

Palaeobotany under the microscope

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Darwin's 'lost fossil found' proclaimed the *Daily Mail* in January 2012. However, the collection of 'lost fossils' recently uncovered in the British Geological Survey's vaults is far more complex and varied than that headline suggests. It comprises more than three hundred microscopic slides of fossil wood, all of which date from the early Nineteenth Century. The slides relate not only to Charles Darwin, but also to his 'inner circle' of John Henslow and Joseph Hooker, as well to a whole host of other leading scientists of the day. Most intriguingly, they shed light on a murky era when advances in microscopical techniques were transforming palaeobotany, the study of fossil plants. In this article, I reveal more about these amazing fossils and explain their significance for the history of microscopy, and science in general.

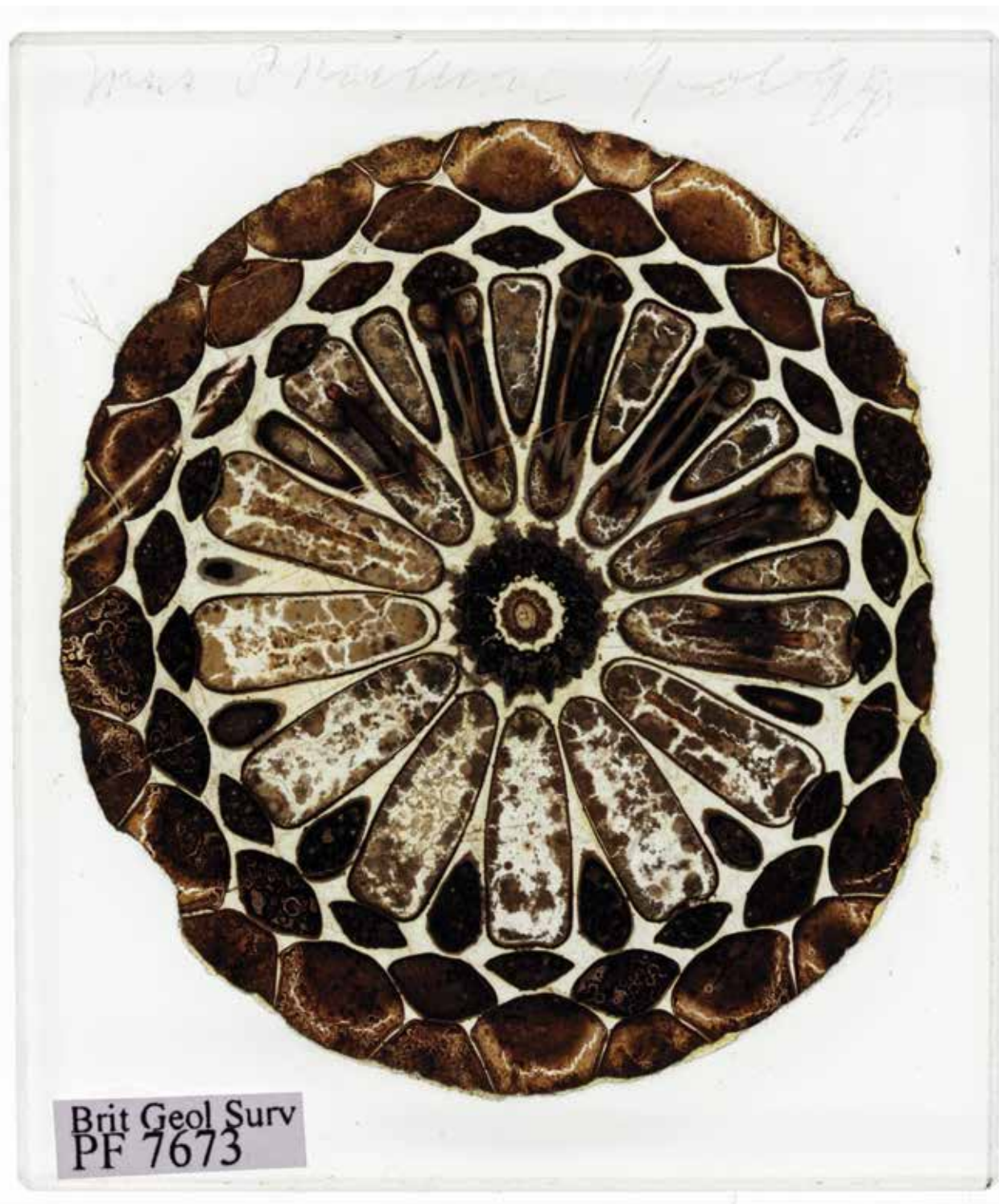


Figure 1. An example of one of Joseph Hooker's coal measure plants from the English Midlands: a 'cone' of a giant club moss tree (copyright British Geological Survey, specimen PF7673).



Figure 2. Collection manager, Paul Shepherd, with the 'unregistered' fossil plant collection at the British Geological Survey.

Fossil treasure trove

It's not everyday that you stumble across a treasure trove. Back in March 2011, I was doing some routine work in the Nottingham warehouse that is home to the massive fossil collections of the British Geological Survey. The collection manager, Paul Shepherd, had pointed me towards an old wooden cabinet as a possible location for the specific fossils for which I was searching. However, as I was rifling through the drawers, I found more than I was bargaining for. In particular, my eye was drawn to a series of seven drawers labeled 'unaccessioned fossil

plants' – in other words, fossils that hadn't been properly numbered in the formal catalogue. I can't resist a mystery, so I pulled one open. What I found inside made by jaw drop.

The drawers contained hundreds of handmade glass microscopic slides, some up to 15 cm across. The subject of all these slides was fossil plants, and fossil wood in particular. The fossils had been ground down into waver-thin translucent sections for study using a transmitted light microscope. I was immediately struck that these fossils were not just scientific

specimens, but also extraordinary artworks showing vivid colours and intricate shapes. The slides were annotated with a diamond scribe, and as I held them up to the light, the spidery text helped to reveal their origin and significance. One key inscription read 'J.D.H. 1846'. This linked the fossils

with renowned Nineteenth Century botanist and explorer, Joseph Dalton Hooker, who had briefly worked for the British Geological Survey in 1846 and who was responsible for assembling the collection.

Double-crossed Nicol

The oldest component of Hooker's slide collection comprises some of the very first microscopic sections of fossils ever made. These are associated with the Edinburgh microscopist, William Nicol, who played a key role in using the petrographic thin section technique in 1828. Scientists had, of course, been studying fossils under the microscope since the days of Robert Hooke in the 1660s, but these were solely surface observations. Nicol's breakthrough was to devise a technique for the production of translucent thin sections – comparable to the sections being made of living plant material – so that fossil plants could be studied with a transmitted light microscope in the same way.

The story of Nicol's microscopic experiments is full of intrigue. It all seems to have begun with the

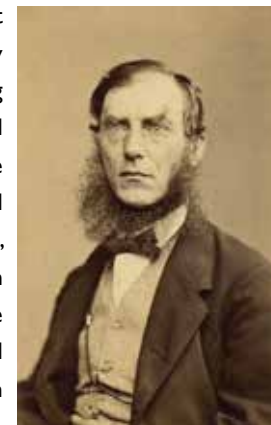


Figure 3. Joseph Hooker at the Geological Survey around 1846 (copyright British Geological Survey, image number P552077).

discovery, in 1826, of a giant fossil tree at Craighleith Quarry on the outskirts of Edinburgh. Working with an ingenious lapidary called George Sanderson, Nicol devised a method of attaching slices of the fossil wood to a glass plate using the resin of the balsam fir tree (*Abies balsamea*) – better known as Canada Balsam. The fossil was then progressively ground away on a turntable until it became translucent and the preserved cellular structure of the 300 million year old tree became apparent. The results were sensational and allowed immediate comparison with the wood of living trees such as the monkey-puzzle conifer, *Araucaria araucana*. However, just at the time when Nicol was reveling in his initial success, a dastardly 'friend' was poised to steal the credit.

Henry Witham was a gentleman naturalist who ran a private museum in downtown Edinburgh. As soon as Nicol showed him examples of the thin sections, Witham immediately recognised their extraordinary potential for transforming palaeobotany. Working with a botanical artist, he swiftly published a beautifully illustrated description of Nicol's thin sections in a landmark book entitled *Fossil Vegetables*. The book, which appeared in 1831, was dedicated to 'my indefatigable friend, Mr. William Nicol' and many historians have imagined a happy collaboration. Not so, however. Nicol was livid. What especially seems to have incensed him was that Witham had published a description of the thin section technique with sufficient detail that anyone with basic know-how could replicate it.

Perhaps Witham expected his friend to be grateful for all the publicity he had brought for his work? While details are scant, what we know is that the two men fell out very badly over the following months. The scale of this rift is most evident in the fact

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Figure 4. Cross-section through the branch of the famous fossil tree found at Craigeith Quarry, Edinburgh, prepared by George Sanderson in 1833 (copyright British Geological Survey, specimen PF7509).

that – when the second edition of Witham's book appeared in 1833 – all references to Nicol had been taken out. Consequently, for many years, scientists assumed that it was Witham who was the innovator of the thin section technique. One of Nicol's other microscopical inventions was a polarizer known today as Nicol's Prism. When geologists use this simple analytical tool, they informally refer to studying minerals in 'crossed Nicols'. This seems, to me, rather ironic given poor old Nicol's double-crossed dealings with the dastardly Henry Witham! Witham died in 1842. Shortly thereafter, his large collection of thin sections – including specimens acquired from Nicol and others later independently cut by Sanderson – were packaged up and sent to the British Geological Survey. However, with the revolutionary thin section technique now in the public domain, it was only a matter of time before others followed the trail that Nicol had blazed.

Darwin's Miserable Hole

The next oldest slides in the Survey's 'lost collection' comprise fossils collected by the young Charles Darwin in the course of his epoch-making Voyage of the Beagle. Darwin had set sail of this round-the-world voyage of discovery in 1831, just as Witham's first edition of *Fossil Vegetables* hit the shops. The official purpose of the Beagle's voyage was to prepare detailed nautical charts of the coast of South America, and much of Darwin's time was spent exploring this region. In 1835, he visited the island of Chiloe on the west coast of Chile. The weather was awful – horizontal rain and a biting wind – and Darwin's scribbled in his notebook that Chiloe was "a miserable hole". That may have been so, but it didn't deter him from doing a spot of fossil collecting.

All along the coast of Chiloe, there were 40 million year old sediments and lavas that contained fossilized wood. Darwin bagged some of these fossils and sent them to Robert Brown, the Curator of Botany at the Natural History Museum, London. Well aware of Nicol's revolutionary new technique, Brown

thin sections of the fossils. On Darwin's return, the two men met to discuss the fossils in May 1837, and identified them as primitive conifers with similarities, once again, to the modern day conifer, *Araucaria*. Two things are particularly noteworthy about these slides. First, Brown reported that the sections were prepared at great personal expense, underlining



Figure 5. A Jurassic fossil wood from Whitby, Yorkshire collected and sectioned by William Nicol in 1831 (copyright British Geological Survey, specimen PF7585).



Figure 6. A thin section of one of Charles Darwin's fossil woods collected from the "miserable hole" that is Chiloe Island, Chile, and sectioned in 1837 (copyright British Geological Survey, specimen PF7455).

the fact that Nicol's technique was still very much 'cutting edge'. Second, by modern standards, or even in comparison to the slides that Nicol had made only six years earlier, Brown's sections are awful – almost worst than useless. This highlights just how technically difficult it was to manufacture such fossil slides.

To date I have been unable to determine the identity of the London-based lapidary who prepared the thin sections for Robert Brown. However, at that time, there was an emerging small army of professional slide-makers, who tirelessly laboured to meet the growing demand for microscopic slides from

gentleman naturalists. All these preparators were skilled in mounting biological materials such as insects or flowers for study under the microscope, and any one of these might have experimented with the far more difficult task of preparing translucent slides of fossils. We know, for example, that Mr. Darker of Lambeth and Mr. Topping of Islington, both in central London, were preparing slides of fossil specimens by the early 1840s, if not earlier. Was one of these responsible for cutting Darwin's slides? We cannot be sure, but it is possible.

The 'inner circle'

In 1843, Darwin gave some of his Beagle fossil slides to Joseph Hooker, and as a result they became incorporated into what would later comprise the British Geological Survey's 'lost collection'. Hooker was Darwin's best friend and scientific confidant, and another member of that 'inner circle' was the Revd. John Henslow. Henslow had mentored Darwin in the course of his Cambridge undergraduate years – and Darwin was sometimes referred to as the man who walked with Henslow. Around 1846, at the time of his brief stint at the British Geological Survey, Hooker became romantically involved with Henslow's daughter, and they eventually married. Much of the remaining fossil material in the Survey's 'lost collection' is closely connected with this web of relationships.

Some of that material came directly from Hooker's own explorations, both overseas and in Britain. Between 1839 and 1843, Hooker sailed around Antarctica and Australia on HMS Erebus. Although his best-known work from that voyage dealt with the Southern Hemisphere flora, he also took the opportunity to collect fossil wood. Two of Hooker's largest collections came from the Kerguelen Islands – a god-forsaken volcanic splinter on the edge of Antarctica – and in Tasmania. Some of these fossil trees were quite spectacular, and the finest were shipped back to Britain where they were later showcased at the Great Exhibition of 1851.



Figure 7. An angiosperm wood (flowering plant) from John Henslow's fossil collection sectioned in the early 1840s (copyright British Geological Survey, specimen PF7665).



Figure 8. The Museum of Practical Geology, where the specimens were housed from 1853 to 1935 (copyright British Geological Survey, image number P640470).

Other fossil material was collected as a result of Hooker's work for the British Geological Survey in 1846. In the course of mapping the coal measures of South Wales and the English Midlands, Hooker made a study of nodules found in the roofs of coal seams. When sectioned, these revealed beautiful details of the cellular structure of the trees that formed the coal. These fossils include the roots, trunks and reproductive 'cones' of giant club-mosses. Although such work seems somewhat esoteric today, in the mid-Nineteenth Century it was of enormous economic importance. Coal was the fuel that was driving the expansion of the British Empire and any information that could improve knowledge of its origin and distribution was of great significance.

Still other fossil slides in the 'lost collection' are labeled 'Miss Henslow'. They presumably represent material from the reverend's own cabinet of curiosities and appear to have reached Hooker via Henslow's daughter in the course of their engagement. This material comprises fossil wood from all over the British Empire, from Antigua to Egypt, but especially from some of the classic fossil sites in the British Isles itself. For example, one slide was cut from a Jurassic fossil tree – 150 million years old – found on the Isle of Portland in Dorset. In Henslow's day, Portland was famous for its high-quality stone and many famous London landmarks, including Saint Paul's Cathedral, are constructed from Portland Stone. Quarrymen regularly uncovered fossil trees on the isle and we know that Henslow made a study of them in the mid-1830s.

The 'lost collection' found in the vaults of the British Geological Survey is of great value

Lost and found

As will be evident, the 'lost collection' found in the vaults of the British Geological Survey is of great value – not only historical, but also for ongoing scientific work. So, in closing, one key remaining question is how did these fossils get mislaid for 165 years? In short, the fault seems to lie with Hooker himself, who failed to properly number the specimens prior to departing on a botanical field trip to India and the Himalayas in 1847. He wasn't entirely culpable, however, because the Survey's formal catalogue system was only introduced in 1848. Furthermore, it seems that when Hooker returned from his travels in 1851, all the specimens were neatly boxed up, awaiting transfer from the Survey's Museum of Economic Geology in Charing Cross to a new facility at the Museum of Practical Geology in Piccadilly, London, which opened its doors in 1853. Then in 1930, the fossil slides moved again, this time to the Geological Museum, London, and then onto their current Nottingham home in 1985. With each move, their origin and significance became ever more obscure.

As Dr. Mike Howe, Chief Curator of the British Geological Survey, has recently remarked this 'lost collection' is, in a sense, a 'known unknown'. The Survey knew that they had the slides in their possession; they just didn't know exactly what they were. In the absence of a proper catalogue, the task of determining the provenance and origin of the slides is enormously challenging; it has taken up much of my time over the past year. However, now identified, the real work begins – to tease out the scientific significance of the fossils, which include numerous 'gems' that have been lost to science since the days of Darwin's youth. Once lost, and now found, images of these stunning fossils are publically available to view and download via the British Geological Survey's online museum: <http://www.bgs.ac.uk/discoveringGeology/geologyOfBritain/archives/jdhooker/>

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