göppert) Schimper

R. fertilis Walton

Lagenostomopsida:

Diplopteridium teilianum (Kidston) Walton

Sphenopteridium capillare Walton

S. pachyrrachis (Göppert) Schimper

Lyginopteris bermudensiformis (Sternberg) Patteisky

Adiantites antiquus (Ettingshausen) Kidston

A. machanekii Stur

Sphenopteris obfalcata Walton

Spathulopteris ellingshausenii (Feistmantel) Kidston

S. clavtgera (Kidston) Walton

Calathiops acicularis Göppert

C. glomerata Walton

C. renieri Walton

Cycadopsida:

Neuropteris antecedens Stur

Holcospermum ellipsoideum (Göppert) Walton

Carpolithus sp.

Interpretation

Lycopsida

The lycopsids are represented at Teilia by a few stem fragments, described by Walton (1931). Most belong to a *Lepidodendron,* which Walton compared with *L. obovatum* Sternberg based on a suggestion by Jongmans. However, *L. obovatum is* a confused taxon whose types probably fall in synonymy with *Lepidodendron aculeatum* Sternberg (Thomas, 1970), a species quite different from the Teilia specimens. A single specimen was compared by Walton with *L. calamitoides* Nathorst, but the leaf cushions are poorly preserved and the leaf scar not distinguishable. Considering the poor preservation of this material, it is best recorded for the time being merely as cf. *Lepidodendron* spp.

A single small fragment of a third type of lycopsid was illustrated by Walton in a rather sketchy line diagram. He referred it to *Sigillaria* sp., but the available evidence is inadequate to justify this assignment. Crookall (1966) does not refer to it in his monograph on British *Sigillaria* species.

Equisetopsida

At Teilia, as in most Visean assemblages, equisetopsids are represented by *Archaeocalamites radiatus.* Walton (1931, pl. 26, fig. 39) shows a stem with the characteristic forked leaves of this species.

Filicopsida(?)

The frond fragments assigned to *Rhodeopteridium* have much smaller pinnules with very slender lobes. It is possible that they are parts of small pteridosperm fronds, but their small size rather suggests that they are filicopsid fronds. Walton (1931) assigned the Teilia specimens of this type to *Rhodeopteridium tenue* (syn. *Rhodea tenuis* Gothan), a species first described from the lower Namurian of Silesia (Gothan, 1913). However, Gothan's diagnosis mentions that the rachises are 'winged', a feature not yet demonstrated in the Teilia specimens.

Progymnospermopsida(?)

Among the commoner plant fossils found at Teilia is foliage belonging to the form-genus *Rhacopteris.* Although there is some evidence available on the fructifications of this form-genus, including one specimen described by Walton (1926) from Teilia, its affinities have never been firmly established. On balance, however, it seems most likely that it belongs to the progymnosperms (Archangelsky and Arrondo, 1966; Beck, 1976). It was initially established for Upper Carboniferous species (Schimper, 1869–74), but a number of Lower Carboniferous species were later included (Stur, 1875). Oberste-Brink (1913) placed these Lower Carboniferous species in a separate section, *Rhacopteris* (*Anisopteris*), based partly on their stratigraphical position, and partly on the greater asymmetry of the pinnules (some authors have gone as far as raising it in rank to form-genus — Hirmer and Guthorl, 1940; Boureau and Doubinger, 1975). However, this division is probably artificial (Walton, 1926) and the Lower Carboniferous species are best referred to simply as *Rhacopteris.*

The commonest *Rhacopteris* species found at Teilia, *R. circularis,* has round, fairly symmetrical pinnules and a radiating nervation. There have also been tentative records of this species from France (Corsin and Dubois, 1932), the Sahara (Boureau, 1953), Nova Scotia (Bell, 1960) and the Himalayas (Hoeg *et al.,* 1955; Pal and Chaloner, 1979), but they are all based on poorly preserved fragments. Somewhat better material has been described from Argentina by Frenguelli (1944) and Peru by Doubinger and Alvarez Ramis (1980), but it is closely associated with *Pseudorhacopteris ovata* (McCoy) Archangelsky, an Upper Carboniferous species from Gondwanaland with very similar shaped pinnules to *R. circularis.* Teilia is the only known locality to yield undoubted examples of *R. circularis.*

The specimens from Teilia identified by Kidston (1889a) as *Rhacopteris inaequilaterata* (Göppert) Stur were included within the synonymy of *R. circularis* by Walton (1926).

A second species from Teilia is *Rhacopteris robusta* (syn. *R.* cf. *petiolata* Walton, 1926, non Göppert). It has asymmetrical pinnules with an incised distal margin, and is thus readily distinguishable from the commoner *R. circularis.* The Teilia specimens have rather smaller pinnules than the types of *R. robusta* from Scotland (Kidston, 1923c, pl. 51, figs 5–7) but compare closely with specimens from Silesia figured by Patteisky (1929, pl. 6, fig. 1).

Walton (1931, p1. 25, fig. 20) figured a single specimen as *Rhacopteris machanekii,* a species based on just one specimen from Moravia (Stur, 1875). Walton implied that it might be a small form of *R. robusta,* a view which is accepted here.

A third species present at this site is *R. petiolata,* which has deeply digitate pinnules. Only one undoubted specimen has been documented (Kidston, 1923c, pl. 53, fig. 5), although some other more fragmentary examples may also belong here (Kidston, 1923c, pl. 53, fig. 3; Walton, 1926, pl. 16, fig. 11).

The fertile specimen of a *Rhacopteris* described by Walton (1926) was essentially similar to the only other example then known (*R. paniculifera* Stur, 1875, pl. 8, fig. 3), in that it showed a dichotomous axis bearing clusters of sporangia. However, unlike Stur's specimen, the one from Teilia has no sterile pinnules attached and so Walton assigned it to a separate species, *R. fertilis.* This remains the only known British example of a *Rhacopteris* bearing fructifications, and

has an important bearing on determining the taxonomic position of this group of leaves, which form such an important component of Lower Carboniferous adpression floras. It suggests that they may be progymnosperms, as they appear similar to *Archaeopteris* fructifications (cf. Phillips *et al.,* 1972). However, the fertile rhacopterids were described before the progymnosperms had been recognized as a major taxon, and they have not been subsequently re-assessed. Teilia should thus play a significant role in the much needed revision of this widely occurring fossil foliage.

Lagenostomopsida

Dominating the assemblage are pteridosperm frond fragments, most probably belonging to the Lagenostomales. The most completely known is *Diplopteridium teilianum,* following the work of Walton (1926, 1931). It has an essentially bipartite architecture, with a dichotomy of the main rachis near the base of the frond; it is thus similar in many ways to *Sphenopteridium.* However, it shows no evidence of the transverse bars that typically occur on *Sphenopteridium* racheis, and so the species was for some time referred to the generalized form-genus *Sphenopteris* (Kidston, 1889a, 1923a). However, Walton demonstrated that at least some fronds produced a third branch in the angle of the 'dichotomy', which probably bore the fructifications. Consequently, he assigned it to a new form-genus, *Diplopteridium.* Seeds or sporangia have not been found attached to this third branch, but a number of *Telangium*-like structures were found in close association (that it was a fertile branch has been confirmed in the related species *Diplopteridium holdenii* Lele and Walton from Puddlebrook — see p. 169). Although these *Telangium*-like structures are not well preserved, Benson (1935a) concluded that they were cupules, which originally bore seeds/ovules.

A number of other bipartite fronds found at Teilia have rachises with transverse bars and so are assigned to *Sphenopteridium.* To date, no evidence has been found of their fructifications. Walton (1931) described three forms. *S. capillare* is quite distinctive, having small, deeply incised pinnules packed closely to one another along the rachis; to date it has only been reported from Teilia. The other specimens have larger, more widely spaced pinnules with more extensive lamina. They mostly belong to *S. pachyrrachis,* a well-known species with a wide distribution, known from Scotland (Kidston, 1923b), Bavaria (Lutz, 1933), the Loire (Bureau, 1913–1914) and Moravia (Patteisky, 1929). The third type recognized by Walton is only known from Teilia by one small pinna fragment, and was identified as *S. crassum.* It only differs from *S. pachyrrachis* in having slightly smaller, broader pinnules and Walton argued that it might merely be an extreme form of that species. It has not therefore been included here in the species list for Teilia.

Walton (1931, pl. 24, figs 16, 17) figures two specimens of *Lyginopteris bermudensiformis.* Two forms have been recognized within this species, *Lyginopteris bermudensiformis fa. bermudensiformis* (synonyms *Lyginopteris bermudensiformis* fa. *schlotheimii* Stur, 1875 and *Lyginopteris bermudensiformis fa. typica* Kidston, 1923c) and *Lyginopteris bermudensiformis fa. geinitzii* Stur, 1875. The Teilia specimens are too fragmentary to be certain, but Walton (1931) suggested that they have most in common with *Lyginopteris bermudensiformis* fa. *bermudensiformis.* The specimen figured by Walton (1931, pl. 24, fig. 16) is of particular interest in that it seems to be a 'miniature' version of *a Lyginopteris* frond, complete with dichotomy. There may be a correlation with the bipartite 'mini-fronds' described by Boersma (1972) for *Mariopteris,* thought to represent the small fronds from the most distal part of the plant.

Kidston (1889a, p. 425–6) recorded some poorly preserved fragments as *?Sphenopteris schlehanii* (Stur) Gothan. This species is now generally included within *Lyginopteris* (Patteisky, 1957) and it is thus likely that Kidston's reported specimens belong to *L. bermudensiformis.*

Associated with these lagenostomalean fronds are a number of fructifications of the *Calathiops*-type (Walton, 1931). None of them show any internal structure, nor are they attached to foliage, and so their affinities must be speculative. However, *C. acicularis* and *C. glomerata* can be compared with the so-called 'micro-cupule' type of lagenostomalean fructification, such as *Telangiopsis* (Kidston, 1924; Long, 1979b). A third type described by Walton as *C. renieri* is nearer to the 'mega-cupule' type of fructification, such as *Megatheca* from the Oil Shale Group of Scotland (Andrews, 1940). Yet another fructification from Teilia, *Calathiops gothanii* Benson, 1935a, seems indistinguishable from *C. glomerate,* to which Benson does not refer.

Other forking fronds in this assemblage belong to *Spathulopteris,* distinguished from *Sphenopteridium* and *Diplopteridium* by the swollen shape of the pinnules, and the absence of pinnae or pinnules attached to the main rachis below the

dichotomy. There is no evidence available of fructifications attached to these fronds or of the rachial anatomy (except that there are no transverse bars across the rachises), but it is likely that they belong to the Calamopityales. The commonest species at Teilia is *S. ettingshausenii,* which has relatively slender pinnule-lobes. It is a widely distributed species, having been recorded from the Visean of Scotland (Kidston, 1923b), Moravia (Patteisky, 1929) and Silesia (Gothan, 1937). A single small fragment was also described by Walton (1931) as *S. clavigera,* which has more swollen lobes than *S. ettingshausenii.* However, this specimen shows little evidence as to the frond architecture and is thus included in the species list with a '?'.

A single seed identified by Walton (1931) as *Carpolithes* sp. gives the impression of being platyspermic, similar to *Samaropsis* described from the Tournaisian of Scotland. As remarked in the discussion on the Whiteadder (p. 124), such seed compressions might be correlatives of the petrified *Lyrasperma* seeds, and these in turn may have calamopityalean affinities.

In contrast to most of the other bipartite fronds in the Teilia assemblage, a number have wedge-shaped pinnules with entire margins, and belong to *Adiantites.* They are also distinguished by the more complex branching of the sterile foliage (Walton, 1931, text-fig. 2). Walton (1931) pointed out, however, that there is often a scar at the dichotomy of the main rachis, which might be the origin of a fertile branch, similar to that seen in *Diplopteridium.* If correct, this suggests lagenostomalean affinities. Two species of this type have been recognized from Teilia: *A. machanekii* (Figure 5.42), which is the most abundant, and has slender straight-sided pinnules (Walton, 1931, pl. 23, fig. 6, p1. 24, fig. 12); and *A. antiquus,* with more rounded pinnules (Kidston, 1889a, pl. 1, fig. 1; Kidston, 1923b, p1. 45, fig. 1; Walton, 1931, text-fig. 2). The specimens described by Kidston (1889a) and Walton (1931) as *A. tenuifolius* and *A.* sp. are too small for a positive identification.

Walton (1931) recorded, but did not figure, *Sphenopteris cf. filiformis* Kidston from Teilia. He suggested that it was perhaps only a young *Adiantites* frond. It has thus not been included here in the list of species for this locality.

Less completely known types of pteridosperm(?) frond from Teilia have been referred to *Sphenopteris obfalcata* Walton, 1931. It has rather swollen pinnule lobes, similar to the type normally found in *Spathulopteris,* but its frond architecture is too imperfectly known for it to be placed there. To date, this species has only been recorded from Teilia.

Cycadopsida

Two small fragments of *Neuropteris antecedens* were described by Walton (1931) and Crookall (1959), and are the oldest evidence of the cycadopsid order Trigonocarpales (Medullosales of some authors) in the fossil record. This pteridosperm order is of considerable interest, being one of the major components of Late Carboniferous and Early Permian equatorial vegetation. It is also of some evolutionary interest, as it is thought to have been ancestral to the extant group, the cycads. The Teilia specimens are too small to confirm the trigonocarpalean affinities of this species, but the more complete material from the former Czechoslovakia figured by Stur (1875) has a distinctly trigonocarpalean aspect. Also of interest is that the Teilia frond fragments are associated with the seeds *Holcospermum ellipsoideum,* which look remarkably like the trigonocarpalean seeds found in the Upper Carboniferous; a similar association has been reported from slightly younger strata in France by Bureau (1913–1914).

General remarks

Teilia Quarry is the only known locality to yield this distinctive assemblage of plant fossils from the Gronant Group. Many of the other assemblages of similar age, such as from south-east Spain (Jongmans, 1956) and the Loire (Bureau, 1913–1914) are dominated by lycopsids and are thus quite different. More comparable is the assemblage from the Posidonienschiefer of Moravia (Stur, 1875; Oberste-Brink, 1913; Patteisky, 1929; Hartung and Patteisky, 1960). In Britain, the closest comparison is found in the upper Oil Shale Group of Scotland, such as at Wardie Shore (see below). There are, however, several of the Teilia species which have not been reported from any of these other areas or localities, including *Rhacopteris circularis, Diplopteridium teilianum* and *Sphenopteridium capillare;* also, the Welsh assemblage does not appear to contain certain elements which characterize many other upper Visean assemblages, such as *Archaeopteridium* and *Fryopteris.* Whether this reflects the lagoonal setting for the Gronant Group or some other

palaeoecological factor, or is merely a function of collecting and/or taxonomic bias, is as yet unclear.

Conclusion

Teilia Quarry is one of the best known sites in Britain for plant fossils from the Lower Carboniferous, about 330 million years old, and has been studied now for over a century. It is particularly well-known for a type of leaf known as *Rhacopteris,* which occurs very commonly in fossil floras of this age. The Teilia material shows an unusually wide range of shapes of these leaves, as well as including one of only two known specimens bearing reproductive organs. The fossil flora here is also very rich in early seed plant remains, including a number of complete fronds, and several types of fructification. Of especial interest are fragments of the frond known as *Neuropteris.* These are the oldest known remains of an order of plants known as the Trigonocarpales, which later in the Carboniferous and Early Permian became very common in the tropical forests, and which is thought to be ancestral to the living group, the cycads. It is also possibly ancestral to the Bennettitales, a group of plants that became important in the later Mesozoic vegetation, and which may be ancestral to the flowering plants. The only other similar fossil flora has been found in Moravia. Other assemblages of the same age tend either to be dominated by lycopsids ('club-mosses'), such as those found in Spain and France, or, as in the Scottish assemblages, to contain quite different species of seed plants.

References

(Figure 5.42) Adiantites machanekii Stur. Almost complete pteridosperm frond; Natural History Museum, specimen V.2755. Gronant Group (Brigantian), Teilia Quarry. x 0.75. (Photo: Photographic Studio, Natural History Museum,

London.)