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# Laggan

## Highlights

This is a significant site for Lower Carboniferous plant petrifications, particularly for lycopsids. They include the best known examples of *in situ* petrified stumps of arborescent lycopsids, and some early examples of herbaceous lycopodiaceans. It has also yielded some of the best known examples of anatomically-preserved strobili of the Archaeocalamitaceae (Sphenopsida).

## Introduction

The *in situ* stumps of fossil trees preserved in Lower Carboniferous volcanogenic deposits at Laggan, on the north-east coast of the Isle of Arran [NR 982 506], were discovered by E.A. Wunsch in 1865 (the early history of work on the site is summarized by Walton, 1935). Despite early contributions by Carruthers (1869) and Binney (1871), significant progress was not made until W.C. Williamson visited the site in 1877, when a considerable quantity of specimens was collected (a colourful account of the visit is given by Williamson, 1896, pp. 169–177). The lycosid stumps were described by Williamson (1880, 1883, 1895), and later by Walton (1935). Other elements in the assemblage have been described by Calder (1935), Walton (1949b), Fry (1954), Beck (1958), Pant and Walton (1961) and Chaphekar (1963), mainly based on specimens from Williamson's original collection.

## Description

### Stratigraphy

The most recent detailed accounts of the geology at Laggan appear to be by Tyrrell (1928) and Walton (1935), although no stratigraphical log was given. The fossils occur in a basaltic ash deposit, some distance below the Corrie Limestone, probably in the Upper Sedimentary Group. Their exact chronostratigraphical position is uncertain, but the deposits probably fall in the upper Viséan.

### Palaeobotany

The following taxa, preserved as calcite petrifications, have been described to date:

Lycopsida:

*Lepidophloios wuenschianus* (Williamson)

Walton

*Levicaulis arranensis* Beck

*Paurodendron arranensis* Fry

*Lycostachys protostelicus* Pant and Walton

*Lepidostrobus* (?) *ambiguus* Binney

*L. wuenschianus* Binney

*L. latus* Binney

*Lepidocarpon* sp.

*Stigmaria* sp.

Equisetopsida:

*Protocalamites goeppertii* (Solms-Laubach) Bateman

*Protocalamostachys arranensis* Walton

Lagenostomopsida:

*Lyginorachis waltonii* Calder

*Lyginorachis* sp.

*Kaloxylon* sp.

## Interpretation

The most famous of the Laggan fossils are the *Lepidophloios wuenschianus* stumps (Williamson, 1880, 1883, 1895; Walton, 1935). They are the best known examples of *in situ*, petrified stumps of arborescent lycopsids; the only other reported specimens are *Lepidodendron saalfeldense* Solms-Laubach from Germany, which are smaller and not so well preserved (Solms-Laubach, 1896). They are particularly important as the stumps contain pieces of the stele from different parts of the trunk (e.g. (Figure 5.29)). This preservational feature appears to have resulted because most of the outer cortex disintegrated shortly after the death of the plants, and the stelar column then collapsed down into the stump, where it became lithified. From these fossils, Walton (1935) was able to deduce that at the base of the trunk there was only a relatively slender protostele, surrounded by a thick layer of secondary wood. In more distal positions, however, the primary xylem formed a wider, medullated siphonostele, but the surrounding secondary wood became concomitantly narrower. These results had important consequences for subsequent ideas about the developmental growth of the arborescent lycopsids (Andrews and Murdy, 1958; Eggert, 1961). Where pieces of the cortex are still preserved, they show that this tissue had clearly developed bands of secretory cells.

Also found in the stumps are fragments of the distal branches of the tree, which are similar to the adpression species *Lepidophloios scoticus* Kidston. They can also be compared with the *Lepidophloios* shoot described from Bearsden by Galtier and Scott (1986b). However, similar shoots are also found associated with *Lepidophloios scottii* Gordon at Pettycur (see above), which differs from the Laggan fossils in not having secretory cells in the cortex. Evidently, different species of lycopsid could produce shoots of essentially identical form.

DiMichele (1979) used *L. wuenschianus* as the 'type' of one of the two groups of *Lepidophloios* species that he recognized, characterized by features of periderm structure, leaf cushion anatomy, and lateral branch architecture. Other members of the group include *L. scottii* Gordon from Pettycur (see above) and *L. johnsonii* from the basal Upper Carboniferous of North America, but *L. wuenschianus* is by far the best known. The differences between the two groups of *Lepidophloios* may reflect palaeoenvironmental differences, the *L. wuenschianus* group occupying more open habitats, whereas the *L. harcourtii* group were forest dwellers.

It has been argued that *Lepidophloios* bore *Lepidocarpon* strobili (e.g. Phillips, 1979). It is not surprising, therefore, that Walton (1935) recorded *Lepidocarpon* in the Laggan stumps, although no description was given.

Binney (1871) described three species of *Lepidostrobos* from Laggan, but they are all incomplete and in need of renewed investigation.

Two other types of lycopsid in the Laggan assemblage were herbaceous, and are both unique to this locality. The stems known as *Levicaulis arranensis* Beck (1958) were less than 40 mm in diameter, with a terete protostele, and apparently without ligules. An associated strobilus known as *Lycostachys protostelicus* Pant and Walton (1961) has a central axis with an almost identical structure and is assumed to have belonged to the same plant. The preserved part of the strobilus

was exclusively microsporangiate, although some megaspores were found in association. If this association is merely coincidental and the cone was homosporous, as suggested by Pant and Walton, then the affinities of this plant probably lie with the Lycopodiaceae.

A second type of herbaceous lycopsid is represented by the stems *Paurodendron arranensis* Fry (1954). Unlike *Levicaulis*, *Paurodendron* is ligulate and thus more similar to *Oxroadia* from Oxroad Bay (p. 131), except for details of the vascular anatomy. It was placed in synonymy with *Selaginella fraipontii* (Leclercq) Schlanker and Leisman from the Upper Carboniferous of North America by Schlanker and Leisman (1969). However, in view of their stratigraphical separation, and the fact that details of the strobili are known from *S. fraipontii*, but not the Laggan plant, it seems wiser to keep them separate. Bateman (1988) has argued that *Paurodendron* and *Oxroadia* represent a distinctive order of lycopsids, which is probably a sister group of the Lepidocarpaceae, although he has subsequently recanted this view (Bateman *et al*, 1992).

## Equisetopsida

The Laggan equisetopsid stems, known as *Protocalamites goeppertii* (Walton, 1949b) differ from *Protocalamites pettycurensis* from Pettycur in having more primary vascular strands, and probably representing larger plants (Bateman, 1991). They are also associated with larger strobili, known as *Protocalamostachys arranensis* Walton (1949b). Historically, the latter are of interest because they were the first strobili of these primitive equisetopsids to be discovered petrified, which helped clarify the distinctive characters of the Archaeocalamitaceae (i.e. the sporangia were borne on peltate sporangiophores, and there were few intervening sterile bracts).

## Pteridosperms

There has been little work on the pteridosperms at Laggan. Calder (1935) described a distinctive lagenostomalean rachis as *Lyginorachis waltonii* Calder, whilst Walton (1935) recorded *Kaloxylon*, which usually refers to lagenostomalean rooting structures.

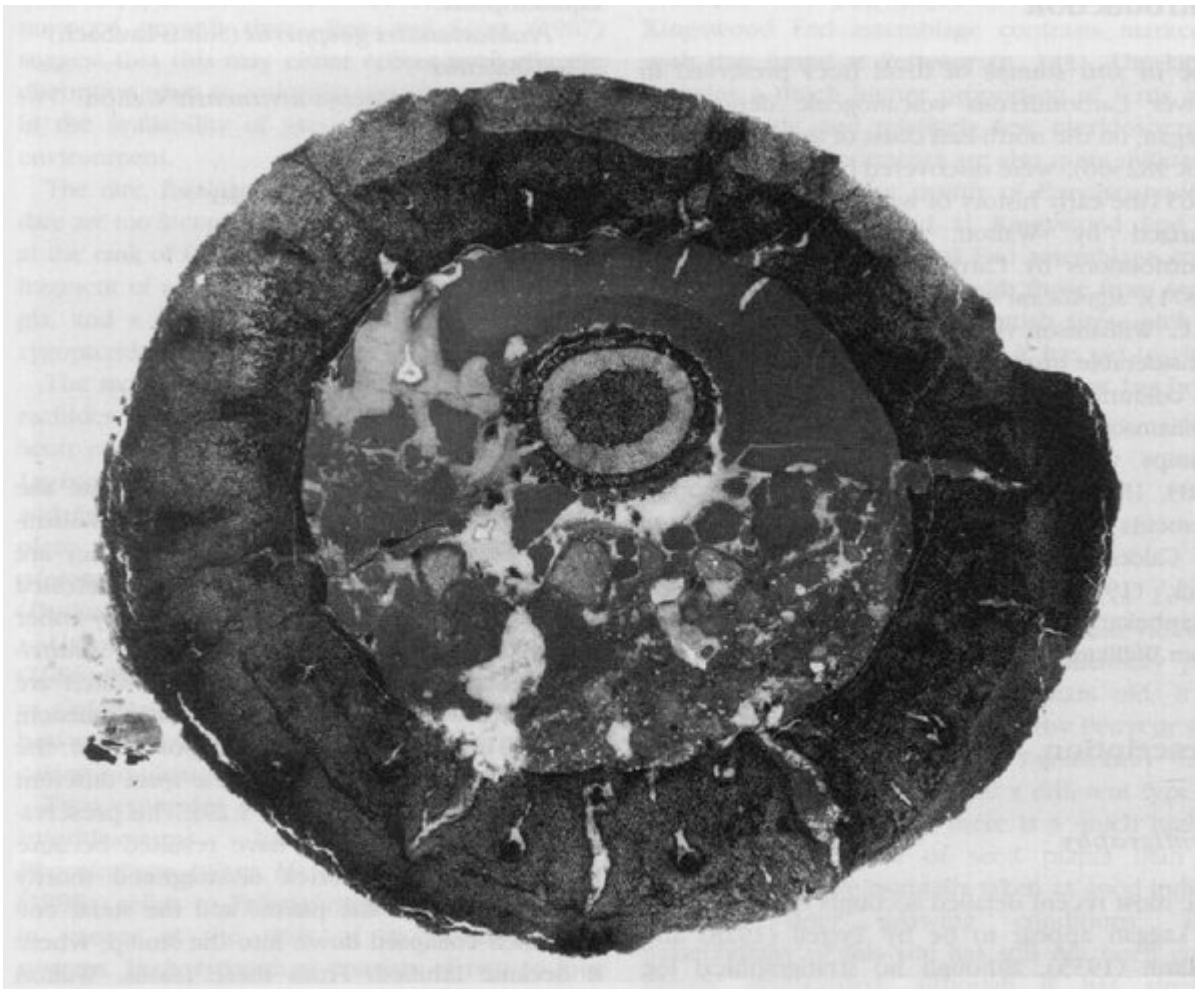
## General remarks

Laggan is another of the internationally important Lower Carboniferous petrification sites in Britain, which includes a particularly significant lycopsid component. Some of the species have been described from elsewhere, such as *Lepidophloios wuenschianus* from Dalmeny (Seward and Hill, 1900), *Protocalamites goeppertii* and *Protocalamostachys arranensis* from Loch Humphrey Burn, and *Lyginorachis waltonii* from Oxroad Bay and Loch Humphrey Burn. Nevertheless, the balance of taxa at Laggan remains unique, as well as being the only known locality for two herbaceous lycopsids.

## Conclusion

Laggan is one of a series of important sites that show Lower Carboniferous rocks in southern Scotland, and which yield plant fossils with their anatomy preserved; they are probably about 340 million years old. This particular site is especially important for its club-mosses, which include both trees (*Lepidophloios*) and small, herbaceous forms (*Levicaulis* and *Paurodendron*). It has also yielded important specimens of horsetails, including a number of reproductive cones, that have been important for understanding the evolutionary history of this group of plants.

## [References](#)



(Figure 5.29) *Lepidophloios wuenschianus* (Williamson) Walton. Transverse section through lycopsid stem; Natural History Museum, London, specimen WC.456a. Visean ash deposits, Laggan. x 2. (Photo: Photographic Studio, Natural History Museum, London.)