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FORUM: NEW PERSPECTIVES

Out on the fringe: Wales and the history of science

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Imagine a scene sometime in the 1750s in the depths of west Wales. This was wild country. Even a century later, George Borrow called it a ‘mountainous wilderness ... a waste of russet-coloured hills, with here and there a black craggy summit’.¹ Through this desolation rides the Reverend William Williams. As he rode, he read – and the book in his saddlebags on this occasion was William Derham’s *Astro-Theology*, first published some twenty years earlier. Williams was a leading figure in the Methodist revolution that had been sweeping through Wales for the past two decades. Disenchanted with an Anglican Church that seemed increasingly disconnected – culturally and linguistically – from their everyday lives, and attracted by powerful and charismatic preachers like Williams himself, men and women across Wales turned to Methodism. They organized themselves into local groups worshipping in meeting houses rather than in their parish churches. Leaders like Williams usually had a number of such groups under their care, and spent much of their time on horseback, travelling between widely scattered communities to minister to their congregations.² That Williams read in the saddle is well known. As shall become clear, he had certainly read Derham’s book as well. It is not too much of an imaginative leap, therefore, to picture him reading about God’s design of the cosmos as he rode through the Welsh hills – and it is a good image with which to begin a discussion about Wales, science and European peripheries.

Peripheries, and European peripheries in particular, are dislocated places – and that is what should make them so interesting to historians of science.³ Amongst other things, looking at the fringes offers an antidote to the overwhelmingly metropolitan focus of much history of science. Examining how nature and the non-human was understood on the peripheries of centres of scientific power can also illuminate the ways in which knowledge moves, and offer new ways of thinking about how science is made – and for whom. Historians of science understand very well the intimate relationship between place and regimes of knowledge production and circulation.⁴ Looking at the dynamics of science at the peripheries makes the importance of place even more evident and underlines

1 George Borrow, *Wild Wales*, London: John Murray, 1862, p. 272.

2 Eryn White, *The Welsh Methodist Society: The Early Societies in South-West Wales, 1737–1750*, Cardiff: University of Wales Press, 2020.

3 Faidra Papaneloupoulou, Agusti Nieto-Galan and Enrique Perdiguerro (eds.), *Popularizing Science and Technology in the European Periphery, 1800–2000*, Aldershot: Ashgate, 2009.

4 David Livingstone, *Putting Science in Its Place: Geographies of Scientific Knowledge*, Chicago: The University of Chicago Press, 2003; James Secord, ‘Knowledge in Transit’, *Isis* (2004) 95, pp. 654–72.

just how fine-grained is the spatiality of science. Wales offers a particularly pertinent example. From a global perspective, a country so close to the centre of scientific power might not even appear (peripheral) at all. The Welsh example demonstrates that peripherality involves more than spatial separation. It involves degrees of cultural and linguistic separation too. Scientific culture in Wales was an attempt both to overcome peripherality and to underline it. As a small European country subsumed in an imperial state, Wales and its peoples could understand science in many ways – both as alien and as indigenous; a source of authority, an agent of suppression – and, perhaps, offering the possibility of progress. Looking at Welsh science, therefore, offers historians a way of getting at the granularity of science’s politics.

Wales in the 1750s would certainly have seemed a place on the periphery as far as most other Europeans were concerned. The sight of an itinerant Methodist enthusiast reading Newtonian philosophy as he rode through the hills might therefore be taken as a sign of that philosophy’s powerful universalizing appeal. Nevertheless, Williams’s religious convictions were far removed from both Newton’s public face of moderate Anglicanism and his private Arianism.⁵ Williams was – and remains – an iconic figure in Wales. Now mainly known as a highly prolific writer of hymns, he was a key figure in Welsh Methodism and an important protagonist in Welsh religious history.⁶ His hymns played a vital role in the broader eighteenth-century revival of Welsh literature.⁷ But while his religious and literary contributions are well known, historians of Welsh culture, and Williams’s biographers, have had rather less to say about his concern with natural philosophy. Just as the territory he covered on horseback was marginal land on the periphery of empire, so have his scientific interests been regarded as being on the margins of Williams’s broad range of concerns. It is this apparent marginality – both of science to the main thrust of William Williams’s ambitions, and of the space he traversed to cement those ambitions to the mainstream of natural-philosophical culture – that makes his horseback readings such a good place to start thinking about how to think about Wales, the history of science and peripheries.

Just as science plays a negligible role in William Williams’s current reputation, science does not play much of a role in the conventional image of Wales and Welsh culture either. The Welsh stereotype is one of religion and rugby, hymns and arias. Contemporary cultural histories of Wales tend to focus on Welsh religious and literary identities. The country’s changing economic and political landscape has received significant attention, particularly from the nineteenth century and the Industrial Revolution onwards.⁸ Until very recently, however, and oddly given Wales’s nineteenth-century role as a site of technological innovation, there has been very little attention given to the role that science and technology might have played in forming and informing Welsh culture.⁹

⁵ See Rob Iliffe, *Priest of Nature: The Religious Worlds of Isaac Newton*, Oxford: Oxford University Press, 2017, for the most recent view of Newton’s religion.

⁶ Edward Morgan, *Ministerial Record, or Brief Account of the Great Progress of Religion under the Ministry of Rev. W. Williams*, London: H. Hughes, 1847.

⁷ Saunders Lewis, *Williams Pantycelyn*, London: Foyle’s Welsh Depot, 1927. Lewis was a key figure in the development of Welsh nationalism during the twentieth century. See also Derec Llwyd Morgan (ed.), *Meddwl a Dychymyg Williams Pantycelyn*, Llandysul: Gomer Press, 1991; E. Wyn James, ‘Popular poetry, Methodism, and the ascendancy of the hymn’, in Geraint Evans and Helen Fulton (eds.), *The Cambridge History of Welsh Literature*, Cambridge: Cambridge University Press, 2019, 306–34.

⁸ John Davies, *A History of Wales*, Harmondsworth: Penguin, 2007; Gwyn A. Williams, *When Was Wales? A History of the Welsh*, Harmondsworth: Penguin, 1985. Gwynfor Evans, *Land of My Fathers: 2000 Years of Welsh History*, rev. edn, Talybont: Y Lolfa, 2013, offers an explicitly nationalist narrative from the first Plaid Cymru MP and former party leader.

⁹ For a counterexample see Chris Evans and Louise Miskell, *Swansea Copper: A Global History*, Baltimore: Johns Hopkins University Press, 2020.

As Williams's example suggests, this is due not to its absence, but to its perceived marginality. Likewise, historians of science have paid little attention to scientific activity in Wales and other similar countries on the fringes of more dominant polities. Histories of science still tend to focus on science's centres of calculation.¹⁰ The identification of science as a product of imperial centres remains dominant. Histories of science in Victorian Britain, for example, tend to focus on the metropolis and the cultural networks woven around it. Similarly, histories of French or German science tend to revolve around centres of imperial political power.¹¹

Looking away from those centres of power and calculation and investigating how science works on the periphery offers an important route to understanding the importance of place. Latour's account of centres of calculation offered a view of scientific knowledge that seems perverse when regarded from sites at a remove from those centres. Latour's account portrays centres of calculation sucking in the raw material of knowledge from the peripheries and spitting it back out transformed into the finished product. It takes for granted that the view from the centre is the only one possible. Looking at peripheries from the perspective of the peripheries themselves offers another way of getting at the uneven and contested terrains through which knowledge circulates. Mid- and west Wales, for example, might appear peripheral from the perspective of an imperial metropolis, but its inhabitants might just as plausibly regard the imperial metropolis as peripheral to their own preoccupations.¹² Williams, in that terrain, was himself a vector for the circulation of knowledge. He played a key role in the ways in which his congregations and readers encountered natural philosophy. The uses he put his readings of Derham and other natural philosophers to were dictated less by imperatives emanating from the centre than by his own concerns.

So why was William Williams reading William Derham's *Astro-Theology* as he rode through the hills of Cardiganshire? To what uses did he put it? His reading is most clearly evident in a long poem, *Golwg ar Deyrnas Crist* (A Survey of Christ's Kingdom), first published in 1756.¹³ It was by any standards a remarkable piece of work. It consisted of an impressive 1,367 verses, amounting to 5,468 lines. Eight years later he published a revised edition, consisting this time of 1,366 verses.¹⁴ *Golwg* offered a detailed account of God's creation and humanity's place within it. It opened with God's transfer of his creation to Christ's care and proceeded with a systematic description of the earthly kingdom that Christ inherited from his Father, ending with Christ's return of creation to God's care at the end of time. The poem is notable for its detail, and in particular for its extended discussions of the latest natural-philosophical ideas about the nature of God's creation. If the universe that he described for his readers was an unmistakably Newtonian one, it was a Newtonian universe redirected to serve Williams's more immediate concerns. He speculated about other suns, 'Nid llai eu gwres, eu golau, eu hanferth faint ynghyd / Na'r haul fawr, olau, eglur, sydd yn goleu'r byd' (Not less in heat, in light, their massive size / Than the huge, clear sun that lights the world), and other worlds, 'Llu heb eu rhifo o fydoedd yn troi o gylch heb ball, / Yn cadw y neu troeon heb un yn cwrdd y llall' (A numberless crowd of worlds all turning without cease / Staying in their orbits without ever meeting each

10 Bruno Latour, *Science in Action: How to Follow Scientists and Engineers through Society*, Milton Keynes: Open University Press, 1987.

11 See, for example, the literature inspired by Nathan Reingold and Marc Rothenberg (eds.), *Scientific Colonialism: A Cross-cultural Comparison*, Washington, DC: Smithsonian Institution Press, 1987.

12 Geraint Jenkins, *The Foundations of Modern Wales: Wales 1642-1780*, Oxford: Oxford University Press, 1987.

13 William Williams, *Golwg ar Deyrnas Crist, neu Grist yn bob Peth, ac ymhob Peth*, Bristol: E. Ffarley, 1756. A modern edition is republished in Garfield H. Hughes, ed., *Gweithiau William Williams Pantycelyn*, 2 vols., Cardiff: University of Wales Press, 1964-7, vol. 1, pp. 3-191.

14 William Williams, *Golwg ar Deyrnas Crist, neu Grist yn bob Peth, ac ymhob Peth*, Carmarthen: John Rees, 1764.

other).¹⁵ The published text included extensive footnotes, made more extensive in the second edition, expanding on the philosophical ideas traced out in the work. These footnotes were expressly intended, as was made clear in his preface, to explain the relevance of *y philosophyddiaeth bresennol* ('the latest philosophy') to the poem's broader religious message. He was conveying unfamiliar ideas in a language and in a literary form that would be familiar to the intended readership.

Works like *Golwg ar Deyrnas Crist* were written for a Welsh readership who did not regard themselves as peripheral. On the contrary, they thought that their activities were central to the world's future salvation. The volume sold enough copies to require a second edition – and it is interesting to note that he had found a publisher closer to home: the first edition was printed in Bristol, the second edition in Carmarthen. Williams regarded the philosophical material woven into the poem as sufficiently significant to warrant the addition of those extensive footnotes. It was material that added weight to his theology. But, just as importantly, he understood that his readers would recognize that the material itself was of significance. Beyond its own intrinsic value, *Golwg ar Deyrnas Crist* offers us a glimpse of a growing Welsh middle-class and literate culture that wanted to repurpose natural philosophy to its own ends. Newtonian philosophy was being refashioned to make it an integral element of the cultural world that Williams and his readers inhabited. It was being turned into something that helped inform their sense of who they were. Many of Williams's hymns were celebrations of the beauty of God's creation. Many of the Welsh men and women who first sang those hymns recognized that, as they sang, they were in the process of making the Newtonian universe their own.

Williams's deep personal engagement with contemporary natural philosophy is evident in texts such as his essay on the aurora borealis. He wrote the essay in 1774, around a period when there had been a succession of unusually extensive and spectacular displays of the Northern Lights. He described seeing the heavens light up: 'o liw gwaed, o liw'r wawr, o liw porffor, ac o liw'r amber; holl liwiau'r enfys' ('coloured like blood, like the dawn, like purple, and like amber; all the colours of the rainbow'). It was as if the heavens were dancing: 'fel pe buasai am ddodi ofn yn y rhan euog o'r byd; ond creu llawenydd anhraethadwy a gogoneddus yn etifeddiion bywyd tragwyddol' (as if to terrify the guilty of the world, but to create unspeakable and wonderful delight for the inheritors of eternal life').¹⁶ He ran through the philosophers' explanations in detail, demonstrating his intimate familiarity with the latest ideas about electricity and the ether. None of the explanations were complete enough for him, though, because they failed to account for the aurora's significance and divine purpose. Whatever the mechanism, the aurora had been put in the heavens by God as a portent of the great religious revival and reformation that was taking place. The aurora blazing in the sky was there to reassure Williams and his co-religionists in Wales's growing Methodist movement that God was on their side and that their success was assured. In other words, it was a reminder of just how central to the world's affairs and God's creation they really were.

Assimilation and distinction

Discussing natural philosophers' accounts of the origins of the aurora, Williams pointed to arguments that it was the 'gelfyddyd newydd o *electricity*' ('the new craft of *electricity*') that best explained the phenomena.¹⁷ Vocabulary is significant here – and what is particularly revealing is actually vocabulary's absence. Electricity in contemporary Welsh is *trydan*

¹⁵ Hughes, *Gweithiau*, op. cit. (13), vol. 1, pp. 45, 46.

¹⁶ Hughes, *Gweithiau*, op. cit. (13), vol. 2, p. 163.

¹⁷ Hughes, *Gweithiau*, op. cit. (13), vol. 2, p. 164.

(and philosophy is *athroniaeth* rather than *ffilosoffyddiaeth*, for that matter). The term *trydan*, along with many others, was coined during the nineteenth century, and brought into usage through dictionaries such as Daniel Silvan Evans's *English and Welsh Dictionary*.¹⁸ For 'electricity', for example, he offered *trydan*, *trydaniaeth* and *lluchiasaeth*.¹⁹ Evans, himself an Anglican curate trained at St David's College, and later professor of Welsh at University College, Aberystwyth, also authored popular scientific books such as *Elfennau Gallofyddiaeth* (Elements of Mechanics) and *Elfennau Seryddiaeth* (Elements of Astronomy). His efforts can be understood as part of a concerted attempt to create a distinctively Welsh scientific culture.²⁰ That, too, can be understood as part of a wider campaign to reform Welsh national culture – a campaign that led to the reform of the National Eisteddfod, for example.²¹ From one perspective, Evans and his peers might be regarded as conduits, bringing the Victorian cult of progress to a new audience on the periphery of empire. From another, however, they were actively engaged in forging a distinctively Welsh progressive culture from this material. They might actually have been engaged in doing both. A similar point might be made about the university colleges established across Wales during the final decades of the century – the first in Aberystwyth in 1872. It is worth noting that chairs in the sciences were established at the colleges from their very beginnings.

Building institutions of science in Wales, however, long pre-dated the establishment of its universities. As throughout nineteenth-century Britain, scientific societies, large and small, both local and more ambitious in their scope, were flourishing. In 1835, for example, the Neath Museum and Society for Promoting the Arts & Sciences was established, aiming at 'the intellectual and moral improvement of those around them'.²² Just a few months later, the Swansea Scientific & Literary Institution was established. By the beginning of the 1840s, that establishment had transformed itself into the far more ambitious and prestigious Royal Institution of South Wales. In the meantime, the Merthyr Literary & Scientific Institution was established in 1837, followed by others in Amlwch, Cardiff and Carmarthen, amongst others. In June 1850, when a public meeting was organized in Aberystwyth to propose the establishment of 'a Philosophical, Mechanical and Mutual Improvement Society', the organizers were keen to emphasize 'the vast disadvantages under which this town laboured for lack of such an institution'.²³ The societies, particularly the ambitious Royal Institution of South Wales, speak to growing urban ambition – just as such institutions did elsewhere. But they also speak to ambitions to participate in the cult of progress as equals. For some, at least, of their promoters they were critically important mechanisms for bringing Wales out of the peripheries. It is clear – and significant – that most of these societies' proceedings were conducted in English – and it is telling to note on what occasions Welsh was used. On at least one occasion, the Merthyr Literary & Scientific Institution announced at the beginning of a lecture that, 'for the benefit of the Working Classes, a summary of the discourse will be given, at the termination, in the Welsh language'.²⁴

18 Daniel Silvan Evans, *An English and Welsh Dictionary Adapted to the Present State of Science and Literature*, 2 vols., Denbigh: Thomas Gee, 1852.

19 Evans, op. cit. (18), vol. 1, p. 584.

20 R. Elwyn Hughes, *Nid Am Un Harddwch Iaith: Rhyddiaith Gwyddoniaeth y 19eg Ganrif*, Cardiff: University of Wales Press, 1990. See also R. Elwyn Hughes, 'The Welsh language in science and technology, 1800–1914', in Geraint Jenkins (ed.), *The Welsh Language and Its Social Domains, 1801–1911*, Cardiff: University of Wales Press, 2000, pp. 405–30.

21 Hywel Teifi Edwards, *Gwyl Gwalia: Yr Eisteddfod Genedlaethol yn Oes Aur Victoria 1858–68*, Llandysul: Gomer Press, 1980.

22 *Merthyr Guardian*, 9 May 1835.

23 'Aberystwyth', *The Welshman*, 21 June 1850.

24 'Merthyr Literary & Scientific Institution', *Merthyr Guardian*, 9 December 1837.

Tensions surrounding class, politics and language permeated the self-consciously new intellectual institutions of Wales. At the founding of the Neath Museum and Society, the Tory *Merthyr Guardian* commented that it was ‘always pleasing to see men of various political opinions joining hand and heart in the noble object of the cultivation of the arts and sciences’.²⁵ For a place like Merthyr Tydfil as well, then the largest urban centre in Wales, establishing a Literary & Scientific Institution in 1837 offered a way of trying to unite a town that had been battered by serious and violent industrial unrest only a few years earlier.²⁶ Ironworks owners and their supporters, like John Josiah Guest, owner of the Dowlais Iron Company, and local solicitor William Meyrick, on the one hand, and workers who had been involved in the Merthyr riots, on the other, could unite (for a short while at least) under the banner of science. Taliesin Williams (son of the prominent antiquarian, self-proclaimed Jacobin and inventor of the Gorsedd, or Bardic Circle, Iolo Morganwg) was one of the institution’s secretaries.²⁷ The fragility of such alliances is underlined by the fact that the Merthyr Literary & Scientific Institution barely survived two years. It was dissolved at the end of a meeting on 31 August 1839 and its assets donated to establishing a Girls’ National School in the town.²⁸ Its founders would soon be found on opposite sides of Chartist barricades.

Science, culture and Wales

The BAAS’s visit to Swansea in 1848 offers a useful case study of how Wales and its marginality to the cultures of British science might be understood, as well as what this might mean for the broader study of peripheries in the history of science. That the visit took place at all demonstrates how well embedded some of Swansea’s promoters were in wider scientific networks that stretched well beyond Wales. Men such as Lewis Weston Dillwyn, owner of the Cambrian Pottery works, and his son John Dillwyn Llewelyn, or the copper magnate John Henry Vivian, and William Robert Grove, were leading fellows of the Royal Society. They had all played an important role in establishing the Royal Institution of South Wales a decade or so earlier – and the Royal Institution of South Wales itself would form a critical part of the plans to bring the BAAS to Swansea. Both as a group anxious to promote Swansea as the leading town in Wales, and as individuals keen to maintain and advance their positions on both local and national stages, these men wanted to recruit the BAAS to their cause. Laying the foundation stone of the Royal Institution of South Wales’s new building a decade or so earlier, Dillwyn had boasted that ‘if carried on with the spirit with which it has been begun, it will hasten the arrival of the time, and I apprehend that the day is not far distant when Swansea will be generally acknowledged as the Metropolis of Wales’.²⁹ For them, the BAAS visit showed that Wales – and Swansea – were close to the centre of scientific power.³⁰

But this was not the only way to read the 1848 meeting. The Marquis of Northampton in his presidential address on the meeting’s opening day offered a quite different approach. The visit to a location so ‘remote from the metropolis, remote from the chief seats of English learning, remote also from those great highways of communication by which modern ingenuity has almost accomplished the extravagant wish of annihilating

²⁵ *Merthyr Guardian*, op. cit. (24).

²⁶ Gwyn A. Williams, *The Merthyr Rising*, Cardiff: University of Wales Press, 1998.

²⁷ For Iolo Morganwg’s wide-ranging efforts to reform and reimagine Welsh culture see Geraint Jenkins (ed.), *A Rattleskull Genius: The Many Faces of Iolo Morganwg*, Cardiff: University of Wales Press, 2009.

²⁸ ‘Merthyr Literary & Scientific Institution’, *Merthyr Guardian*, 31 August 1839.

²⁹ ‘Royal Institution of South Wales’, *The Cambrian*, 1 September 1838.

³⁰ Louise Miskell, *Intelligent Town: An Urban History of Swansea 1780–1855*, Cardiff: University of Wales Press, 2006.

space and time', was an act of condescension.³¹ The BAAS was in Swansea to instruct, rather than be instructed. The previous year's meeting had been in Oxford – a place where 'during the lapse of many centuries, science and learning have made their abode, and where religion has consecrated their union'. Swansea, by implication, was not. It was 'in a corner, as it were, of Great Britain' and 'separated from the highways of steam'.³² Grove, who had been instrumental in securing the meeting, was caricatured as having, 'like a potent magician, or like a representative of the Bard and Druid of Ancient Britain, summoned us to the shores of the Bristol Channel'.³³ Just as Shakespeare in *Henry IV, Part One* had reduced the Welsh military and political hero Owain Glyndŵr to a self-satisfied mystic, Northampton reduced the barrister, natural philosopher and leading reformer of the Royal Society to an exotic other. Thirty-two years later when the BAAS returned to Swansea and to Wales, some commentators had clearly not forgotten the president's disdain for the occasion, noting that Northampton 'did not regard Swansea with a favourable eye when comparing the old town with the gothic towers of Oxford, in which the conference took place the year before'.³⁴

Northampton's dismissal of Swansea – and of Wales – makes it clear that, for some metropolitans, this country's only role was to provide the resources from which others could generate scientific knowledge. Wales played a key role during the first half of the nineteenth century in the working out of geological controversy, for example. It was the Welsh landscape that provided much of the ammunition for the fierce debates between Adam Sedgewick, Roderick Impey Murchison and Henry de la Beche about the order of geological strata.³⁵ Wales was a sufficiently important site for geology that de la Beche, as director of the Geological Survey, was based for several years in Swansea. Both Charles Darwin and Alfred Russel Wallace in different ways gained practical experience of geologizing and surveying in Wales. The Welsh population provided much of the raw material for John Beddow's *The Races of Britain* (1885) – an early version of it was, in fact, presented for an essay prize at the National Eisteddfod in 1867.³⁶ Scientific work like this embodied a view of peripheral places like Wales as a kind of scientific *terra nullius*. The landscape and its population were there to provide material for others to work with, not to themselves be active in knowledge production.

But at the same time, there was clearly a growing market for science in Welsh, producing a stream of popular science and natural philosophy that remains underexplored by historians. Throughout the century there was a steady flow of natural-theological texts translated into Welsh, for example. William Paley's *Natural Theology* (1802) was translated by Hugh Jones as *Duwinyddiaeth Naturiol, neu yr Amlygiadau o Dduw mewn Natur*. Similarly, Thomas Chalmers's *A Series of Discourses on the Christian Revelation, Viewed in Connection with the Modern Astronomy* (1817) was translated as *Pregethau Seryddol, neu Gyfres o Bregethau ar Grefydd Ddatguddiedig yn ei Chysylltiad a Seryddiaeth Ddiweddar* by Griffith Parry in 1846, and Thomas Dick's *The Christian Philosopher* (1823) as *Yr Anianydd Cristionogol, neu Gysylltiad Gwyddoniaeth ac Athroniaeth a Chrefydd* by Thomas Levi in 1860. There was also a significant number of scientific books written directly in Welsh, such as Edward Mills's *Y Darluniadur Anianyddol* (1850) and A.W. Jarvis's *Penwyddeg a Mesmeriaeth* (1854). All of this speaks to a

31 'Presidential Address', *Report of the British Association for the Advancement of Science* (1848) 18, pp. xxxi–xxxix, xxxi.

32 'Presidential Address', op. cit. (31), p. xxxi.

33 'Presidential Address', op. cit. (31), p. xxxiii.

34 'British Association at Swansea', *Western Mail*, 24 August 1880, p. 3.

35 James Secord, *Controversy in Victorian Geology: The Cambrian-Silurian Dispute*, Princeton, NJ: Princeton University Press, 1986.

36 John Beddow, *The Races of Britain*, new edn with intro. by David Allen, London: Hutchinson, 1971; first published 1885.

Welsh market for scientific works as well as a pool of expertise capable of writing and translating such texts. As with the proliferation of scientific societies, Welsh scientific writing – and there was scientific writing in the prolific Welsh periodical press as well – can be understood both as attempts to make Wales part of a broader scientific culture and as an attempt to generate an autonomous scientific culture in Wales. The Welsh case raises questions about translation and adaptation that historians of other peripheries might usefully explore when considering the role of popular science, and the role played by understandings of science in popular culture.

The matter of Wales

However the place of science in Welsh culture is understood, it is clear, at least, that there is history here. It is easy to point to a succession of figures with Welsh connections who have made significant contributions to the scientific canon, from Robert Recorde, John Dee and Edward Lhuyd, to Edward Bowen, Evan James Williams and John Meurig Thomas. Welsh scientific culture could provide opportunities for individual advancement in a variety of ways. William Robert Grove's Swansea upbringing clearly played an important role in his early development as a natural philosopher. The town's thriving scientific culture and his connections to men such as Lewis Weston Dillwyn and John Henry Vivian, who were fellows of the Royal Society with access to important scientific networks, certainly helped Grove establish himself on the metropolitan scene.³⁷ Another example is Benjamin Davies. Born in Llangynllo in Cardiganshire in 1863, the 'extraordinarily clever boy' was recommended to Oliver Lodge by his uncle, Rhys Jones, who had been a fellow student of Lodge's at the London University. He became Lodge's laboratory assistant at Liverpool and assisted him in his key experimental work on the ether. When Lodge moved to Birmingham, he took Davies with him. Davies eventually left to become one of the Eastern Telegraph Company's electrical researchers and ended his career as head of their research department. John Jones from Bangor in north Wales offers another example of a self-made Welsh enthusiast for science. Like Davies, he had no formal training, teaching himself Greek and astronomy, building his own telescopes, and even coming to the attention of Samuel Smiles, author of *Self Help*.³⁸ What might these careers tell us about how protagonists in other peripheries fashioned themselves? Were the two Mumbai shipwrights, Hirjeebhoy Merwanjee and Jehanger Nowrojee, for example, engaged in the same sort of strategy of moving from periphery to centre and back again when they visited London in the late 1830s?³⁹

As the examples discussed already suggest, science occupied a prominent place in Welsh intellectual culture throughout the eighteenth and nineteenth centuries. In view of this, the degree to which science has not just been treated as largely peripheral, but has been actively written out of Welsh history in the twentieth century, itself bears investigating.⁴⁰ It contrasts sharply with Scotland, for example, which was clearly understood to be a place where science belonged. In this context, it is worth noting that Scotland's universities were founded in the fifteenth century: it was another four hundred years before Wales acquired its own independent institutions of higher education. Trinity College Dublin might have been established in the late sixteenth century, but the

³⁷ Iwan Rhys Morus, *William Robert Grove: Victorian Gentleman of Science*, Cardiff: University of Wales Press, 2017.

³⁸ J. Silas Evans, *Seryddiaeth a Seryddwyr*, Cardiff: William Lewis, 1923. This book is itself an example of the continuation of the Victorian tradition of popular science in Welsh into the early twentieth century.

³⁹ Jehanger Nowrojee and Hirjeebhoy Merwanjee, *Journal of a Residence of Two Years and a Half in Great Britain*, London: W.H. Allen & Co., 1841.

⁴⁰ Iwan Rhys Morus, 'On science in a small country', *Physics Today* (2018) 71, 42–8.

perceived associations of Ireland's scientific culture with the Ascendancy meant that there was little interest in making science part of the post-independence national narrative. Science belonged to another culture – and an aggressive, invasive culture at that. It is tempting to speculate whether something similar took place in early twentieth-century attempts to redefine Welsh history and culture as distinct and separate. If so, then that raises interesting questions about science's historical peripheralities in Wales and Welsh culture, which could well apply to other peripheries.

Looking at science's place in Welsh history can also offer interesting counternarratives to the ways we think about the circulation and ownership of scientific knowledge. When we think about the ways in which science is generated and moves around, it remains difficult to move away from that Latourian model of centres of calculation, or from models of diffusion. In these kinds of models, as with Northampton's BAAS presidential address, peripheries tend to be seen either in terms of resources for the centre, or as recipients of knowledge flowing out from the centre.⁴¹ Wales offers a more complex perspective on peripheral knowledge. For William Williams, the Newtonian philosophy he adopted and adapted in *Golwg ar Deyrnas Crist*, for example, was a tool for making Wales a centre of religious enlightenment. Swansea, with its aspirations to become the 'Metropolis of Wales', was a space both central and peripheral to different actors at different times. For Northampton, it was a place on the edge of both Britain and the culture of science. For Grove, the place shifted between centre and periphery at different points in his career. Science could provide tools that might be used both to assimilate Wales into the imperial centre and to construct an autonomous Welsh intellectual culture. It could be successively central and peripheral itself to such projects.

As a space both peripheral and proximal to centres of imperial power, Wales was a useful site for the demonstration of technological ambition and bravura. Take the example of Thomas Telford's Pontcysyllte aqueduct, built over the Dee valley near Llangollen to carry the Ellesmere Canal across the river. Built of brick and cast iron it was an entirely deliberate evocation of imperial Rome on the part of its builders. As Telford himself put it, Pontcysyllte

added a striking feature to the beautiful vale of Llangollen, where formerly was the fastness of Owen Glendower, but which, now cleared of its entangled woods contains a useful line of intercourse between England and Ireland; and the water drawn from the once sacred Devon furnishes the means of distributing prosperity over the adjacent land of the Saxons.⁴²

He could have said much the same of his other masterpiece, the Menai suspension bridge, the largest in the world, with its sixteen huge chains bearing the road across the strait a hundred feet above the water. Both were conduits that linked Dublin with London, reducing Wales to mere scenery. Telford meant constructions like these to be deliberately hyperbolic. A commentator remarked that 'the Menai Bridge appeared more like the work of some great magician than the mere result of man's skill and industry'.⁴³ They were a way of marking a Welsh landscape that was both peripheral and vital to imperial concerns. Again, as with Northampton's contemptuous dismissal of Grove, the implication that advanced technological structures in Wales were to be attributed to magic rather than the skills and labour of its people is a striking one. It bears comparison to similar

⁴¹ Kapil Raj, *Relocating Modern Science: Circulation and Construction of Knowledge in South Asia and Europe, 1650–1900*, London: Palgrave Macmillan, 2007.

⁴² Quoted in Samuel Smiles, *The Life of Thomas Telford, Civil Engineer*, London: John Murray, 1867, p. 162.

⁴³ Smiles, op. cit. (42), p. 278.

Victorian discussions of the superiority of their technologies over the ‘feats of pretended magic and the wildest fictions of the East’.⁴⁴

The career of the self-described *hogyn o'r dre* (boy from the town) William Henry Preece offers another pertinent example of how Wales might oscillate between centre and periphery. Born in Caernarfon in 1834, when Preece returned there in 1899 to receive the freedom of the borough he did so as the man who had been ‘at the head of the telegraphic system of the Empire for a large number of years, and had brought it to its present efficient state’.⁴⁵ Just as Nikola Tesla could move with comparative seamlessness from Smiljan, on the furthest fringes of the Austrian Empire, to Paris and New York, so could the schoolboy who had ‘acquired his first ideas of electricity’ in Caernarfon move from the peripheries to the centres of British technological and scientific power with comparative ease. There were connecting networks that made it possible.⁴⁶ The enthusiasm with which the town greeted his success suggests how they saw their place too. Taking advantage of the particularities of Welsh geography, Preece transformed his native landscape into a centre for experiments in wireless telegraphy. During the early 1890s he carried out experiments on the Conway and Dee estuaries, and between Flat Holm in the Bristol Channel and Lavernock on the south Wales mainland. A few years later in 1897 he helped Guglielmo Marconi carry out his own wireless experiments at the same site. In 1913 Marconi established an experimental wireless station at Waunfawr, near Preece’s native Caernarfon.⁴⁷

Through experiments such as these, the peripheral Welsh landscape could become central to late Victorian imperial enterprise. They were not the only such experiments. When, in 1783, Thomas Johnes started developing the Hafod Uchtryd estate in Cwm Ystwyth he was intent on using the site as an experiment in the use of marginally productive land.⁴⁸ To do so he drew on his connections to Joseph Banks and his learned empire.⁴⁹ Banks, as president of the Royal Society with close links to court and Admiralty, controlled substantial resources to which, through Banks, a protégé like Johnes had access. Hafod under Johnes was a node in a globe-spanning network of horticultural and botanical experiment that stretched from Tahiti to the Caribbean, with its centre in Kew Gardens. Two centuries later, the Pwllpeiran Uplands Research Centre occupies part of the former Hafod estate. It too is a site where global and local knowledge systems collide and entangle. Peripheral knowledge developed on the peripheries was and is a vital element in making these places productive. Marconi’s experiments on Flat Holm and later at Waunfawr were entirely contingent on local knowledge too. As well as being sites where knowledge was generated for centres of calculation, places like these were also sites where peripheries could claim ownership of their own expertise.

What these examples suggest is that looking at Welsh science and its relation to place can offer some useful strategies for better understanding knowledge on the peripheries more generally. In the Welsh case, both the presence and the apparent absence of

44 William James Copleston, *Memoir of Edward Copleston, D.D., Bishop of Llandaff*, London: John W. Parker and Son, 1851, p. 169.

45 ‘Honouring Sir W.H. Preece’, *Carnarvon and Denbigh Herald*, 22 September 1899, p. 5. See E.C. Baker, *Sir William Preece FRS: Victorian Engineer Extraordinary*, London: Hutchinson, 1976.

46 W. Bernard Carlson, *Tesla: Inventor of the Electrical Age*, Princeton, NJ: Princeton University Press, 2013; Iwan Rhys Morus, *Nikola Tesla and the Electrical Future*, London: Icon Books, 2019.

47 Hari Williams, *Marconi and His Wireless Stations in Wales*, Llanrwst: Gwasg Carreg Gwalch, 1999.

48 Elizabeth Inglis-Jones, *Peacocks in Paradise*, London: Faber & Faber, 1950.

49 David Phillip Miller, ‘Joseph Banks, empire, and centres of calculation in late Hanoverian London’, in David Phillip Miller and Peter Hanns Reill (eds.), *Visions of Empire: Voyages, Botany, and Representations of Nature*, Cambridge: Cambridge University Press, 1996, pp. 21–36; John Gascoigne, *Joseph Banks and the English Enlightenment: Useful Knowledge and Polite Culture*, Cambridge: Cambridge University Press, 2008.

scientific culture in Welsh histories is revealing of the ways in which science was (and is) understood and refashioned in particular places. Attempts to forge a distinctively Welsh scientific culture through vocabulary, for instance, suggest the labour required to make science salient away from the centre. The disappearance of science from dominant Welsh national narratives during the twentieth century is suggestive of how the cultural politics of science might be understood from the outside. Thinking about the contested status of science in peripheral places can also offer ways of addressing the saliency of the history of science now. The Welsh example shows that science did not simply flow effortlessly from centre to periphery. It was imported, refashioned and replanted to make it fit into new landscapes. There was much enthusiasm for electrification in Welsh towns at the end of the nineteenth century, for example, as a way of demonstrating that the electrical future belonged to Wales as much as to anywhere. The enthusiasm was accompanied, though, by an awareness that this shared electrical future needed to be adapted to make it fit for the periphery. What the Welsh example suggests is that looking at science from the periphery offers a good way of decentring our view of where science belongs and where it is going.

Welsh science from the eighteenth century onwards was about similarity and difference. Both science's prominence and its marginality in Welsh history raise questions about what kinds of scientific identities are seen as properly legitimate – where science is seen to belong, and to whom. It is striking that even so close to the centres of power science can seem out of place. In that sense, Wales was on the margin in more senses than the spatial. Welsh participants in science – practitioners and audiences – clearly found ways to make science central to their affairs. Engagement in science could be a powerful signal of belonging to a larger imperial polity. It could also be a way of expressing a different kind of identity. In Wales, science could be moulded to the contours of another cultural landscape. Welsh practitioners and audiences could appropriate what they needed from science for their own purposes. In a broader post-colonial context, it is that dialectic between assimilation and appropriation that makes it both interesting and important for historians of science to look again at science in Wales.

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