INTRODUCTION: A BIOGRAPHY OF A SCIENTIFIC REGION

> One important meaning of the scientific ideal is an aspiration to escape the bounds of locality and culture.[1]

There has emerged over recent years a significant corpus of literature that has demonstrated the profoundly spatial nature of the scientific enterprise.[2] Opposed to the general perception that science is placeless (a sentiment summarized by Porter, above), this work has sought to expose science as something utterly grounded in its social and spatial, not to mention temporal, political and economic contexts. In doing so, it has also engaged with the elevated epistemological position science has fashioned for itself, by suggesting that it should be treated like any other form of knowledge: that is, as 'a cultural formation, embedded in wider networks of social relations and political power, and *shaped by the local environments* in which its practitioners carry out their tasks'.[3] Developing this argument further, Livingstone notes that scientific knowledge is made in many different places and asks:

> Does it matter where? Can the location of scientific endeavour make any difference to the conduct of science? And even more important, can it affect the content of science? In my view the answer to these questions is yes.[4]

Livingstone's viewpoint is shared by others. Commentators have pointed out a host of geographies that run through science, including those of site, place, space and region; network, trace, travel and movement; and survey, map, cartography, nation, territory and border.[5]

There have admittedly been some reservations expressed about this approach to the study of science. For instance, Shapin takes issue with the tendency as he sees it to treat geography as a 'factor' – in similar manner to cultural values, gender or national identity say – that can come into play to influence the development of science.[6] Rather than something that *might* influence the progress of scientific knowledge, Shapin asserts that space *must always* be a 'necessary condition for there to be such a thing as science'. In other words, geography,

'like temporality or embodiment' is a necessary prerequisite for science to even take place at all. To claim then that science has a geography is perhaps obvious and unexceptional. 'Where else could science take place but in places' queries Shapin, 'and how else could it travel but across spaces?'[7]

Shapin's observation is far from a dismissal of a historical geography of science. While he asserts that geography should be viewed as ubiquitous to life in general and science in particular, he also argues that it is entirely possible to apprehend science from a geographical perspective. Demonstrating that science can be understood geographically should therefore not be viewed as an end in itself, but as the basis upon which rich stories can be built. A historical geography of science is a partial perspective on science but is nonetheless one that can shed light on certain aspects of its lifeworld. The next section will consider recent scholarship in turn, beginning with studies that have concentrated on the places of science, before moving on to studies of the movement of science, and then the cartographies of science.

Placing Science

'Place' as a term would seem simple to define. In fact, its simplicity is deceptive and has actually preoccupied geographers for a number of years now.[8] If, for the benefit of this book, we use it to refer most straightforwardly to a 'local setting' or a 'circumscribed locality', and then consider it in terms only of scientific activities, we find that it can still refer to an almost unimaginable number of examples.[9] There are places in which scientific knowledge is produced, such as laboratories and scientific institutions, palaces and academies. There are places where scientific information is collected, such as observatories and field stations; the vast array of habitats that contain things worthy of observation; not to mention the human body itself, which as Humboldt famously showed, is a good receptor of natural processes. There are also places where scientific information is reorganized, disseminated and received, like museums, exhibitions, lecture halls, classrooms, coffeehouses and drawing rooms.[10]

The study of science at its most local and intimate has been justified in a number of ways. For instance, Withers has argued that 'only in local context could one see how far the nature of science was consequential upon the social relations at work there, and not elsewhere – or anywhere else'.[11] Shapin's landmark study of the experimental work of the Royal Society of London does just this, where he shows that access to and participation in its experiments 'was achieved in a highly informal manner, through the tacit system of recognition, rights, and expectations that operated in the wider society of gentlemen'.[12]

The study of science in place also presents us with the opportunity to recover the actions and voices of those otherwise only faintly recorded in, lost to or even

excised from the historical record. Taking inspiration from work in postcolonial studies, historians and geographers of science have inquired into localities such as public houses, provincial scientific societies, fieldsites, drawing rooms, and even the laboratories of the famous, only to find a supporting cast of actors whose scientific abilities and influence were often far beyond their social standing – think for instance of the artisanal botanists in the northwest of England; the women involved in running astrophysical observatories; the silent technicians who ran the experiments at the Royal Society of London, or colonial collectors who supplied Kew Gardens with many of its plant specimens.[13] In a similar vein, such geographically fine-grained analysis helps us to gain a better appreciation of the otherwise mute audiences for science – those who listened to lectures, attended exhibitions and visited museums, for instance. By paying attention to the history of a particular exhibition, a particular museum, or to the way an idea or a book was received in a particular place, we can often in turn pick out responses to those events that would otherwise be drowned out in more general historical surveys.[14]

Studying science in place doesn't just track from the former to the latter of course. It is not always the case that science only exerts its influence onto place; places also affect science and how it is received. As work on the reception of Darwinism has shown, some places accept scientific ideas and others reject them, and for a complex set of reasons, from politics to religion to imperialism.[15] Science can also find itself part of the way in which place identities are constructed and contested, while places can also have a strong pull on a scientist's work. As De Bont notes, place 'plays a role in *orienting* the scientist towards a particular type of research and to a particular use of the spaces at his disposal', such that they 'can be "led" in various directions depending on the "ecologies" in which they work'.[16]

To borrow a term from Pearson it is probably fair to note that many historical geographers have, in their obsession with place, become 'enthralled by the "lure of the local"'.[17] This is certainly not peculiar to historical geography. Secord has argued that microhistory, modelled on the anthropological notion of 'thick description', has become the foundation of cultural history and to work in the history of science in particular. Although not antithetical to this, Secord does warn that the localization of culture has a tendency to become an end in itself rather than a method of analysis – in other words, that demonstrating the local-ness of things is seen as a reasonable outcome of research rather than a historiographical position that undergirds it. The result? For Secord at least, 'that we end up with a rich array of research that somehow adds up to less than the sum of its parts'.[18] In support of this, Harris has suggested that microhistories run the risk of being unacquainted with scientific practices that extended beyond the laboratory, court, or academy.[19]

While the spectre of parochialism surely haunts some work, geographers and historians have been careful to assert that studies of circumscribed localities, or indeed of individual events, can provide 'a different way of investigating the 'big questions' surrounding process and structures'.[20] Put differently, but with a similar point in mind, Finnegan argues that the 'the local and regional are not fixed points or bounded territories but rather instantiations of wider networks and flows'; while Driver and Samuel suggest that we treat places as 'not so much singular points as constellations, the product of all sorts of social relations which cut across particular locations in a multiplicity of ways'.[21] Any good historical geography of science should therefore assume that place can only be satisfactorily understood in the context of much wider forces acting upon and through it – social forces, but also economic, political, and cultural ones too. Even the most fine-grained of historical geographies should also remember that places function – indeed are actively constituted – in relation to many other places.

Geographies of Movement

The consideration of place within a broader spatial economy is important for the simple reason that things move, whether they be people, ideas or objects. This point is particularly relevant to the study of science; an enterprise that has staked its very credibility on its ability to reach across space and ultimately to be universal in its extent. As Barry has put it, the 'power of a scientific argument or a measurement is not determined by its truth, but rather judged in terms of its capacity to act across space and time – to mobilize a network of social and technical actors'.[22] This is not to say that science labours to project itself as some sort of 'ordered totality' over society and space; it operates rather 'in terms of more localized entities' where the aim is to reproduce itself across these myriad points in its network.[23] In other words, science extends itself out from a single point by replicating itself in other places. The success of science depends entirely on its ability to ensure that procedures and findings from one place can be produced elsewhere. This is of course much less simple than it sounds and requires no less than the establishment of precision, the replication of instrumentation, the regulation of techniques of observation, and the standardization of measurement and experimentation. In turn, the information that instruments help collect has to be performed in an accepted, standardized form, so that one data set can be compared to another from another locality; so that, in short, knowledge can circulate more freely. Barry argues that 'effective long-distance communication required both measurement of the properties of objects, and the management and training of operatives and engineers who could be relied upon to carry out their work at a long distance from the centre'.[24]

Excellent empirical studies have been conducted into the interconnection of otherwise separate spaces of science. There have been a good number on the standardization of instruments and their dissemination out to myriad observation points. Golinski, for instance, traces the development of instruments from objects of investigation in themselves to tools that can be taken for granted and 'employed together with other instruments in complex systems that configure objects so as to make them available for observation and manipulation'.[25] Others have considered the reorganization of information such that it can be moved easily from site to site. Porter, for instance, points to the significance of quantification as key to the movement of knowledge, as it 'promotes the fixing of conventions, the creation of stable entities that can be deployed across great distances'.[26] Meanwhile, Schaffer has studied the invention of the metrological tradition in the immediate aftermath of the Napoleonic Wars – the 'construction of reliable common standards of measurement' that were 'supposed to allow science more effortlessly to escape the trammels of interest and judgement'.[27] Of course even metrology – perhaps the ultimate example of the attempt to create universal values – was not removed from local circumstance. Schaffer notes that 'the issue of place was crucial' in the determination of metrological standards.[28] Where was the best location for a standards site? Where should standards trials be performed? How should standards be carried out into the wider world? How should society deal with the co-presence of contradictory standards, as was the case with the British imperial yard and the French republican metre? And what about dealing with the inadvertent destruction of standards? Questions such as these effectively highlight the very local nature of measurement, a factor most obvious when things go awry. Indeed, it is often when things don't work as they should that we can see the operations of science most clearly – as a form of local craft knowledge that works by persuading other people in other places to organize their practices in an identical fashion. As Livingstone so succinctly puts it: 'What looks like the universalism of science – its seemingly problem-free transferability from one arena to another – turns out to have much to do with the replicating, standardizing, or customizing of local procedure'.[29]

Science's project to replicate itself across space doesn't just have to consider the transplantation of the tools of its trade – the instruments, infrastructure, technicians, and so on – but also the audiences for its work. Scientific ideas have to be disseminated, either orally, visually or textually. Just like everything else, audiences have geographies too and it matters where ideas are received. Where a book is read or where a talk is heard, for instance, will have profound implications for how it is understood. In his analysis of the anonymous publication and reception of the controversial and sensational *Vestiges of the Natural History of Creation*, Secord notes that reading and the culture of print were central to civic identity for most towns of any size in Victorian Britain, and that the burgeoning

railway network moved books, periodicals and newspapers out from centres of publication to the provinces in a matter of hours. However, Secord also argues that the reception of these texts was resolutely local and not simply the case of a metropolitan view being imposed upon and taken up by provincial audiences. For instance, 'It took just six hours for books to reach Liverpool from London by train, but they were read differently when they arrived; in the case of an anonymous work, even the suspected author could change'.[30] A similar point has also been made for the audiences of the many scientific lectures and exhibitions that were available across nineteenth century Britain: Morus has argued that what mattered for an audience's appreciation of science and its epistemological status was 'quite literally the geographic (and therefore cultural) locations of the places where they took place'.[31] What was a quite reasonable claim in one place was quite literally unthinkable in another.

Cartographies of Science

The majority of studies into science's geographies are preoccupied with the material sites in which scientific knowledge has been made, moved and received. However, it is also possible to consider scientific ideas themselves from a geographical perspective. How, for instance, do particular scientific ideas embody different spatial preconceptions? How has science produced particular understandings of space as a quantity found in nature? How have particular spaces and spatialities impacted upon the formulation of scientific theories?

The case of Enlightenment naturalist Alexander von Humboldt offers a good illustration of the pertinence of some of these questions. Humboldt has become famous for his emphasis on both empirical measurement and the generation of universal laws of nature. In particular he was a strong advocate for the use of mapping technologies to bring out natural commonalities. To facilitate his investigations Humboldt pioneered the isoline technique of cartography, enclosing and joining areas of equal value, whether pertaining to barometric pressure, temperature or vegetation type.[32] These lines were the product of averaging and interpolation; the drawing of which 'constituted an act of faith in both the physical "co-operation of forces" and in the emergence of global order out of local averages'.[33] As such, isolines and the notion of equilibrium they supported 'prescribed a particular organization and dynamic of science'.[34] In other words, isolines – a technology with a geographical end itself – carried within themselves rules for the progress of Humboldt's scientific agenda.

Not only did Humboldt's scientific practices embody spatial presuppositions, they also helped observers to consider the world through a geographical lens. Camerini makes an associative point in her analysis of the role of maps in debates over evolution and biogeography in the mid-nineteenth century. She

notes that in their struggles to demonstrate the existence of faunal provinces, Charles Darwin and Alfred Wallace made use of maps as mental tools as well as representational devices. 'Darwin', Camerini claims, 'employed the idea of regions as a conceptual scaffolding for a complex combination of geological, biological, and geographical phenomena', while for Wallace, 'the map, a pictorial metaphor, served as a unifying framework for disparate information about insect, bird, and mammalian forms in their respective locations'.[35]

Wallace became famous for depicting and dividing the Asian and Australian biotas with a single line that became known as 'Wallace's line'. Here he followed a trend to employ mapping techniques as tools in debates about the origins and distribution of animal and plant life. By Wallace's day, a whole range of geographical terms were available to the naturalist: 'new terms, such as *isotherms, life zones, plant community, vegetation assemblage,* and *species range*, gave additional evidence of the increasing role of map-based concepts in the study of geographical distribution'.[36] Other terms were borrowed from geo-political and political-arithmetic thinking: animal and plant units existed as 'nations', 'states', 'provinces' and 'kingdoms', occupied 'stations' and 'outposts' and could even be 'natives' or 'colonists'. 'This was', Browne notes, 'the muscular language of expansionist power'.[37] As such then, whilst nineteenth-century naturalists claimed to identify distinct geographies in the chaos of nature, so too did they impose their own political geographical preoccupations on the natural world. In other instances naturalists blurred the natural and the political by following political boundaries in the formation of regional units for the mapping of nature. In turn, geologists routinely used maps to show the geographies of stratigraphy, but in doing so also laid claim to their own intellectual territories.

Regionalizing Science

It has been demonstrated here that science has a diversity of historical geographies – whether they be tangible places like a museum, or spaces that are acts of the imagination, such as those we find on a map. Clearly there is also now enough evidence to support the claim that a historical-geographical approach to the study of science has some significant historiographical benefits. The final section of this introduction will relate this general discussion more fully to the theme of this book in particular.

The geographical focus of this book is on Cornwall, the most south-westerly county of England (Figure I.1). In line with earlier comments, much of the analysis in the following chapters will be concerned with the myriad places in which Cornish science was practised – its scientific museums, lecture halls, exhibitions, observatories, gardens and fieldsites. The book will also trace out the

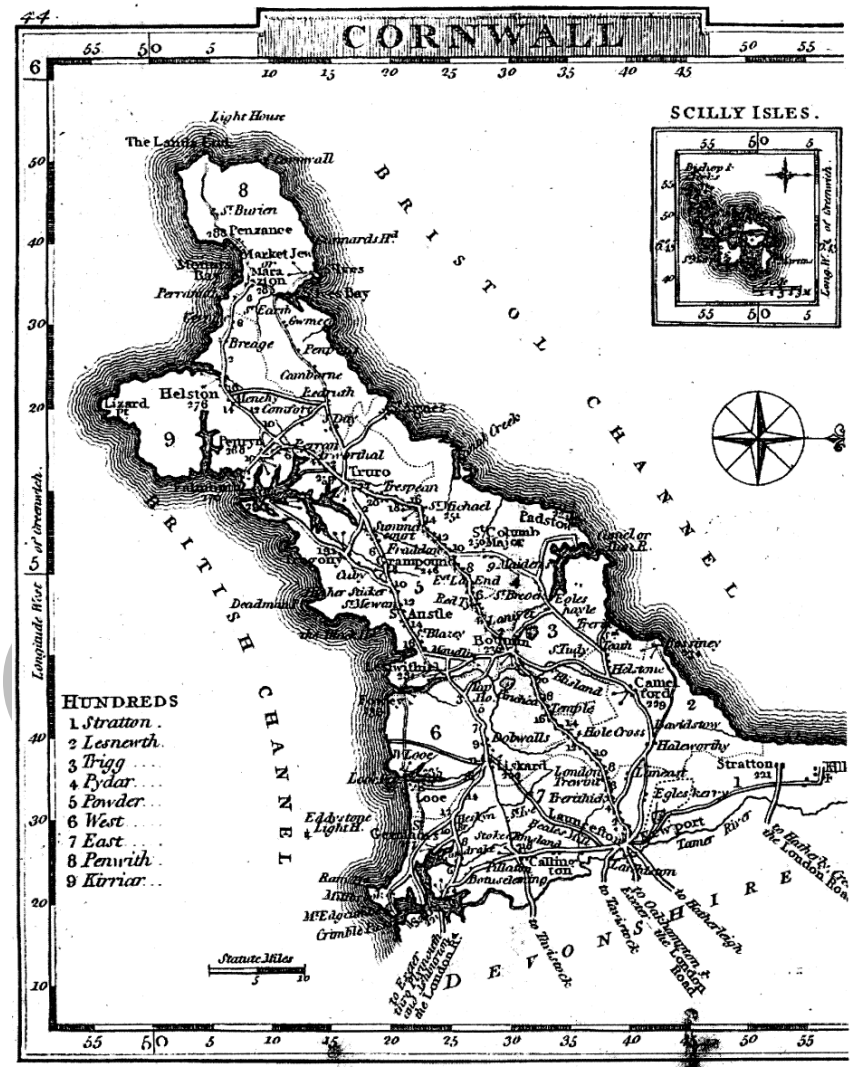

Figure I.1. Map of Cornwall. From Cooke's 1829 *A Topographical and Statistical Description of the County of Cornwall.*

complex relations between those places and others beyond the county boundary – it will ask how arguments and ideas, instruments and regulations, people and personalities moved from institutions beyond Cornwall, and helped promote, and sometimes retard, scientific conduct within the county. Traffic in the other direction will also be central to the discussion.

Cornwall is not treated here simply as a container for a diverse array of sites in which science was conducted; the region itself is the object of analysis too. Choosing to focus on this geographical scale is no accident. Indeed, in doing so this volume will address a lacuna in studies of the historical geographies of science. As Secord and Harris have already told us, there is a preponderance of studies that focus on the micro-scale. There are also those studies that consider science at a general epistemological level – what we might refer to as the global or meso-scale. Studies that operate at the intermediate scales of the region or nation are much less common (even if many are framed in terms of the latter – think of the frequency with which terms such as 'English science' or the 'Scottish Enlightenment' are uncritically invoked).[38] As Finnegan warns us, 'concentrating on the movement between the local and the global may miss the ways in which science becomes entangled with national concerns or regional identities'.[39]

In his own book-length support for historical geographies of science, Livingstone notes that all sorts of processes operate at the regional level: particular technical and theoretical innovations are variously promoted and impeded; warrant and trustworthiness are understood and achieved in different ways; and scientific knowledge is appropriated according to particular senses of self-understanding and put to different uses. Asking 'Just how regional and subregional factors have conditioned the production and consumption of scientific knowledge, the way it was received in different places, and how science has expressed or channelled local loyalties', therefore become vital questions when we choose to consider the region as the locus of our investigations.[40] This is not to say that the region should be treated as a stable, fixed and immutable context in which science happens; rather, following Finnegan, it is an approach 'that analyses rather than assumes the boundaries and character of different regional spaces'.[41] In other words, it asks how scientific practices and representations actively articulated the region as an object of study, and continued to shape and re-shape it in response to changing theories and agendas. Figure I.1, taken from an 1829 guidebook to Cornwall, is an appropriate map to support this section and this point, given the way that it consciously defamiliarized the region's geography by turning Cornwall 90 degrees out of its usual orientation.[42]

This approach to the region takes seriously the terms within which individuals and institutions operated in nineteenth-century Britain, and the things that they valued. As this study will show, the region was a very meaningful entity for many, even if such loyalty was often sniffed at by metropolitan actors. The

county in particular had long-running historical, political and cultural significance, which inflected everything from industry to ideas; from politics to religion. Counties also had an everyday significance to the lives of their inhabitants, defining boundaries big enough for entire lives to be lived out in, but where journeys from one edge to another could be made in a day or so. If we really want to deepen our understanding of what science meant to its nineteenth-century practitioners across Britain then it is critical that we pay attention to the geographical (and hence social and cultural) contexts that were meaningful to them, rather than only to the contexts that metropolitan savants asserted were important, or, even worse, to those contexts that are most significant to us now.

We might justify the study of science in Cornwall in particular on the basis that it allows us to reflect more generally on the role of the region in the history of science – that it can, in other words, act as a useful case-study for other processes going on elsewhere. It is, after all, the most well-defined and easily delimited of all the English counties, with only one administrative border (with Devon). However, this study can hopefully also be justified on a more singular basis. As this book will show, Cornwall had a very significant impact on the fortunes of science in nineteenth-century Britain. It produced important scientific figures like William Borlase, John Stackhouse, Humphrey Davy, Davies Gilbert, and John Couch Adams. It established some of the earliest scientific societies in Britain; it entertained some of the most prominent scientific luminaries of the age, who came to conduct fieldwork and to speak at Cornish societies. Cornwall was also an important centre of Britain's industrial revolution and a centre of mechanical innovation, particularly in relation to mining. Lastly, the county played host to a diverse array of plants and animals, due to its extensive coastline and mild climate; was covered in well-preserved prehistoric monuments; had some unusual, not to mention economically valuable, geological features; and was often the first place on mainland Britain to experience the prevailing weather that rolled in off the Atlantic. This book provides a history of their study. In fact it is, more than anything else, a biography of a scientific region. Like any good biography, it provides a fine-grained examination of its subject on its own terms, while assuming that it was also shaped by a set of wider processes and contexts.

A Brief Summary of Themes

The second and third chapters of this volume provide a set of historical contexts that are relevant to Chapters 3 to 7. Chapter 1 discusses the significance of the work of the Rev. William Borlase in Cornwall in the eighteenth century for that carried out in the following century; Cornwall's early industrialization and its effects on the region's economic prospects and social composition; and the way in which a burgeoning associational scientific culture in Britain was taken up

in Cornwall. Chapter 2 continues the theme and examines the historical geographies of associational science in Cornwall. It pays particular attention to the museum; the conversazione; the exhibition; and the field-excursion.

In a somewhat different manner, each of Chapters 3 to 7 are organized around one particular scientific enterprise as it was pursued in Cornwall: Geology; zoology; botany; antiquarianism; and finally meteorology. There is obviously no one way of organizing a history of science. However, an account that foregrounds scientific knowledges (rather than, say, scientific practices) allows us to see clearly the trajectories of debates in particular fields of inquiry as they were conducted in place – a vista that would otherwise be lost to us if we assumed a different viewing point. The order in which this suite of chapters has been placed is also not coincidental, moving as it does from considerations of the subterranean, to treatments of land and sea, to a contemplation of the sky. It is also appropriate that we should start with geology, given that this was the first field of inquiry in Cornwall to be institutionalized.

There are three broad sets of questions that run through this volume and all are addressed in some way in each of the individual chapters. The first asks: *What role did science play in the making of place, landscape and region in the nineteenth century?* How did particular scientific enterprises actively construct strong ideas of the region through the production of maps, the use of photography and drawings, the pursuit of geographically organized collections, and the layout of museum displays, for instance? Who were the intended audiences for these geographical presentiments and how did science cater, or not, for different constituencies? Also: what role did various material sites play in the furtherance of science in the region? And finally: How did appreciations of the role of the region change across the course of the nineteenth century? To help us answer this, Chapter 1 looks at how place and region were understood and valued in the eighteenth century, so that nineteenth-century arguments can be thrown into some relief.

The second question asks: *How did science operate in provincial Victorian society?* This is tackled in a variety of ways. Individual chapters examine the social contours of particular scientific inquiries and the roles of different social and gender groups in the formation of regional scientific cultures. How was expertise and authority achieved, not to mention undermined, in different scientific fields through negotiation with both local practitioners and those from other places, particularly the metropolis? In turn, how were practices and reputations shaped through interventions from national authorities operating far from Cornwall? In line with one of the questions posed in the previous paragraph, how did the role and significance of regional science change in relation to the wider scientific scene in Britain through the course of the nineteenth century?

The third question is: *What roles did science play in wider society in the region?* Individual chapters trace out the way particular scientific knowledges and practices were presented and put to use. They consider exactly when and where science was presumed to – and actually sometimes did – play a role in a host of enterprises. These included education; entertainment; mining and manufacturing; the improvement of soil and land; the promotion of local and regional forms of patriotism and belonging; and the promotion of landscape and artefact preservation. How in turn did these agendas shape science?

These three questions provide the framework upon which this biography of Cornwall as a scientific region is constructed. They will also enable me to support and substantiate Livingstone's contention as laid out above: that science is 'a cultural formation, embedded in wider networks of social relations and political power, and shaped by the local environments in which its practitioners carry out their tasks'. It made a difference that the scientific knowledge discussed in the following chapters was produced in Cornwall and not elsewhere, and this book shows us how.