University of Reading

The value of the Literary and Historical study of Biology to Biologists

a scoping study

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Sponsored by the
Arts and Humanities Research Council

Executive summary

The aim of this study is to establish whether and how far work on biology within the humanities – particularly history, literary criticism and critical theory – may be of value to practising biologists. The study is comprised of two main parts:

- a review of the existing literature on biology within these disciplines, particularly where it seeks to engage directly with biologists;
- a report on a workshop, attended by 30 biologists, at which the participants were introduced to different humanities approaches to biology, asked to consider how relevant and/or useful they might be to their own work, and invited to think about how biologists might work with humanities academics and/or techniques in research, teaching, museum curating and textual analysis.

The key findings of this study are:

- that there is marked interest in humanities research on biology among a sizeable group of biologists;
- that there is enthusiasm for research collaboration between the humanities and biology on both sides, that such collaboration should be on equal terms and that it would be mutually beneficial;
- that the main obstacles to such collaboration are entrenched research structures on the one hand (especially the REF) and the perception that the constructivism of the humanities amounts to a denial of the possibility of scientific objectivity on the other;
- that it would be beneficial to both biology and humanities students to be taught alongside one another in an interdisciplinary way for at least one module within their university degrees;
- with regard to specific humanities disciplines:
    - that history has practical applications for biologists, in positioning their own work in relation to earlier research and to contemporary culture values;
    - that literature can assist in reflecting on science and its values, providing an important supplement to the work of science itself, particularly aesthetically;
    - that critical and theoretical approaches to texts can help scientists to be aware of their own assumptions and to improve their own writing.

On the basis of this study, we conclude that there is real potential for the humanities to play a part in the future development of biology, and that co-disciplinary collaborations between biologists and humanities scholars in research and teaching could lay the foundations for a new, more rounded and ultimately more complete approach to the study of human beings, our fellow organisms and the environments we share with them.

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Cultivating Common Ground

Introduction

1.1 – The problem

This study is an exploration of how working scientists perceive and respond to humanities scholarship which takes science as its subject of study. Our starting point was the assumption that too little of this work gets exposure to scientists and that such exposure has the potential to be mutually beneficial. In particular, we set out with the view that the practice, teaching and communication of science could all benefit from the rounded understanding of science itself offered by the humanities. While there are prominent scientists known for their openness to the humanities, notably the late Stephen Jay Gould, there is also a common perception – famously fuelled by the hoax on the editors and readers of *Social Text* in 1996 by the physicist Alan Sokal – that the humanities refuse to admit the truth claims of science itself, and that scientists scorn the humanities in turn for this supposed postmodern scepticism. We wanted to dig below these generalizations, to see what scientists actually think of the humanities, and how receptive they are to them. Ultimately we wanted to explore the transformative potential inherent in the dialogue between science and the humanities, and to advance that dialogue in the process.

1.2 – The context: 'Science in Culture'

Key to enabling our project to go ahead was the AHRC's decision in their *Delivery Plan 2011-2015* to develop 'Science in Culture' as a research theme and to put out a call for 'exploratory awards' of the type that funded our research. Our project aims to establish a firmer basis for the kind of future 'cutting-edge inter-relationships' at which the 'Science in Culture' theme aims. One significant context which makes this a priority has been the emergence of a set of policy issues that require working scientists to engage with a public that lacks scientific training. An example from recent history is genetic modification. Public disquiet over this new technology has meant that GM crops have been grown very little in Europe over the past 20 years, whilst they have been extensively planted elsewhere. This situation arose partly through a failure to anticipate public perceptions, concerns and reactions. While serious efforts have been made to ensure the better engagement of scientists with the public (e.g. BBSRC requires such engagement as part of its grant awarding process), problems persist, for example with climate change and the distortion in the media of the ways in which climate research is carried out. It may be that one of the causes of the partial failure of attempts to promote the public understanding of science is the scientists' own limited understanding of the range of perspectives and values which bear on how the public understand them and their research. The humanities may be able to play a key role in addressing misunderstandings of this kind, by securing the interest and engagement of scientists in other ways of thinking.

1.3 – The research group

The Principal Investigator, Co-Investigators and Research Fellow on the project were all based at the University of Reading. Each has experience of interdisciplinary working, both with each other and in other contexts:

- Nick Battey (PI) is Professor of Plant Development. He has a long-standing interest in how non-scientific approaches to the natural world might offer valuable complementary information to scientific ones, which he has explored both through a series of experimental research papers [2002-03] and through undergraduate teaching and a resulting textbook [Hatcher and Battey, 2011].
- David Stack (CI) is a Reader in History. He has written books on the Victorian economist and science-writer Thomas Hodgskin [1998], socialism and evolutionary thought [2003], and the phrenologist George Combe [2008], and is currently working on a project on botany in nineteenth-century social and political thinking, funded by the ESRC.
- Françoise Le Saux (CI) is Professor of Medieval Languages and Literature. She has a long-standing interest in the interaction between scientific developments and general culture in the middle ages, and is currently working on the impact of the translations of scientific texts from the Arabic into Latin from the twelfth century onwards, and on the rise of the figure of the 'natural magician' – the forerunner of the present-day scientist – with specific reference to narratives of motherless human generation.
- John Holmes (CI) is a Senior Lecturer in English Literature and the Chair of the British Society for Literature and Science. He has worked extensively on science in Victorian and modern poetry [e.g. 2009; 2012; forthcoming] and is currently working on a project on the Pre-Raphaelites and science funded by the AHRC.
- Karín Lesnik-Oberstein (CI) is Professor of Critical Theory. Her research is transdisciplinary, combining work in history, literature and literary theory, psychology, psychotherapy and anthropology, to examine how different ideas about childhood underpin different ideas about children's literature, teaching, learning and emotion [e.g. 2006; 2008; 2012].
- Rachel Crossland (RF) joined the project with a background in research on literature and physics, specifically on Einstein and modernism, which further broadened the group's expertise.

Together the PI and the CIs have developed structures within the University of Reading to pursue their shared interests. In 2009, members of the project established the University's 'Darwin Reading Group' to explore the writings of Charles Darwin and other nineteenth-century evolutionists from differing disciplinary perspectives. More recently, the project group has designed a new interdisciplinary undergraduate module at Reading, entitled 'Science, Culture and Society', which will bring together undergraduates from science and humanities backgrounds.

1.4 – The focus: Biology and the Humanities

1.4.i

It was necessary to limit our study to certain branches of both the humanities and sciences. Our decision to focus on how biologists respond to literary and historical research was partly pragmatic. Biology, history and literature are the areas of our individual expertise, and each of us from the humanities side undertakes research in which biology is an

important theme. Our combination of a common interest with divergent but complementary expertise fitted and indeed determined the aims of this project, in terms both of engaging the community of biologists and of being able to present to them a range of different humanities approaches.

1.4.ii

Beyond this, however, there was a deeper justification. So much of the debate about the relationship of the humanities and science is still framed in terms of C. P. Snow's 'two cultures'. It seemed almost incumbent upon us to take up Snow's suggestion, in the follow-up essay to his famous Rede Lecture, that biology might provide the best model for future interdisciplinary work across science and humanities, in part because it does (or did) not require formal mathematical training, but more because it confronts self-evidently 'human' questions of origins, species, self and environment. On the humanities side, we wanted to bring to bear humanities disciplines which do not lay such direct claim to relevance to the practice and interpretation of science as philosophy does (through ethics, philosophy of science etc.), but which nonetheless may have a transformative impact upon them. Finally, working with biologists allowed us to sidestep some of the more self-explanatory models of teaching humanities, for instance to medical doctors, where 'humanities' are already assumed as having the simple function of 'humanising' a potentially technocratic realm.

1.5 – Objectives and aims

1.5.i

The primary objective of our research was to gain a better understanding of how biologists respond to humanities research into biology. We aimed to explore:

- how far working biologists are aware of humanities research on biology;
- whether exposure to this research confirms or complicates their expectations of the humanities;
- how far they are open or alternatively hostile to different ways of thinking about biology from humanities perspectives;
- how far they see these alternative approaches as bearing on their own work in studying, researching and teaching biology;
- whether they see them as potentially transformative for their own practice as researchers, teachers or writers, and in what ways.

1.5.ii

The overall aims of our study were therefore:

- to develop a clearer understanding of the factors that determine the engagement (or otherwise) of biologists with humanities research;
- to gain a fuller picture of the possibilities for and obstacles to interdisciplinary research and learning;
- to instigate a process whereby the insights derived from historical and literary research on biology may be integrated into future research in biology and the use of that research within society.

1.6 – Methodology

Our research for this project combines two elements:

- a literature review, surveying engagements with biology in history, medieval studies, literary criticism and literary theory, and considering the ways in which they might be relevant to the discipline of biology itself;
- a qualitative study of the responses of a self-selecting group of biologists to a workshop entitled Cultivating Common Ground, at which they were introduced to some of the ways in which these four humanities disciplines approach biology and invited to consider possible applications of these approaches.

This approach had clear limitations. The literature review could not cover all aspects of even those areas of the humanities included within it, let alone of the humanities as a whole, while the workshop was too small to bear meaningful statistical analyses and cannot necessarily be considered representative. Whatever the limitations of a small study, however, it had the advantage of allowing us to probe, in relation to specific examples, how biologists regard the historical and literary treatments of their subject, and to explore in some detail how this exposure to different ways of thinking about biological subject matter that are alternative or complementary to their own might influence their future practice.

Literature review

2.1 – Introduction

It is impossible to conduct a literature review in this area without making reference to C. P. Snow and the 1959 Rede Lecture in which he formulated his enduring epigrammatic expression for the distance between 'natural Luddites' (literary scholars) and their insular and narrow-minded scientific colleagues [Snow, 1998]. This is not to say that the notion of 'two cultures' was, or is, necessarily either accurate or helpful. But whatever one's view of its usefulness – and those of us in the group sometimes took different views on this – there is no denying the pervasiveness of Snow's formulation. Although Snow himself declared 'a plague on both their houses', it is his comments upon the scientifically impoverished humanists, unable to explain the second law of thermodynamics at a dinner party, that most endure, and have been repeated by Steven Pinker among others [Pinker, 2002; for a critique, see Waugh, 2011]. This is despite the willingness of many humanities' scholars to lead the way in interdisciplinary research. While specimens of José Ortega y Gasset's 'learned ignoramus' [1957: 112] are to be found in the humanities, there are many humanities scholars who have crossed and/or worked on the porous borders of the interdisciplinary divide. In addition to our workshop, therefore, each of the CIs undertook to review literature in his or her area of specialism to see to what degree a case could already be made for the value of historical and literary studies of biology to biologists. What follows does not claim to be a comprehensive or even necessarily a balanced view; rather, it is a series of snapshots of discrete areas of the humanities and the ways in which they are interpenetrated by biology.

2.2 – The value of Historical Study to Biology

2.2.i

The standard defence of the value of history is appropriately ancient: 'Not to know what happened before you were born', as Cicero put it, 'is to remain forever a child'. But how convincing is that epigram to scientists who have, in Snow's famous characterization, 'the future in their bones'? [Snow, 1998: 11] The claim that history, and in particular the history of science (the history of their own disciplinary culture), might be of some value to scientists has been made repeatedly, on many different grounds.

2.2.ii

The simplest argument is a structural one: that the history of science can help to build a bridge of mutual understanding between the humanists and the natural sciences. This was the view both of George Sarton, the Belgian chemist and historian often regarded as the 'father of the history of science', and of Herbert Butterfield, Regius Professor of Modern History at Cambridge and author of *The Origins of Modern Science* (1949). Sarton, writing in the inter-war period, claimed that 'the construction of that bridge is the main cultural need of our time' [Sarton, 1988: 57-58; see also Butterfield, 1949: vii]. More than a quarter of a

century later, Snow was of a similar mind. It is often forgotten that in *The Two Cultures* he left some types of history traversing the wasteland between the scientific and literary, and sympathised with Sarton and Butterfield's 'bridge-building' inclinations. On one level, the bridge-building objective is so innocuous as to barely merit comment. Who could possibly object to using history to help science and the humanities to know each other better? But little thought seems to have been given to how a bridge, even if it were possible to construct one, might lead to exchanges that could transform practices on both sides.

2.2.iii

More challenging were the attempts, which gained ever-increasing pace from the late-1960s, to write a history of science that contextualised scientific knowledge and understanding. For most of the first half of the twentieth century, Anglo-American histories of science tended to embody the worst aspects of 'Whig history' – i.e. the teleological tendency to reach into the past for 'precursors' and 'anticipations' of present theories – and adopt the logical positivist emphasis on the 'context of justification' (how science was justified by testing etc) rather than the 'context of discovery'. Such approaches were anathema to the new 'social history' of science, which drew upon a number of overlapping intellectual strands. As with social history more generally, there was a Marxist inspiration, found, for example, in J.D. Bernal's four-volume *Science in History* (1954). Bernal, who was also the author of *The Social Function of Science* (1939), was one of a rare breed: a practising scientist (he was a crystallographer) who understood his discipline's history in a broader social context. Few other social historians of science possessed the same credentials. Nonetheless, some outstanding work was done in, for example, Darwin studies [see Young, 1969; Desmond and Moore, 1991]. The impact – actual as opposed to potential – on the way contemporary biologists saw their own work, however, was negligible. Similarly limited in utility was Thomas Kuhn's *The Structure of Scientific Revolutions* (1962). Although this was widely read, it was Kuhn's concern with key moments of change in the history of science, rather than his account of the day-to-day activities of what he called 'normal science', that held the attention.

2.2.iv

Before we go any further, it might be instructive to consider what historical contextualisation might have meant for the practice of science, and why it apparently had only this limited impact. For many historians, the argument that *'meaning and context'* are inseparably intertwined has become almost the defining feature of the discipline [Tully, 1988]. 'Meaning', it follows, is by definition always historically constituted. Applied to science it suggests that it is impossible to elucidate the meaning of scientific statements in purely empirical terms, because all observation is theory laden, all knowledge is ultimately historical. From this it follows that to the extent natural science is a human activity, it can only be fully understood through historical research. Contextualisation, that is, contained a challenge both to the 'logical positivism' of Popper and the Vienna School and, perhaps more dangerously, to the 'common sense' approach of most practising scientists. What it offered was a 'historical' understanding of scientific knowledge, but it was never obvious what this might mean in practical terms.

2.2.v

One recurrent complaint about the 'social' approach was that for all that it established context, it attended very little to the 'internal content' of science itself, and therefore lacked both appeal and practical application. One of its key weaknesses was an inability to establish a meaningful connection between structure and agent, and as a result it tended to render scientists little more than ciphers for broader social forces [Hacking, 1999]. Few scientists were likely to recognize themselves in such terms. The writings of Bruno Latour

are, in some ways, a reaction to these perceived weaknesses of the 'social' approach, and the influence of his works, from *Laboratory Life* (with Steve Woolgar, 1979) and *Science in Action* (1987) on, has been one of the most profound and still not adequately acknowledged developments in the history of science. What Latour offered was an approach that began with the material practices of the working scientist: the emphasis thus shifted to 'actor networks' in which 'knowledge subjects' (people) interacted with material objects and science emerged as a set of integrated practices. Applied to historical subjects this has led to active attempts to 'follow' scientists through their work. See, for example, Jim Endersby's book on Joseph Hooker [Endersby, 2008], in which the chapters are divided according to the material practices of a Victorian botanist – travelling, collecting, classifying, publishing etc. – and the small fortunes being spent constructing electronic databases of correspondence networks.

2.2.vi

There are many problems with 'Latourian history'. Extending Latour's anthropological observation of working scientists to the 'following' of dead ones is inherently problematic, and often rather arbitrary. The 'networks', moreover, which form a key theme in recent histories of science can, most kindly, be described as nebulous, while Latour himself has endured a degree of ridicule at the hands of scientists, not least during the 'Sokal Affair'. The undoubted benefit to have emerged from his influence, however, is a greater focus by historians upon scientific working practices, which points towards a synthesis whereby historians regularly study both day-to-day activity and the broader intellectual context. One of the most hopeful indicators of how the field might develop is Lorraine Daston and Peter Galison's study of the changing nature of objectivity in the nineteenth-century making of scientific images [Daston and Galison, 2007]. What is so exciting about their work is the notion of 'epistemic virtues' they develop. On Daston and Galison's account all scientific work embodies both epistemology and something more: scientific knowledge, and knowledge production, is epistemology plus the values of the persons and institutions involved. Together these form the 'epistemic virtues' – the norms, techniques, ethical values, and 'regulative ideals' – that are embodied in practising scientists' sense of self and embedded in their institutions. This points the way to fascinating future developments in the history of science. It also suggests how biology might be transformed by history.

2.2.vii

Bridge building, contextualisation (in its various formats), and Latour's 'actor network' approach all possessed transformative potential, in the sense that each could be used to bring into question the 'epistemic virtues' of practising scientists. But equally each could – and often has been – dismissed as interesting, but inessential. The 'bridge' was something to be crossed for leisure at weekends; it did not lead directly into the lab. Both the Contextualists and Latourians, in their different ways, were primarily concerned with *describing* what science was, rather than *proposing* what it could be. None of these approaches transformed the epistemic virtues of practising scientists. Nor, on their own, could they. If we are looking for a transformative value in history it may well not be found primarily in the spread of historical knowledge, but rather in a dissemination of historical practice. There are some very historically knowledgeable scientists; it seems likely that fewer scientists think as historians in the lab, at the workbench, or when writing at a computer screen. Perhaps it is not the spreading of knowledge that is needed so much as a change in epistemic virtues. The real transformative value of historical study to biologists is likely to come if it can encourage biologists to develop a more historical perspective on their working practices.

2.3 – The value of studying the Middle Ages to Biology

2.3.i

One productive way to think about a more unified practice between the humanities and natural sciences is to look to earlier periods when the 'two cultures' split did not pertain. Although a popular activity for historians and literary critics alike, there has been a tendency to focus quite narrowly, either on Classical Antiquity or on the nineteenth century just before the 'one culture' society fractured, with the consequent neglect of the Middle Ages [e.g. Rostand, 1956].

2.3.ii

One reason for this, highlighted by Maaike van der Lugt in her ground-breaking study *Le Ver, le démon et la vierge. Les théories médiévales de la génération extraordinaire. Une étude sur les rapports entre théologie, philosophie naturelle et médecine* [2004: 23-28], is the fact that medieval biological discourse (and in particular, theories of the generation of living creatures) is closely connected to debates in the field of angelology and demonology, in which even theologians tend no longer to be very interested. A more important reason, however, is probably to be found in the simple mechanism of semantic evolution, as is implicitly acknowledged in the title of Lynn Thorndike's *A History of Magic and Experimental Science* (1923-58), though historians of magic tend to underestimate this linguistic dimension. Magic nowadays evokes the opposite of science, a belief system drawing upon the supernatural to produce and explain effects, as opposed to a system of knowledge based on observation and conforming to reliable, natural rules. In fact, 'magia' was a more complex concept, referring to the knowledge of the Chaldeans, whose expertise in the natural sciences, and especially astronomy, was renowned throughout the ancient world. These early practitioners of 'magic' were magi, as in the well-known story of the Nativity of Christ, rather than magicians in the current sense of the term. The present term of 'science' was throughout the Middle Ages a generic one, including all elements of the educational model inherited from classical antiquity, both the language-based *trivium* (grammar, logic, rhetoric) and the mathematics-based *quadrivium* (arithmetic, geometry, astronomy, music). Some of the specific areas of 'scientia' have been identified as forerunners of modern sciences: earth-centred astrology is the foundation for modern, heliocentric astronomy, and alchemy has long been recognised as the ancestor of modern chemistry. These divisions within what we might recognise as 'scientific' knowledge were themselves relatively recent in the intellectual history of the Western world, and are closely bound to a change in the way people viewed the world initiated in the twelfth century by the rediscovery of classical texts, in particular the writings of Aristotle, mediated through Arabic culture and made accessible in the newly-established universities through Latin translations.

2.3.iii

By the thirteenth century, this had led to a paradigm shift with a more theoretical approach to the natural world that encouraged abstract speculation and extrapolation from confirmed observation leading to new experimentation. The language skills of the *trivium* started to lose the high status they had once enjoyed, displaced by the increasingly valued technical skills of the *quadrivium* and the greater social relevance and prestige of theology. The thirteenth century saw the appearance of a new concept: natural magic, referring to the manipulation of the natural world through the understanding of the laws governing nature. A prime example of 'natural magic' is alchemy, or the art of transmutation of commonplace materials into distinct substances [Newman, 2005: 34], from making pigments for painters to creating an artificial 'rational being', according to one infamous text attributed at the time to Plato. Biological science, therefore, belonged to 'natural magic', but was not limited

to it because of the theological and ethical implications that inevitably travel with the study of life and living creatures. From the first Christian scientific writers in the fifth century until well into the modern period, the world as a whole was seen as having profound significance [Steneck, 1976]: in the bestiaries, the breeding and feeding habits of animals are not only described, but are also the object of commentaries spelling out the eschatological or moral implications of these habits; similarly, lapidaries chart the virtues of stones (e.g. the work of Albertus Magnus).

2.3.iv

In the thirteenth century we see the near-universal acceptance of a theory of generation, and in particular of human generation, derived from the writings of Aristotle, especially *On the Generation of Animals* [1943]. Male sperm is seen as providing both vivification and shape to the new being, while the role of the mother is minimised to that of a nurturer and incubator [Cadden, 1993]. This leads to the theoretical possibility of creating a human being artificially, without recourse to a human mother – what will later be referred to as the homunculus. An early 'scientific' text giving instructions to produce such a creature is known as the *Liber vaccae* or *Book of the Cow*; this late twelfth-century translation from the Arabic made its way from Spain to the University of Paris, where the Bishop of Paris and University Master William of Auvergne condemned it in the strongest of terms. The *Liber vaccae* never became a university textbook, but remained for a century or so on the margins of respectable medical study before finding its way to the occult sciences shelf in later medieval and early modern libraries [Láng, 2008; Page, 2000; van der Lugt, 2009].

2.3.v

The ontological status of the 'rational animal' supposedly created through the procedures outlined in the *Liber vaccae* is a matter of debate among scholars. David Pingree [1993; 2001; 2006] sees the entire experiment as an instance of demonic magic, the homunculus being a demon lured into the artificial physical body, while van der Lugt is definite that thirteenth-century scholastics would have understood the creature to be human. For Newman, the creature would have to have been considered human; he therefore sees the refusal of the text to refer to the homunculus in such terms as a forerunner of present-day scientific discourses that dehumanise the human conceptus created for research purposes. These considerations are of course purely hypothetical; it is impossible to create a living being following the instructions of the *Liber vaccae*, and the Arabic redactor of the work admits as much in a discrete and easily overlooked aside. But it gives rise to ethical issues that are still with us today, while the ability to create an artificial, hybrid human being becomes a regular element of the legends surrounding early modern scientist-magicians like Dr Dee or Faust (irrespective of whether they were engaged in biological magic) and informs the popular image in literature of the 'mad scientist' from Frankenstein to Dr Moreau. The divide between the humanities and the sciences thus not only has its seeds in the Middle Ages, with the increasing loss of status of the *trivium* and incipient scientific specialisation: we can also chart the resulting misunderstanding and distrust of science by non-specialists to this period. To quote Lynn White Jr., 'The essence of C.P. Snow's 'two cultures' is to be found in Europe 600 years ago' [1978: 54].

2.4 – The value of Literature and Literary Criticism to Biology

2.4.i

It is an article of faith among literary scholars working on literature and science that the traffic between the two fields runs in both directions – that it is not only poets and novelists who respond to science, but also scientists who are influenced by literature. This is the position spelt out in what remains the most influential study in the field, certainly in the UK, Gillian Beer's *Darwin's Plots* (1983, 3rd ed. 2009). Beer writes specifically about the Victorian period when, she argues, there was still a direct interchange of ideas between scientists and the reading public, and when scientists themselves often drew for inspiration and even data on literary sources. Her examples include the geologist Charles Lyell citing Ovid and Darwin reading Milton. More generally, she presents a picture of nineteenth-century culture in which literary authors and scientists contribute together to the intellectual climate of the age. This ideal of literature and science as operating as one culture provided the title of another field-defining book, an anthology of essays edited by Beer's counterpart in the USA, George Levine [Levine, 1987]. Beer's conception of Victorian culture, in which literature and science are shaped by the worldviews of writers and scientists, which are in turn formed by literature and science together, is characteristic of scholarship on this period [e.g. Amigoni, 2007; Dawson, 2007]. There are also studies which have shown more precisely how literature contributed to the work of Victorian scientists, including how fiction was taken up and used as evidence by psychologists and psychiatrists [Shuttleworth, 2010], and how scientists drew on poetry in articulating their distinct scientific worldviews [Holmes, forthcoming].

2.4.ii

To what extent does the model of culture described in the work of Beer and others persist today? And does the literary study of science in culture itself operate as a two-way process? Literary scholars have argued for the relevance of their work to biology in particular in three ways. Firstly, they have suggested that literary texts and literary scholarship bear on debates as to the implications and ramifications of biology. For Shuttleworth, this is best done by tacitly demonstrating how debates over the status and psychology of children in the nineteenth century anticipate and therefore illuminate current debates on the same subject, without denying the historical distance between their different moments. The widely held view that Darwin's *Origin of Species* 'exceeds all other scientific "classics" of past centuries in immediate and continued relevance to the basic theoretical formulations and debates of current practitioners', as Gould remarked [2002: 58], has enabled Beer [2009] and especially Levine [2006; 2011] to enter into current debates on the significance of evolution through close readings of Darwin's own works. Likewise, Holmes [2009] has argued that poetry can deepen our apprehension of what it is for us to live in a Darwinian universe, whether it was written in the immediate aftermath of the *Origin* in the 1860s or yesterday. For Levine and Holmes in particular, one of the roles of literary scholarship is to demonstrate and articulate the richness of the visions of nature available within a Darwinian paradigm in the face of resistance to evolutionary theory, without sidestepping the existential challenges that paradigm poses.

2.4.iii

Secondly, two associated schools of literary criticism have emerged which seek to draw on the findings of biology in analysing literary texts, in turn offering up their interpretations of these texts as further data to contribute to the developing scientific paradigm. The first of

these schools – variously known as literary Darwinism, biopoetics or evocriticism – reads literature according to the terms of adaptationist evolutionary psychology, seeking to account for the evolution of narrative in particular, and explaining developments in plot and characterisation as reflecting human universals. This theoretical position has been articulated at length [e.g. Carroll, 2004; Gottschall, 2008; Boyd, 2009], but in practice it has rarely succeeded in moving beyond reductive analyses of texts, and has been critiqued too for its simplistic and partisan understanding of evolutionary biology [see Kramnick, 2011; 2012]. The second school that looks to current biology for its analytical framework is cognitive criticism. The working assumption for this school is that cognitive psychology and literary criticism are interrelated disciplines which can contribute to one another in a virtuous circle – that cognitive psychology can provide models for thinking about how literature works, but also that literature and literary criticism can in turn provide a more nuanced understanding of cognition [e.g. Spolsky, 1993; Turner, 1996; Zunshine, 2006].

2.4.iv

The third way in which literary scholars have sought to demonstrate the relevance of literature to science is through direct dialogue and collaboration. Examples of dialogue include the discussions of evolution from various perspectives, setting novelists, poets and critics alongside biologists, held at the ICA in London in May 2004 [see Wells and McFadden, 2006] and at the Cambridge Darwin Festival in July 2009. Another high-profile and influential collaboration was organised by the poet and scholar Robert Crawford and funded by the Wellcome Trust and the Arts Council of England. Crawford arranged for several poets and scientists, including biologists, to meet in pairs. In each pair, the poet composed a poem based on his or her understanding of and responses to the scientist's work, to which the scientist then responded in turn. The resulting book [Crawford, 2006] included further essays by poets and scientists reflecting on the state of relations between the two fields. A recent example of this model being followed by a UK university is the Litmus project, launched by Peter Middleton at the University of Southampton, which paired postgraduate science students with creative writing students.

2.4.v

It is a moot point whether any of this work has had an impact on the practices of any working scientists, although some at least of it has garnered polite and sometimes enthusiastic interest from individual biologists. In addition to literary critics seeking to engage with biology in their work, several prominent biologists have drawn on literature and literary concepts in their own work. Like the literary Darwinists, Steven Pinker [1997] and Edward O. Wilson [1998] have sought to explain literature and the arts as products of evolution. Wilson [1984; 1998], Gould [2003], Richard Dawkins [1998] and the philosopher of science Mary Midgley [2001] have all invoked the concept of poetry to set out ideals of how biology should be articulated and understood, albeit to very different effects. For Wilson in his early work, the two fields are complementary, though increasingly biology becomes a means of explaining literature – a process of consilience in which biology is clearly the senior partner. For Dawkins, the role of the poetry should be to celebrate science, while science itself should relearn the wonder expressed in poetry. Midgley by contrast sees the arts as well placed to critique the reductionism of Dawkins's and Wilson's worldviews, while Gould calls for a consilience on more equal and less ambitious terms than those set out by Wilson, with collaborations respecting rather than effacing the fundamental differences between the methods of science and the humanities. Except as recast by the literary Darwinists, literary criticism may have little to add to Wilson's later programme on its own terms, nor to Pinker's or Dawkins's. By contrast, Wilson's earlier work, Midgley's model, and especially Gould's, may suggest active possibilities for engagement, collaboration and mutual benefit. One very promising practical initiative along these lines

has been the 'One Culture' festival held at the Royal Society in October 2011, which culminated in a talk by the biologist and President of the Royal Society Sir Paul Nurse on Darwin and Milton.

2.5 – The value of Feminist Critical Study to Biology

2.5.i

Our review of history, literature and literary criticism has shown that the humanities and biology have a history of interdisciplinary engagement. This is even more directly the case with respect to critical theory, and specifically with respect to feminist theory and gender studies as part of critical theory. Although dating is always disputable, for our purposes this interdisciplinary relationship may be traced from the early 1970s and can be usefully, if roughly, divided up in to two main areas of focus, which should however not be taken as in any sense mutually exclusive, but as very much overlapping and co-extensive. Firstly, and most obviously, feminist theory and gender studies are core to biological research on sex and/or gender. Secondly, feminist theory and gender studies have affected biological research more widely with regard to the ways in which gender in and of itself raises the widest scientific questions around, for instance, perception and vision, consciousness, objectivity, and activity and passivity.

2.5.ii

In this sense, the history of the involvement of biology and feminist theory is truly *mutual*, not just in that biology has been affected by the considerations of feminist theory, but because of biology's essential role with respect to ideas about and research into sex, gender, bodies, sexuality and reproduction, biology has also in turn fundamentally affected feminist theory. In fact, it might be argued that biology and gender in and of themselves constitute an exemplary demonstration of the problem of the very concept of 'interdisciplinarity'. How and why would there be a conceivable 'biology' apart from 'gender'? Equally, are not definitions of 'sex' and/or 'gender' produced by ideas of the 'biological'? In other words, where is the 'inter' and which are the 'disciplines'? This problem also pervades our discussion here as much work by feminist theorists cannot be classified as necessarily simply 'humanities' or 'social sciences' or 'natural sciences', precisely because gender is bound up in defining these disciplines or areas *as such*. It is the question of gender, and gender as question, which already challenges such divisions and separations. Thus the attempt, in this discussion, to limit consideration to writings explicitly about 'biology' imposes a limitation challenged in and of itself by many feminist theorists. It may nevertheless also be seen as a positive side-effect of this that most of the writers referred to are themselves trained and often practising biologists, so that even in this sense the question is not whether they are 'feminist theorists' *or* 'biologists', as in most cases they are both, and, they argue, necessarily and inextricably so.

2.5.iii

The classic works of Bleier [1984], Birke [1986], Fausto-Sterling [1992; 2000], Blaffer Hrdy [1981; 1999; 2009], Lloyd [2005] and Fine [2010] all engage with problematic assumptions about the biological, cognitive and neurological capacities of men and women. Although the scientists writing here rely in turn on differing scientific and philosophical paradigms, they are all nevertheless committed to the practice of science, and in many ways argue that gendered assumptions lead to, or are part of, *bad* science, and in doing so also argue that science itself is therefore demonstrably not 'objective' or 'outside' of societal and cultural assumptions, but is, to some extent or other (depending on their particular approach),

shaped by them. Although it is widely assumed that 'sex' constitutes unchanging, universal, ways of biological functioning, often particularly in relation to reproduction, in all sexually-reproducing living creatures (human, plant and animal), 'gender' is usually seen to be constituted by cultural or social aspects of femininity and masculinity in humans (and some animals). In this conception, 'sex' in humans is seen to be the unchangeable 'bottom line' while 'gender' is seen to be subject to change and variation, so that biology itself is assumed as an 'outside' to culture and history, and culture and history are assumed as secondary add-ons 'on top' of biology. However, the work discussed here all explores, to one extent or another, the 'dividing lines' between such ideas of biology and such ideas of history and culture. These divisions turn out to be difficult to draw, raising the question whether there is in fact such an unchanging, universal, 'biological' 'sex' at all.

2.5.iv

The second focus is a further working out of these implications of the work explicitly engaging with issues of sex and gender themselves. Writings here most famously include those of the physicist and mathematical biologist Evelyn Fox Keller [1983; 1985; 1989; 1992; 1995; 2000; 2002; 2010] and the developmental biologist and primatologist Donna Jeanne Haraway [1991; 1997], where the central concern comes to be the role that *language* plays in all biological and scientific research. Both Fox Keller and Haraway have written classically on the way science is produced through the metaphors and models that it employs, but Haraway argues that language is not a reflection or representation of material reality, but a producer of it, while Fox Keller has always maintained a commitment to the idea of a science that does 'represent' a real or natural world. Where Fox Keller retains ideas of sensorial access to elements of a material world beyond culture, however mediated or complexly entangled, this is not the case for theorists such as Haraway, where every 'fact' can be read further as produced in language. In 'practical' terms this means that for theorists such as Fox Keller their analysis aims to achieve as much of a disentanglement of culture/ language and the 'natural' as possible, to produce the best possible science, whilst for theorists of the Haraway kind, the practical effort is one of an ongoing (unending) process of analysis of how all science, including concepts of the 'natural', is a production from vested cultural views and beliefs, most of which are not conscious or intentional.

2.6 – Conclusions

2.6.i

A number of immediate general conclusions can be drawn from this brief review:

- that there is a diversity of research in the humanities that relates to biology;
- that the extant interdisciplinarity of history, literature and literary theory with biology is lively and in several cases mutual;
- that there are numerous individuals working in history and literary theory in particular, from Sarton to Haraway, with a *bona fide* scientific background;
- that these and others remain determined to reach across the borders that divide the disciplines.

What should also be obvious is the inadequacy, not only of the 'two cultures' epigram, but also of some of the other favourite characterizations of the humanities/science divide, such as knowledge (science) versus understanding (humanities) [Collini, 2012] or empirical science versus interpretivist humanities. There may be differences of emphasis, but all

intellectual inquiry requires both. These dichotomies seriously underestimate the extent to which all cognition entails interpretation. This is not to suggest that science and the humanities are identical; if that were the case there would be little value in suggesting that biology may benefit from an engagement with history and literature.

2.6.ii

On the basis of this literature review, what might a biology inflected with history and literature look like? Clearly this would depend in part upon what area of biology and what type of history, literary criticism or critical theory were involved. In general terms, however, three points would appear to be central:

- **An acceptance that there is 'no view from nowhere'**
  One of the shibboleths of science is the notion of 'objectivity'. In history and literature, by contrast, it is equally axiomatic that there is 'no view from nowhere' [Nagel, 1986], both because all knowledge exists within a certain historical context, and because knowledge is bound up with our own subjectivity.
- **Greater reflexivity**
  To be *reflexive*, in the sense in which Roger Smith [2007] uses the term, means not only to recognise that there is no view from nowhere, but to follow that realisation up by examining and continually bearing in mind the unfounded assumptions in any body of knowledge. In the past thirty years, history, for example, has become an increasingly reflexive discipline, to the extent that fewer and fewer historians regard 'the past' as an entity to be unveiled or discovered, and most, to some extent at least, now understand 'the past' as an artefact they construct.
- **Breadth of vision**
  To accept that there is no view from nowhere is also to realise that, by looking at the same concept or subject from multiple viewpoints, we can greatly enrich our knowledge and understanding of it and our responses – intellectual, imaginative, and emotional – to it. Literature and history are ideally suited to providing this breadth of vision, which can be seen as supplementing biology in the first instance, but which may in turn come to be incorporated into it or fused with it in such a way as to generate new ways of doing both biology and the humanities themselves [e.g. Midgley, 2001; Holmes, 2009; Hatcher and Battey, 2011].

2.6.iii

The differences that exist between biology on one side and history, literature and literary theory on the other are a matter of practice more than principle. A more reflexive biology, in short, is possible. (Indeed, it is arguable that it is already the norm in continental education systems and research institutes.) Precisely what it would look like would depend on the subjects, problems, disciplines and ideas involved, but in broad terms it would be less inclined to present itself as an unproblematic representation of an ahistorical nature and more inclined to recognize its own characteristics and limitations as a particular way of constructing nature. At the same time, it would be strengthened and enriched by being able to draw on a fuller range of knowledge, experience and understanding, without having to exclude so much of what the human enterprise of seeking to understand nature has brought into being. To the extent that history and literature have undergone a similar process, they provide some clues as to what the new biology might look like: questioning, at times ironic, and perhaps even poetic.

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The workshop: Cultivating Common Ground

3.1 – Participants

3.1.i

The workshop was advertised widely through learned societies, universities and schools. There was a very positive response from university biologists in particular. In addition to the PI, CIs, RF and 2 assistants, there were 30 participants:

- 15 academics in biology
- 3 biology PhD students
- 1 Chief Executive of a Research Council (BBSRC)
- 1 institute-based research biologist
- 1 university-based public engagement manager
- 1 academic journal manager
- 3 academics from outside biology (1 sociologist and 2 literary scholars)
- 2 science communicators for museums (the Natural History Museum and the Museo delle Scienze in Trento, Italy)
- 2 school Heads of Biology
- 1 schoolteacher from outside biology (a historian).

Of the 38 participants overall, 30 were biologists. For a full list of the participants, see Appendix 1.

3.1.ii

A further 18 people wished to attend the workshop but were unable to, while 9 more expressed interest in the project. While the majority of these are again university-based, three work in museums (the Science Museum, the Natural History Museum and the Oxford University Museum of Natural History), one at the Cambridge University Botanic Garden, one in a research institute and one as a schoolteacher.

3.2 – Questionnaire

3.2.i – The sample

Prior to the workshop a questionnaire was distributed to all participants. 27 of them completed the questionnaire, including two of the academics who were not biologists.

As the object of the project was primarily to study the attitudes of biologists to the humanities, the digest of the information provided by the participants below excludes the answers of these two respondents from the sample. For the first question this is a sample of 25. One of these did not answer any questions in the subsequent sections, so the sample for these sections is considered to be 24. For the questionnaire itself and the full details of responses, see Appendix 2.

3.2.ii – Educational backgrounds

Participants were asked about their educational backgrounds. 20 of the sample went to school in the UK; 21 took their undergraduate degrees in the UK; and 20 had studied for postgraduate qualifications partly or wholly in the UK. As we had expected, and with one exception, those who went to school in the UK had specialised in science before going to university. Given a bigger sample, it would be interesting to correlate the answers to these questions with those later in the questionnaire, to see how far the perception of science and the humanities as 'two cultures' is an artefact of the UK education system.

3.2.iii – Biology and the Humanities

Participants were asked which, if any, of a list of ten humanities areas they thought might be relevant to their work on biology, and which, if any, they thought their colleagues might think were relevant. History and Philosophy and Critical Theory (bracketed together) received markedly the highest number of responses, with over three-quarters of respondents thinking that they might be relevant to their own work. Between two-thirds and one-third thought the following areas might be, in descending order: Politics, Art, Literature, Theology and Media Studies. Only a quarter or fewer thought that Music, Languages and Theatre might. For each subject, the proportion of participants who thought their colleagues might think it to be relevant to biology was lower, reflecting the extent to which the participants recognized themselves as being a self-selecting group. History, Politics, and Philosophy and Critical Theory were the subjects thought to be the most likely to find favour with biologists more widely. Three respondents made suggestions for further relevant subjects as follows: Psychology; Comparative Religion, Linguistics, Cultural Theory; and Sociology. Strikingly, the participants' expectations about which humanities disciplines were likely to bear on their own work were broadly confirmed for them by the workshop itself, with more of them seeing a practical application for History or Critical Theory than for Literature. It is moot whether this suggests that their preconceptions were correct, or whether the preconceptions determined their responses to the workshop. It may well also be significant that no distinction was made in the question between certain art forms or topics in and of themselves, and the academic study thereof within the humanities.

3.2.iv – Engagement with interdisciplinary organisations

Participants were asked about their level of engagement with seven interdisciplinary organisations: the British Society for Literature and Science (BSLS); the British Society for the History of Science (BSHS); the British Society for the Philosophy of Science (BSPS); the International Society for the History, Philosophy and Social Studies of Biology (ISHPSSB); the London Interdisciplinary Discussion Group; the Public Communication of Science and Technology Network (PCST); and the Society for Literature, Science and the Arts (SLSA). Nearly a third of the sample had not encountered any of these organisations. The BSHS and the PCST had the highest profiles, with between a third and a half of respondents having heard of them. Five were aware of the BSPS, but no more than two had even heard of each of the others. In terms of active participation, however, these divisions broke down, as no more than two respondents were on the mailing list for or had attended an event organised by any one of the seven organisations. The following additional organisations were identified by participants under 'Other': the Society for Social Studies of Science (4S) and the European Association for the Study of Science and Technology (EASST), both by the same participant; and the Psci-com mailing list. These results suggest that biologists who are

interested in interdisciplinary work are not currently involved in or even necessarily aware of the learned societies through which humanities academics themselves tend to pursue interdisciplinary research.

3.2.v – The relationship between Science and the Humanities

Participants were asked to respond to five statements on a sliding scale from strongly agree to strongly disagree.

- **1. Science, like the Humanities, is a product of its culture.**

  Nearly three-quarters of the sample agreed with this statement, nearly half of those strongly. Only two respondents disagreed. One respondent remarked that a distinction needed to be drawn between science being fostered within a culture and being determined by it.

- **2. It is possible to be entirely objective in scientific research.**

  Nine respondents (three-eighths of the sample) disagreed with this statement, while six (a quarter) agreed with it. The remainder either were ambivalent or did not answer.

- **3. Gender is core to thinking critically about science.**

  Half the sample disagreed with this statement, while none agreed with it, although one conceded that 'no doubt, gender issues lie at the core of the history of science in some cultures', while another pointed out that 'gender bias in science policy or process is important to think about but as something that might be studied it is merely one of many variables'.

- **4. Scientific papers are textual constructions as much as any piece of literature.**

  Over half the sample agreed with this statement, while only three respondents disagreed.

- **5. Science is more useful, and thus more valuable, than the Humanities.**

  Over half the sample disagreed with this statement, most of them strongly. Only two respondents agreed with it.

The statements were designed to be bald and polemical in their tone to provoke a range of responses. **1**, **3** and **4** were uncompromising statements of positions that might be held by humanities scholars working on science. **2** and **5** were statements that could represent an uncompromising scientism. The responses to them were revealing in three ways:

- the broad endorsements of statements **1** and **4** suggested a predisposition among the sample towards thinking about science in terms of its social and historical context and to a lesser extent its textual constructedness
- the rejection of statement **5** and, for some, of statement **2** suggested an equivalent predisposition against scientism (it is worth noting too that a number of respondents queried the implicit equation between use and value in statement **5**)
- the lack of agreement with statement **3** suggested that the biologists' sympathy towards humanities approaches did not extend to feminist criticism, at least not within the study or practice of science

These results tally with the fact that this was a self-selecting sample of biologists already interested in engaging with the humanities. (Notably gender was not identified as a theme of the workshop within the initial publicity.) Indeed, one respondent who agreed strongly with statement **1** and disagreed with statement **2** noted that at least one colleague of theirs would have disagreed with their position on both questions. One participant, in responding to these statements, also drew out the importance of distinguishing between 'the scientific

process, science policy and the corpus of scientific knowledge'. This distinction will be worth bearing in mind as we consider the conclusions of this study and future projects.

3.2.vi – Benefits to Biology from the Humanities

The final section of the questionnaire asked the participants to highlight any specific areas of biology which they thought would benefit from direct contact and engagement with the humanities. Of the 20 members of the sample who responded to this question, six thought that any or all areas of biology would benefit from direct contact and engagement with the humanities, while a further two thought that any areas relating to the human condition would benefit. The following areas within or aspects of biology were identified by at least one respondent (if more than one the number is given in parentheses) as likely to benefit from engagement with the humanities, suggesting possible areas for future investigation and collaboration: medicine (4); ecology and environmental biology (4); neuroscience and experimental psychology (3); ethics (3); imaging (2); public engagement; embryology and reproductive biology; evolutionary biology; genetics; GM. The following humanities subjects were mentioned specifically by at least one respondent: history (6); philosophy (3); literature (2); the visual arts (2); archaeology; sociology; theology; epistemology. One respondent remarked that, while the biologists might be 'better' as people as a result of an engagement with the humanities, and might 'do more humane science with perhaps more benign influence on economics and politics', this would not necessarily mean that their science itself would be '"better" (in the senses of, for example, following less blind alleys, ignoring fewer important questions, having greater predictive power, giving better explanations, enabling cleverer engineering, being clearer)'. As in the final response cited to the previous question, this comment draws distinctions between scientific policy, processes and results.

3.3 – Humanities presentations

3.3.i – Introduction

Following an introduction to the workshop and project as a whole by Nick Battey, the workshop itself began with short presentations by the four CIs from the humanities. Each presentation was followed by a few minutes for questions, as a prelude to later discussions.

3.3.ii– History for Biologists; or why study Phrenology?

In this presentation David Stack used the various ways in which historians have studied phrenology in the Victorian period as a means to explore the relationship between history and science more broadly. There were, it was argued, two main questions to be asked about Victorian phrenology: a 'scientific' and ahistorical question (was it true?) and a historical question (what did its popularity mean?). This led on to a discussion of how, since the 1970s, historians had largely stopped asking what was 'right' or 'wrong' about phrenology to probe instead what its existence and popularity might tell us. In this way phrenology had come to be seen as a mediator of the values of the Victorian age. From this starting point three main ways in which the relationship between history and science might be conceptualized were considered:

- Complementary: knowledge (science) and understanding (humanities)
- Bridge-building: with the history of science providing a meeting point
- Lessons from history: e.g. comparing phrenology to fMRI.

Each of these models, it was argued, was flawed. The real value of history for biology would be found in biologists integrating the reflexive practices of the historian into their own work.

3.3.iii – Cultivating common ground: why a historical perspective is important

The second presentation was aimed at encouraging scientists to identify elements of permanence in scientific research, even when dealing with periods where the accepted scientific theories have long been disproved. Françoise Le Saux focused on extracts from the *Liber vaccae*, or *Book of the Cow*, once attributed to Plato and translated from the Arabic into Latin in twelfth-century Spain. The star experiment of this text was the creation of a 'rational animal' using human sperm, vegetal and mineral substances, blood, and a cow or ewe as incubator. While the procedure itself might strike the twenty-first-century scientist as fanciful (though it was a logical development from pseudo-Aristotelian theories of generation), the ethical issues arising from the creation of a human or part-human creature as a means of obtaining the precious substances contained in its body are still relevant. Similarly, the instructions to the practitioner in another recipe (for invisibility) point to the necessity of projecting a certain image in order to obtain the resources necessary for applied scientific research. The patrons have changed, from powerful individuals to funding bodies answerable to the public, but the strategies used by scientists through the ages in response to practical, financial pressures might be recognised as not dissimilar.

3.3.iv – Poetry and Biology

In this presentation John Holmes outlined the ways in which poetry can engage with biology, and gave examples of poems which may alter their readers' perceptions of biology as a science and biological processes. Four overlapping engagements, which can be explored through the study of poetry responding to biology, were identified:

- poetry which responds to particular developments in biology, read in its historical context (e.g. Victorian poetry responding to palaeontology);
- poetry which explores the implications of biology for how we understand and respond to our own condition as living beings, read in the light of persistent and current ideas within biology (e.g. poetry on humanity's place in nature in the light of Darwinism);
- poetry which seeks to advance a particular political response to biological issues (e.g. poetry advocating environmental politics in the light of ecology);
- poetry which offers perspectives on biology itself, as a discipline and a field of knowledge.

Three poems were chosen as potential examples of the fourth type: D. M. Black, 'Kew Gardens', from *Collected Poems, 1964-87* (1991); Pattiann Rogers, 'Opus From Space', from *Eating Bread and Honey* (1997); and Robinson Jeffers, extract on the death of Old Martial, from *Cawdor* (1928). The first of these poems was chosen because it at once pays respectful tribute to biology as a science and identifies an aesthetic response to nature which, it suggests, cannot be scientifically explained. The second and third poems were chosen because they propose unfamiliar ways of looking at life and death respectively, and also because between them they embody different religious responses to evolutionary theory, the former grounded in Christian theism, the latter in materialism. Where Rogers takes phototropism as a governing metaphor for the impulse of living things towards the state of life, Jeffers takes the simulation of consciousness in dreaming as grounds for postulating an equivalent simulation after death generated by the processes of decay in the brain.

3.3.v – A close analysis of a passage from Sarah Blaffer Hrdy's *Mother Nature*

The final presentation by Karín Lesnik-Oberstein encapsulated the approach of a critical theorist, as distinct from what is usually understood by a 'literary' scholar. The key

difference between biology and the humanities in this case was defined as residing in the critical theorist's working from the assumption that there is no 'subjective' and 'objective', but that these are themselves specifically cultural and historical concepts and oppositions. This assumption in turn, it was explained, was grounded on reading everything as having a *perspective* (including this perspective itself). This was not a 'relativist' position, as relativism, famously and paradoxically, claims its own objectivity in asserting the truth of relativism. Instead, it proceeded from reading all texts – and everything qualifies as 'text', not just written documents, but also buildings, plants, films, molecules, emotions – in very close detail through their narrational perspectives. This style of close analysis was demonstrated through a few lines from the sociobiologist Sarah Blaffer Hrdy's book *Mother Nature: Natural Selection and the Female of the Species* (1999). This text was chosen for no specific reasons other than that it makes claims about biology and that the speaker had written on it before in connection with demonstrating how texts that claim objectively to critique other texts for being subjective can be read to have specific perspectives themselves too. The key point, however, was that thousands of texts could have been subject to critique in a similar manner.

3.4 – Initial responses to the presentations

3.4.i

Each of the four presentations was followed by a brief opportunity for questions and discussion. Two fundamental (and related) questions were raised in relation to both the first and the last of the presentations:

- What do humanities scholars consider to be the status of a 'real', 'unconstructed' world 'out there'?
- Do the humanities accept (as it was asserted scientists do) that it is possible to garner *objective* knowledge?

One participant in particular felt 'threatened' by the suggestion that it might be possible to take the humanities – and particularly their questioning of scientific 'objectivity' – into the laboratory. In the discussion it became clear that there was not one agreed humanities position in relation to the first question, but a range of different views, for all that the humanities participants were keen to stress that objectivity is itself a historical, and therefore culturally conditioned, concept.

3.4.ii

In relation to the first presentation two further points emerged:

- the biologists present were fairly forgiving of phrenology, discussing the distinction between 'bad' and 'wrong' science, and pointing out that the phrenologists' use of proxies (in the form of reading the brain from the skull), however mistaken, was legitimate scientific practice (as in the case of the search for the Higgs-Boson in particle physics);
- there was a generally positive view of history, with one participant even criticizing the speaker for undervaluing the use of history.

3.4.iii
The discussion that followed the second presentation focused upon two issues:

- how scientists present themselves and are presented today (e.g. how they are still cast in the role of 'magicians'), and the impact which this can have on science, especially in terms of funding;
- the relation between biology in general and specifically *human* biology.

The humanities, it was suggested, tend to focus disproportionately upon human biology, which, in the words of one participant, is not much more than a footnote to biology.

3.4.iv
There was a particularly positive reaction among the assembled biologists to the third presentation, though this reflected an enjoyment of the poems at least as much as a broader acceptance of the value of literary studies. Two main themes arose, which recurred later in the day:

- the difference between an art form itself and the study thereof within the humanities;
- the assumption that literature is, by definition, about a generalized and generalizable response, including an emotional response, and that this is a desirable 'supplement' to a 'lack' or insufficiency in biology.

The first distinction is pertinent to the suggestion by one of the participants that humanities scholars can 'give [scientists] joy about what they're looking at'. That 'joy' is a product both of the poetry itself, unmediated by humanities scholarship, and of the interpretative exercise of literary criticism, as it draws out the implications of the poetry for readers whose expertise is in science, not literature, thereby exemplifying one way in which the humanities can add value to the arts themselves.

3.4.v
There was limited time for responses to the fourth presentation, but in addition to the points concerning objectivity and the 'real' world above (3.4.i), the question of intentionality was also raised, with Lesnik-Oberstein asking whether anyone who writes is ever in control of the implications of what they write.

3.5 – Biologists' responses: five questions

3.5.i – Rationale
Following on from the presentations, the participants were asked to consider five questions that related broadly to the morning's talks. The rationale for these questions was an attempt to build out from the morning sessions to explore some of the broader themes underlying any interaction between biology and the humanities. The questions were considered in groups of about 6 participants, with detailed accounts kept by nominated scribes. These accounts have been edited together in the following summary.

3.5.ii – Does History matter for Biologists?
There was a general consensus that history was 'a good thing'. When this was probed further a number of different and sometimes overlapping answers emerged. The most popular reason for saying that history mattered was its ability to provide 'context'. It was

argued that the diachronic understanding of the development of any subject is crucial, but is often lacking from biology. Participants recognised the importance of context and historical framework in relation to the scientific questions which one is able to ask. History can thus enable biologists to get perspective on a particular paradigm.

This contextual justification often spilt over into a utilitarian one: history – for the most part defined as the history of science – was said to have the potential to deepen or enhance the understanding of scientific practitioners. Interestingly, this was seen primarily as a need for early career researchers: PhD students in particular should be encouraged to understand the history of their subject, for example to know the history and context of a particular scientific paper rather than just accessing it via a review. A further utilitarian justification related to how history could help inform the teaching of biology. Understanding the history of science could be useful for teaching science subjects at school level in that it allows for a consideration of preconceptions and of the fact that science may not be fully objective.

Beyond contextualization and utilitarian considerations, there was some resistance to the claim that history might make a 'transformative' contribution to biological practice by encouraging a more historical and reflexive sensibility to be incorporated into the way scientists work. Some biologists objected that the virtue of challenging assumptions does not need to be taught to biology from history: reflexivity is what scientists do, and a scientist should always know what their assumptions are. For another group, the division between the disciplines was appropriate, and both should and would be retained: although history and science can be interested in the same things, such as environmental change, their approaches will always be different.

3.5.iii – What are the costs of specialisation, and how can they be overcome?

The 'costs' discussed included:

- a reluctance to speak outside one's own areas of expertise;
- an inability to communicate outside of these areas;
- complacency and a reluctance to challenge one's own assumptions;
- a lack of awareness of the implications of one's work, including ethical implications;
- poor use of scientific evidence in policy.

One group argued that 'costs' was not the best way in which to frame this discussion, and that we should instead think in terms of the 'contexts of specialisation', asking why university departments and laboratories are set up in the way they are. Various groups highlighted the undeniable benefits and indeed the necessity of specialisation in order to provide detail and secure funding, and to enable one to keep up with the literature. Specialisation can thus be seen as an inevitable consequence of the scale of the enterprise. Moreover, there is a difference between the specialisation of an individual and that of a discipline, and the costs are different depending on whether the focus is on teaching or research. It was particularly those who work in science communication who were seen to need to have an overview of the whole field. It was also recognised that there is specialisation even within a subject like biology, and on the other hand that a practice such as critical thinking may be shared by such apparently different disciplines as history and science.

The groups then looked at the obstacles to and possibilities for cross-disciplinary or interdisciplinary work. They commented:

- that the pressures of the REF (Research Excellence Framework) impeded interdisciplinary work, reinforcing the 'myopia' of the specialist, and acting as 'a destructive force' when it came to writing reviews, books or syntheses which would enable one to step back, catch up and establish a broader view;
- that interdisciplinary research should be about opportunities for conversation, rather than the wholesale adoption of methods from different disciplines;
- that strong interdisciplinary work would be theme or problem driven, and that such work requires two or more people who are well grounded in their own disciplines to meet in the middle, rather than for one person to stand in the middle trying to create a bridge between two discrete disciplines;
- that there is an obligation to be more than a specialist, however, and to think divergently as well as convergently.

3.5.iv – How might Literature affect the practice of Biology?

Literature was seen to be able to inspire science, including by imagining what might become possible, as in science fiction, but a number of the groups felt that its practical and technical applications, or effects on the processes of biological research, were not easy to locate or define. Even though the three poems from the morning session had all presented a biological perspective, they were unable to identify how such pieces would affect the practice of biology. A number of arguments were advanced against the notion that literature might influence scientific practice:

- literature was conceived of primarily as a personal, individual experience – it was allowed that literature could be enriching for an individual, and thus had a potential creative impact on their work, but the same could be said of any art form or activity;
- even when interdisciplinary 'encounters' were engineered they did not transform 'practice' (one participant gave the example of an artist in residence located in a laboratory, whose presence may have changed the way scientists thought about their work, but not their actual practice);
- there were no grounds to believe that literature exercised, or could exercise, any influence at the laboratory bench, and not much evidence of biology itself being literature either;
- science fiction can even be unhelpful to the public understanding of science by sensationalising the role of the scientist.

Where the participants were more positive was in seeing literature as a 'supplement' to the strictly scientific. The suggestion in Black's 'Kew Gardens' that the biological paradigm is not completely satisfactory and that there are certain questions which science cannot answer, in particular in relation to beauty, was generally accepted. Indeed, the traffic between disciplines was seen as especially interesting in terms of how wonder functions and how we think about beauty. Some participants felt that the poems considered in the morning session might present biologists with a plea to remember the imagination and the spiritual side of nature, particularly as biology is the study of life forms: while science might explain the mysteries presented in literature, this need not necessarily take away from the experience. Likewise, literature was described by one participant as a way to confront the bleakness of science, and by another as a consolation for science. Literature, it was suggested, can raise questions that practising scientists cannot ask and can create a space for conversations, allowing scientists to address them – what one participant called 'an ethics of enabling'.

Literature was also seen in instrumental terms as an aid to the public communication of scientific ideas, which could enhance the impact of such ideas on the political and financial world. Its study could also improve the quality of the writing of scientific papers and funding applications, while reading could inform the thinking process and inspire. The sterile and inaccessible nature of biological papers drew comment from a number of groups. Finally, it was acknowledged that scientific metaphors can come from literary works and that all scientists have to work within the framework of a common language and webs of shared metaphors.

3.5.v – Can you think of any implications for your own work of reading language in this way?

This question related to Lesnik-Oberstein's presentation. The responses were mixed. On the one hand some groups felt that this way of reading emphasised the need to acknowledge the ambiguities, ambivalences and baggage carried by language and the need to be clear and self-aware in one's use of language, especially when devising new terms. This raised related questions of accessibility and obscurity in modern academic papers in biology, as well as issues concerning the difference between what scientists say and what the public hear, especially in terms of the media presentation of science. There was recognition that language may not have the same meaning within science as outside of it, and that the public communication of science puts a premium on clarity.

On the other hand, two groups were sceptical:

- highlighting the amount of time needed to read this closely and critically;
- asking whether there is in fact a loss of overall meaning when analysing to this level;
- questioning the need for this type of reading in all situations and stressing that scientists needed to pay closer attention to writing instead;
- suggesting that if the metaphors were roughly correct there was no need to worry about them, although recognising that scientists should aim to get as close to accuracy as possible.

There was a general consensus in one of these groups in particular that this kind of reading was not worth the bother and that it was not as interesting as the phenomenon itself; indeed, one participant described this kind of reading as like throwing away the baby and analysing the bath water. This group associated this type of reading with a view that the world was just ‘a social, linguistic construction’, a position that they rejected.

3.5.vi – Have any of this morning’s talks challenged your expectations?

Each group answered 'yes' to this question, although most had not had time to consider it in any detail. Points raised included:

- the challenging of ‘comfort zones’;
- the challenging of the territorial and defensive natures of different disciplines, in particular in relation to funding;
- an unexpected willingness for dialogue.

3.6 – Biological perspectives: Parasitoids

3.6.i

The aim of this presentation was to explore the potential of the outputs of biology to be approached and enhanced through literary and historical study; the presence of a mixed audience of biologists laced with humanities practitioners offered a rare opportunity to gain immediate and first-hand responses to these outputs. In introducing the session, Nick Battey explained briefly the range of activities which constitute modern biology, and suggested that the topic of parasitism might provide opportunities for diverse interpretations and interdisciplinary study. Dr Paul Hatcher from the School of Biological Sciences at Reading then showed two films, the 1931 piece *War in the Trees* narrated by Neil Chrystal (supplied courtesy of Dr Tim Boon, Science Museum, and the British Film Institute) and part of a film from 2008 about the emerald jewel wasp (by History.com, a US TV channel).

3.6.ii

Hatcher introduced these films by asking how we could consider them from a humanities point of view, and what the humanities could bring to our understanding of them. He noted that *War in the Trees* was presented by the person who did the work described by the film; was this perhaps more common in 1931 than now? More importantly, Hatcher noted the lack of context provided within the film. It focuses on the life-history of the insect, and is presented as a triumph of science, offering help to those engaged in forestry in the outposts of the British Empire. There is very little background information: how the target of the parasitoid, the wood wasp, was itself introduced to UK colonies through the wood trade; and the limits to how far the author of the film actually considered the parasitoid to be a viable solution to the problem. These aspects offer opportunities for humanities-biology collaboration, given the expertise of the humanities in drawing out the wider historical and social context. Similar considerations applied to the more recent film as well. The tone has interesting similarities to that of the earlier film in which the British scientist offered insight and potential control over nature. Here the US scientist in the lab has knowledge, power and authority, and provides illumination into the life-cycles of the cockroach and the parasitoid, to the accompaniment of dramatic, warlike music.

3.6.iii

After watching the films, a number of the workshop participants picked up on the language used in the voice-overs, highlighting the fact that it was similar to that used in horror films, while another participant asked if he was supposed to respond to the films in some kind of poetic way. It was suggested that these were films for instruction or entertainment, and thus secondary matter. Hatcher added that the propagandistic tone of the 1931 film is absent from the scientific papers on the subject written by Chrystal. There was also some discussion of the certainty, simplicity and clarity of the narration, and of the question as to how scientific uncertainty should be managed in media stories. Lesnik-Oberstein raised the question of supplement and lack in these films in relation to the primacy of image and narration, asking which was supplementing which. She also talked about perspective, and the way in which this links to the public communication of science, in particular in terms of the current movement towards experiencing the ideas being discussed in television programmes. This linked to a point about the difference between documentary television programmes on the sciences and on the arts: while programmes on ecology, for example, are often presented in a sophisticated way, arts programmes are often not. This raises questions about the ways in which we are informed about other disciplines.

3.7 – Breakout sessions

3.7.i – Choice of sessions

Participants were invited to choose to attend one of four breakout sessions on:

- constructing an interdisciplinary research funding bid;
- designing an interdisciplinary undergraduate module on biology and the humanities;
- using the humanities in museums;
- reading texts.

Each session was accompanied by introductory material and/or questions to help structure the discussion. Following the sessions participants reported back to the plenary.

3.7.ii – Research

This was the most popular of the sessions, attracting 10 participants, indicating an appetite for interdisciplinary research. In addition to a list of the sections of a standard funding bid, participants were supplied with copies of information from the AHRC website about its themes (Science in Culture, Translating Cultures, Care for the Future), from BBSRC on its subject areas, and on cross-Research Council initiatives such as Living with Environmental Change. The limiting effects of the REF on interdisciplinary exploration were remarked upon, but a number of potential funding bodies – including the AHRC (especially 'Translating Cultures'), Wellcome Trust, and ESRC (for projects relating to social policy) – were identified. In addition, the Leverhulme Trust and the MRC were mentioned. This led on to a discussion of potential areas for joint research. Two topics, in particular, were identified:

- biomedical issues and/or GM crops – key questions suggested for investigation included public expectations from such research, the way these expectations shape public understanding, and the ways in which scientific discourse is interpreted (or misinterpreted) outside of specialist circles;
- a more abstract approach, focusing on the philosophical/historical/social dimensions of the interaction between scientific cultures and human sciences, identifying and exploring barriers, considering where problems stem from and what implications they may have for the wider society.

The main problem that would need to be addressed when formulating interdisciplinary research projects was seen to be framing the research questions in such a way that they were neither too vague nor too specific. Such projects would also require a team encompassing a wide range of expertise in addition to biology, for example in philosophy (esp. philosophy of science), history and linguistics. Depending on the framing of the project, it would be useful to include a social scientist who could act as facilitator for qualitative research, or a scientific journalist. One important focus would therefore be on knowledge exchange. What are the disenabling structures that impede communication? To what extent are the methods of different disciplines transferable? It was felt quite strongly that biology and the humanities would have to be considered as equal partners, rather than subordinated one to the other. However, in order to obtain a grant, it would probably be necessary to give the project a utilitarian gloss – for example, what can biologists bring to the humanities? The impact of such a project would be on the level

of policy (scientific education; social policies; funding bodies) and pedagogical methodology (esp. schools, but also universities), with academic beneficiaries in the humanities, biological sciences and medicine.

3.7.iii – Teaching

Five participants attended this session. The discussion centred on the possibility of running an interdisciplinary module for first-year undergraduates, which would bring together biology, history and English students. All participants agreed that such a module was both desirable and necessary. It was felt that students arrive at university with a strong identity as either a 'scientist' or 'humanist', even if they generally lack the requisite skills to demonstrate or fully explain that identity. Some argued that this was a product of the British education system, and a culture in which school students are not only able, but often very keen, to specialise post-16 (and to an extent post-13). The rationale for an interdisciplinary module was agreed to be:

- to provide a 'melting pot';
- to encourage students to bring two subjects together;
- to explore the value of exposing students to different cultural norms and ways of working.

'Aims and objectives' proved the most difficult area to define. Some felt that the module *should not* just be 'remedial culture' for scientists, but equally that the module *could not* be 'remedial science' for humanities. It was agreed, therefore, that the focus of the aims and objectives should be on 'skills and understanding' more than on knowledge/content per se.

It was felt that the different groups of students would gain different benefits from the module. Biologists would leave the module with more developed skills in reading and interpretation of texts (and perhaps a greater understanding of written composition, essay skills etc.). Humanities students would leave the module with an enhanced ability to think logically. The difficulty of constructing a form of assessment suitable to both groups of learners, and appropriate to the content of the module, was discussed at some length. Two problems, in particular, came through very strongly:

- an individual module allows very little space in which to develop new skill sets, yet if an interdisciplinary module is to be distinctive this is precisely what it needs to do;
- there was the danger (or perhaps even the inevitability) of learners dividing in terms of performance along disciplinary lines.

To counter these difficulties the group proposed:

- a stronger emphasis on formative assessment than in most modules, to give students a greater opportunity to learn what was expected of them;
- that formative work explicitly relate to summative assessment, to help overcome the lack of motivation sometimes found in 'strategic learners';
- that the summative assessment be conditional upon completion of the formative stages;
- the inclusion of project work, to give learners time to develop new skills, in place of written examinations, where learners would be more likely to revert to disciplinary type;

- group work, with the groups socially engineered to force learners from different disciplinary backgrounds together;
- a task with constituent elements on which the learners had to work together, so that all students would find an element they would be happy to take the lead on, peer instruction would occur, at least to a limited degree, and, with an overall mark awarded to the work, each learner would feel a sense of responsibility to the whole project, rather than just their own section.

3.7.iv – Museums

The aim of this session, which six participants attended, was to consider ways in which humanities approaches might be used in displaying objects in natural history museums, and to consider more widely the possible functions of the humanities in the public communication of science. This session was held in the University of Reading's natural history museum, the Cole Museum of Zoology. Participants were introduced to the Cole Museum by its curator, Dr Amanda Callaghan, and were given time to familiarise themselves with the museum before engaging in a discussion structured through a series of questions. There was a strong sense that the humanities had a role in museums of natural history, including:

- in drawing out the ethical and political questions bearing on the display of natural specimens;
- in considering those specimens in their own right as once-living individuals;
- in encouraging multiple perspectives on the same specimens, reaching beyond the limitations of displays aimed at one specific purpose;
- in drawing out the aesthetic dimensions of specimens and exhibits;
- in encouraging imaginative responses to specimens and exhibits.

It was felt that history, history of science, literature and the arts could all be used to enhance the displays in natural history museums in this way. As in the earlier literature session, there was a suggestion that the humanities could add a sense of awe and wonder to science, whilst also helping the public to take away more information.

One participant had reservations over the educational value of encouraging artistic expression in museums for its own sake. In the plenary discussion afterwards there was a sense that this *was* valuable, but that this was not necessarily the same thing as using humanities approaches in exhibitions or interpretations, and that the latter might best be used less as an end in themselves and more for the purposes outlined above. The question of the role of the humanities in museum design was also raised. Finally, it was remarked that, by contrast with teaching and research, where genuinely interdisciplinary collaboration between the humanities and biology is rare and can meet with institutional or structural resistance, in the museum sector the advantages of such collaborations are already widely recognised, with the result that there is a good deal of opportunity and enthusiasm for them.

3.7.v – Text

This was the second most popular session, attended by nine of the workshop participants, who looked together at the opening few pages of Vittorio Gallese and Alvin Goldman's article 'Mirror Neurons and the Simulation Theory of Mind-Reading', *Trends in Cognitive Sciences*, 2:12 (December 1998), 493-501 (available at: http://www.unipr.it/arpa/mirror/pubs/pdffiles/Gallese/Gallese-Goldman%201998.pdf). This is an influential article in the research on 'mirror neurons' by two of the founding researchers

in the field, but the choice of article was, in some ways, secondary: the point of the session was to highlight how scientists and critical theorists might formulate different accounts of the same material. The key issue was taken to be perspective, which all participants read as not being considered in the arguments of the article itself. For the biologists, however, this simply invalidated the article scientifically speaking, whilst Lesnik-Oberstein argued that the degree to which 'mirror neurons' have been taken up scientifically and culturally warrants an on-going critique in and of itself.

There was a question mark over the status of the analysed article, which was described as 'a waste of time' by a number of the participants, leading others to ask whether it was worth critiquing a text of this kind. Other questions which this exercise raised were why there is an enthusiasm for this kind of science in the humanities when some scientists would not see it as science, and, more widely, what is viewed as science from the humanities perspective and vice versa. Such questions also raise the issue of the cultural role of bad science: the biologists themselves were not interested in this particular piece of science because in their view it was bad, yet this area of science continues to secure funding so should not be ignored.

One other interesting point that was raised concerned the ways in which humanities scholars read texts, with the biologists asking what the difference is between reading a part of a text and the whole of a text. How is a 'part' or 'detail' related to a 'whole'? If later sections of the article refute or contradict the prior sections, does this not still rely on a reading of the earlier sections to establish this? Is the issue then what claims to reading are made to be about, rather than an idea of a 'whole' reading necessarily being the only 'correct' reading? What is the relationship too of the abstract to the article itself? Some participants saw abstracts as necessary, accurate summaries which enabled readers to select from large amounts of scientific publications, whilst others saw abstracts as often misleading by 'overselling' or oversimplifying the contents of the articles themselves. The abstract of this particular article was seen by almost all participants to be tentative, speculative and uncertain.

3.8 – Plenary

The workshop closed with a brief plenary discussion and the invitation to participants to join with the organisers in reflecting on how the day's activities and explorations might be taken forward in future. These reflections and the resulting proposals and plans are discussed in the following sections.

Achievements and reflections

4.1 – Levels of interest

4.1.i

The workshop exceeded our expectations in many regards. Overall, the workshop was oversubscribed, to the extent that we decided to increase the number of participants from 20-25 as originally projected to 30. Nearly as many people again expressed an interest in the project but did not attend the workshop, mostly because they were not free on that day. Even allowing for this being a self-selecting sample, this is extremely encouraging, as it suggests that there is a substantial constituency of biologists who are interested in exploring ways in which they might be able to collaborate with the humanities to enrich their own work.

4.1.ii

Equally encouraging was the range of UK universities represented – 16 in total, including old and new universities, and universities from Scotland and Wales as well as England. This suggests that this interest is widespread and does not merely exist in a few pockets here and there. The range of ages and career stages represented was also promising, suggesting that interest in the humanities spans across the generations and is not inevitably suppressed either by a long career in science or by the exacting demands of PhD study. That Douglas Kell, the head of the BBSRC, attended is a further sign that there is not only an appetite for this kind of interdisciplinary work in biology at this time but also support for it. Professor Kell emphasized that co-funding is a real possibility now, and urged scientists to begin with their own ambitions of what they want to do.

4.1.iii

Outside the university sector interest was more muted. Of the 57 people who expressed an interest in the project, six were from museums or equivalent institutions, although in the end only two of these attended. This probably reflects an existing commitment to this kind of collaboration in museums, which came up in the workshop itself: while many people in science and natural history museums are keen on collaborating with artists and humanities scholars, it is not news to them that this kind of work can be done. Nevertheless, their interest in the project may provide very valuable expertise and avenues for public engagement as this work progresses.

4.1.iv

More disappointing was the lack of interest on the part of schoolteachers. We contacted the heads of science in around 200 schools in Berkshire, Surrey and West London, together with selected school offices across the South East and around 100 further individual biology

teachers in the region; we scheduled the workshop for state school term time in order to avoid the holidays; and we offered to buy teachers out of teaching for that day. In the end only 1 teacher attended as a result of this publicity (the other 2 were personal contacts). Various factors may have contributed to this, particularly the demands of and constraints on school curricula. It may be that there is not a great deal of appetite at present for drawing on the humanities in teaching biology at school, or that teachers see little opportunity to employ such approaches even if they want to (particularly in the state sector, where a lack of resources can prevent schools from offering the interdisciplinary extended project at A-level). It may well also be that, if a workshop of this kind were to appeal to teachers, it would need to be directed exclusively at schools, and to be linked to specific proposals and opportunities for delivering the curriculum in new ways.

4.2 – Feedback and conclusions from the workshop

4.2.i

Since the workshop, we have had feedback from 25 of the 30 participants. Almost all the respondents were very enthusiastic about the workshop itself, describing it variously as 'really interesting', 'excellent', 'most enjoyable', 'brilliant', 'very stimulating' and 'dynamic', while around half the participants have expressed an active interest in further interdisciplinary collaboration. Different participants identify different aspects of the workshop as especially useful or enjoyable, and the sample is not itself large enough to support statistical generalisations, but certain perceptions and attitudes are worth noting. These include the views:

- that **history** may have practical applications for biologists, in positioning their own work both diachronically (in relation to earlier research) and synchronically (in relation to contemporary culture and values);
- that **literature** may aid in reflecting on science and its values, providing an important supplement to the work of science itself, particularly aesthetically;
- that **critical and theoretical approaches to texts** may help scientists to be aware of their own assumptions and to improve their own writing.

These responses complement and flesh out the suggestions for how the humanities might inflect biology made in the literature review above (2.6.ii).

4.2.ii

The main obstacles to interdisciplinarity identified by the participants were:

- with regards to research, entrenched research cultures and funding structures, in particular the REF;
- with regards to university teaching, the different identities and skills of science and humanities students;
- the perception that the humanities are committed to a constructivist anti-realism which denies the possibility of objective knowledge.

A range of different positions on this last issue were taken by the humanities academics at the workshop, as the three biologists who raise this in their responses acknowledge, and strong constructivism was not identified nor promoted by the workshop as a whole as the humanities' perspective. Nevertheless, it is worth noting that this remains a perceived gulf

between science and the humanities, and also that, whether or not a biologist or a clinician accepts that scientific knowledge is to a degree culturally contingent, there may be strong practical or ethical reasons why it is not appropriate for them to bring that insight to bear on their own working practice.

4.2.iii
Two important distinctions recurred at the workshop which would need to be borne in mind in devising future interdisciplinary projects between biology and the humanities:

- the distinction between the arts themselves (including literature) and the critical study and interpretation of them by the humanities;
- the distinction between scientific research, the corpus of scientific knowledge and science policy identified by one participant in particular, together with the communication of science as a fourth strand.

Although both the arts and the humanities may potentially bear on or respond to any of these four elements of science, each of them will do so in different ways and to differing degrees in each case.

4.3 – Overall conclusions

4.3.i
Referring back to the objectives of our study (1.5.i), we have established:

- that there is considerable and genuine interest in humanities approaches to biology, and some prior knowledge of these approaches, particularly among academic biologists and museum employees;
- that interested biologists who are exposed to humanities research on biology are for the most part pleasantly surprised by the openness to collaboration and interdisciplinarity on the part of humanities academics;
- that there is an openness to different humanities approaches among biologists, although there remains some anxiety over whether the humanities as a whole may espouse strong forms of constructivism;
- that history, literature and critical theory can all be seen by biologists to have relevance to biology, as outlined above (4.2.i);
- that history is seen as having the most direct relevance to biological research itself, while literature and critical theory are seen to have more relevance to reflecting on and communicating that research.

4.3.ii
Referring back to our overall aims (1.5.ii), we have identified several factors which may bear on the level and nature of engagement with the humanities by biologists, including:

- educational history;
- research opportunities;
- preconceptions about the differences between the worldviews of the humanities and the sciences.

We have also identified factors which do not appear to be crucial, at least not in the case of the academics in our sample:

- age/stage of career;
- university/institutional affiliation.

We are not in a position to draw any definite conclusions, positive or negative, about the potential interest in humanities work on biology among schoolteachers, as we do not know what the factors were that led to their not attending the workshop.

4.3.iii

We have established that, while there remain some obstacles to interdisciplinary research and teaching, there is also considerable enthusiasm for interdisciplinary research in particular; a strong sense that both research and teaching in biology could benefit from more engagement with the humanities; and a perception that both humanities and biology students would gain from being taught alongside one another. On this basis, there are strong grounds for believing that the humanities may be able to play an active role in the future development of biology, helping to augment and reshape aspects of research and teaching in the science which itself bears most directly on the human sphere. Finally, it is worth adding that the biologists were clear that the humanities too could benefit from greater knowledge of and experience in biology, and that collaborations in both teaching and research could and should be properly mutual – a view that we wholeheartedly endorse.

Next steps

5.1 – Dissemination and outputs

This scoping study is published on the University of Reading website, and has been made available to the AHRC for use and further distribution. Hard copies are being printed to be sent to influential institutions and individuals concerned with the furtherance of science, the humanities and education. The findings of our literature review and workshop will be announced publicly through a press release targeted at the science and educational media. The publication of the scoping study will be announced on the British Society for Literature and Science website and in *The Systematist* (the Newsletter of the Systematics Association), while a report on the workshop itself is being published in *Viewpoint* (the magazine of the British Society for the History of Science). In addition, we are submitting reports of and reflections on the project for publication in *New Phytologist* and *Bioscience Education*.

5.2 – Teaching

We will be launching our new first-year module on 'Science, Culture and Society' in 2013, which will be open to students from across the University of Reading. We will incorporate suggestions from the workshop into the final programme for the module, and continue to refine and promote it in the light of our on-going research.

5.3 – Network

Several participants have expressed enthusiasm about being part of an on-going interdisciplinary network, as have many of the other people who expressed interest but were unable to attend. We will establish and facilitate this network through the Cultivating Common Ground website (http://www.reading.ac.uk/cultivating-common-ground/) and blog (http://blogs.reading.ac.uk/cultivating-common-ground/), which were set up in the first instance for the workshop. Participants will be given automatic access to the blog and a mailing list, while new members will be able to join the network via the University of Reading website.

5.4 – Future research

We are continuing to pursue interdisciplinary research in our own individual areas, including through on-going collaborations with high-profile scientific organizations including the Royal Society, Kew Gardens, the Natural History Museum and the Oxford University Museum. We are taking the aims of this specific project forward by working with several universities and other institutions engaged by the workshop on a Collaborative Research Training Programme for co-disciplinary research between biology and the humanities, including doctoral studentships, a new Master's-level degree, and an interdisciplinary journal. The aims of this programme will be (1) to cultivate a generation of academics who will have genuine expertise in both biology and the humanities, and who

will thus be able to take forward the aim of integrating the insights derived from historical and literary research on biology into biology itself; (2) to deepen the understanding of the relationship between biology and the humanities among current academics through the process of supervising co-disciplinary research; (3) to provide a forum for the publication of co-disciplinary research; and (4) to apply that research to the communication of biology in the public sphere, through museums in the first instance. Ultimately, we hope to help reshape the study of human beings, their fellow organisms and their environment by bringing together the approaches and insights of science and the humanities.

Appendix 1

List of participants

Prof Nick Battey, Professor of Plant Development, University of Reading (PI)
Miss Samantha Bedry, Applied Ecology & Conservation Graduate, University of Reading (assistant)
Mr Chris Bladon, Head of Biology, The Gryphon School, Sherborne, Dorset
Dr Mark Brown, Reader in Evolutionary Ecology and Conservation, Royal Holloway, University of London
Dr John Cartwright, Senior Lecturer in Biology, University of Chester
Mr Oliver Caspari, PhD Student, Dept of Plant Sciences, University of Cambridge
Dr Tinashe Chiurugwi, Research Scientist, Rothamsted Research
Dr Martin Christlieb, Public Engagement Manager, Dept of Oncology, University of Oxford
Dr Rachel Crossland, Research Fellow in Biology and the Humanities, University of Reading (RF)
Dr Jeremy Green, Reader in Developmental Cell Biology, King's College, London
Dr Jean Harrington, Associate Research Fellow, ESRC Centre for Genomics in Society (EGENIS), University of Exeter
Dr Paul Hatcher, Senior Lecturer in Applied Ecology, University of Reading
Dr John Holmes, Senior Lecturer in English Literature, University of Reading (CI)
Dr Tara Hurst, Lecturer in Cell and Molecular Biology, Nottingham Trent University
Prof Douglas Kell, Chief Executive of BBSRC and Research Chair in Bioanalytical Sciences, University of Manchester
Dr Medhat Khattar, Lecturer in Microbiology, Nottingham Trent University
Dr Andrew Lack, Senior Lecturer in Environmental Biology, Oxford Brookes University
Prof Françoise Le Saux, Professor of Medieval Languages and Literature, University of Reading (CI)
Prof Karín Lesnik-Oberstein, Professor of Critical Theory, University of Reading (CI)
Prof Keith Lindsey, Professor of Plant Molecular Biology, Durham University
Dr Deborah Mackay, Reader in Human Genetics, University of Southampton
Dr Lucia Martinelli, Senior Researcher, Museo delle Scienze, Trento, Italy
Ms Ivvet Modinou, Nature Live Manager, Natural History Museum
Miss Melanie Orros, PhD student, Environmental Biology Division, University of Reading
Dr Richard Payne, Research Associate, Manchester Metropolitan University
Prof Robin Plevin, Professor of Pharmacology, University of Strathclyde
Dr Mags Pullen, Research Associate, School of Biological and Biomedical Sciences, Durham University
Mr George Reed, undergraduate student in Biological Sciences, University of Reading (assistant)
Dr Angelique Richardson, Senior Lecturer in English, University of Exeter
Dr Andrew Savory, Head of Biology, Winchester College
Prof Michael Shaw, Professor of Plant Disease Ecology, University of Reading
Mr Tom Simmons, PhD student, Cell and Molecular Biology, University of Edinburgh
Dr David Stack, Reader in History, University of Reading (CI)
Prof Howard (Sid) Thomas, Emeritus Professor of Biological, Environmental and Rural Sciences, Aberystwyth University

Dr Fiona Tooke, Peer Review Manager, *New Phytologist*
Dr James Webster, History Teacher and Director of Studies, Winchester College
Prof Rick Welch, Dean of Arts and Sciences Emeritus, University of Maryland, Baltimore County, and Affiliated Research Scholar, Dept of History and Philosophy of Science, University of Cambridge
Dr Alison Wood, Research Associate, Faculties of English and Divinity, University of Cambridge

Appendix 2

Questionnaire and responses

Numbers of responses are given in parentheses ( ), with numbers excluding non-biologists in square brackets [ ]. In total there were 27 respondents.

Introduction

This questionnaire forms part of the research for the 'Cultivating Common Ground' scoping study on the relationship between, and potential for interdisciplinary collaboration between, biology and the humanities. It should take no more than 10 minutes to complete.

Section 1

Given that the current educational system in England and Wales allows for relatively early specialisation in particular subjects and areas of study, the first section of this questionnaire relates to your own educational background.

1. In which country or countries did you complete your school education? (27 [25])

- Australia: 1 [0]
- Germany: 1
- Italy: 1
- Jersey: 1
- Kuwait: 1
- UK: 20 [19], including 1 who specified Scotland
- USA: 1
- Zimbabwe: 1

2. In which country did you complete your undergraduate degree? (27 [25])

- Australia: 1 [0]
- Italy: 1
- Kuwait: 1
- UK: 22 [21], including 1 who specified Scotland
- USA: 1
- Zimbabwe: 1

3. If you have completed, or are currently completing, a postgraduate qualification, in which country or countries were/are you based for your postgraduate studies? (25 [23])

- The Netherlands and Italy: 1
- UK: 20 [18]
- UK and Norway: 1
- USA: 1
- USA and Belgium: 1
- USA and UK: 1

4. At what stage in your education did you begin to specialise in science? (27)

- School up to 16: 6
- School 16-18: 16
- Undergraduate degree: 3
- Postgraduate qualification: 0
- Other, please specify: 2
- I don't specialise in science. **This person only filled in the first three questions (all UK), and left the rest of the questionnaire blank.**
- My research deals with literature, science and religion in the nineteenth century. I'm not sure this constitutes a specialisation in science, however. **This person answered the rest of the questionnaire, but their answers are not included in the sample for the report.**

Section 2

We are interested to know your views on the relationship between biology and humanities subjects, as well as whether or not you see your own views as representative of those of other biologists.

5. Which, if any, of the following humanities areas do you think might be relevant to your work on biology? And which, if any, do you think your colleagues might think were relevant? Please tick all that apply. (25 [24])

Subject	Me	My colleagues	Response count
Art	14 [13]	6 [5]	16
History	21 [20]	13 [12]	21
Languages	5	5 [4]	8
Literature	12 [11]	6 [5]	14
Media Studies	9 [8]	6 [5]	10
Music	6	5	7
Philosophy and Critical Theory	20 [19]	10 [9]	21
Politics	15	11 [10]	18
Theatre	4	3 [2]	6
Theology	10 [9]	7 [6]	13

Other, please specify: 3

- Psychology
- Comparative Religion, Linguistics, Cultural Theory
- Sociology

Section 3

We would like to know the extent to which you are already involved with interdisciplinary organizations.

6. Which, if any, of the following interdisciplinary organizations have you previously heard of or engaged with to any extent? Please tick all that apply. (18 [17 of 24 biologists])

Interdisciplinary Organization	Heard of	On mailing list for	Been to at least one event organized by	Member of	Response Count
The British Society for Literature and Science	3 [2]	3 [2]	3 [2]	1 [0]	4 [3]
The British Society for the History of Science	11 [10]	1 [0]	3 [2]	1 [0]	12 [11]
The British Society for the Philosophy of Science	6 [5]	1 [0]	1	0	6 [5]
The International Society for the History, Philosophy and Social Studies of Biology	2 [1]	0	1	0	3 [2]
The London Interdisciplinary Discussion Group	3 [2]	2 [1]	1	0	3 [2]
The Public Communication of Science and Technology Network	8	2	1	1	8
The Society for Literature, Science, and the Arts	2 [1]	0	0	0	2 [1]

Other, please specify: 3

- To my shame, none.
- Society for Social Studies of Science (4S); European Association for the Study of Science and Technology (EASST).
- Psci-com mailing list.

Section 4

We are interested in your views on the relationship between the sciences and the humanities.

6. Please indicate the extent to which you agree or disagree with the following five statements. (24 [23])

Statement	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Science, like the humanities, is a product of its culture.	8	10 [9]	3	2	0
It is possible to be entirely objective in scientific research.	0	6	7 [6]	8	1
Gender is core to thinking critically about science.	0	0	7	8 [7]	5
Scientific papers are textual constructions as much as any piece of literature.	2	12 [11]	5	1	2
Science is more useful, and thus more valuable, than the humanities.	0	2	6	6	9 [8]

If you would like to comment on any of the above, please do so here: (10)

- Although they are loosely coupled, the scientific process, science policy and the corpus of scientific knowledge are three separate things for which the answers to the questions above will differ. For example, gender bias in science policy or process is important to think about but as something that might be studied it is merely one of many variables.
- For the last question it very much depends on which aspects of science and which aspects of the humanities are being compared. I would certainly say that cancer research for example might be more useful than certain aspects of the humanities but equally some humanity-related projects are far more 'useful' than some scientific research
- Product of culture can mean various things. Clearly all science is a product of culture since without culture there would be no science. Need to distinguish between fostered with a culture, shaped by it and determined (in strong sociological sense) by it.

- Q2: it is possible – but rare and extremely difficult! Q3: ABOUT science (rather than in science)? This seems unlikely... Q4: sorry, don't know exactly what you mean by textual construction so can't address that one
- The meaning of the above query on 'gender' is unclear? No doubt, gender issues lie at the core of the history of science in some cultures.
- In the first question, I'm assuming that your meaning is that science is a product of its own culture, rather than that of the broader human culture? If so, I would argue that while science is a product of its own culture, it is also a product of the broader culture as it does not exist in a silo isolated from the rest of the world
- At least one colleague disagrees with me about the first two statements. Values are not directly comparable; uses more easily so, so I question the last statement. **First two answers were 'strongly agree' and 'disagree'.**
- Each question felt like a trap. Not written by a scientist I'll wager.
- What do you mean by 'useful'? You don't distinguish levels or aspects of the subject. Having chosen the question and the method, I think it is possible to both be and define 'objective'; but what seems of interest, what gets funded, the type of question asked [e.g. '...we could look at molecular mechanisms and do some real science', which I heard last week] are very strongly culturally determined. But I'd go to economics and sociology rather than most of the humanities for understanding....
- I am not sure what you mean by the gender question.

Section 5

Finally, please answer the following question on biology and the humanities.

8. Which, if any, specific areas of biology do you think would benefit from direct contact and engagement with the humanities, and why? (21 [20])

- Any/all.
- Imaging - strongly pictorial and not well understood.
- I'm not sure I know how to answer this. Do you mean historical areas (such as understanding the organization of biological study in Britain? The rise of certain kinds of language and descriptive models?) Many examples I suspect in contemporary research, and too many to list here: depiction, description and aesthetics of observation come to mind (as well as the thoroughly mined ideas of molecular biology and ethics, biodmed and philosophy, media studies and perceptions of technological possibility; work on creativity and elegance, on imagination and enquiry) **This response was from a humanities academic.**
- Embryology and reproductive biology benefit from direct contact with philosophy and history to have a cultural and ethical perspective on what they are doing and why non-scientists act and feel the way they do about reproductive technologies. Likewise for geneticists. Many biologists, but particularly those engaged in generating images would benefit from contact with visual artists (from sculptors to fabric designers) to appreciate that their own images have aesthetic value beyond their purely scientific value.
- I am an ecologist so can't really speak for other areas but I would say that my field could benefit from contact and engagement with the humanities because it is about raising awareness and understanding of the world around us. Literature for example can do this.

- Contentious issues such as GM crops and foods need a philosophical focus that can be provided by the humanities
- Specific areas of biology which I feel would benefit are: ecology and phenology where an historical perspective can aid in the interpretation and understanding of data – evolutionary biology where I think literature and theology can present challenges to the biologist for further research –neuroscience, here I think literature and art, in particular, are likely to be a part of research, in terms of looking at cognitive/behavioural responses
- Medicine, because it often deals with matters which are not entirely understandable, yet demanding a solution like neurological and mental illness.
- Human behavioural studies, experimental psychology, Neuroscience, ... Because biology and humanities are two angles to take trying to understand what it means to be human, and perhaps what the point of it is.
- Ethical dimension of biology. Using the history of science to illustrate epistemology
- Health drug use as well as benefits it has the potential to profoundly damage society
- Any form of study which is going to impact upon our quality of life or that of the world we live in, must be nourished by contact with the milieu in which that study is going to be delivered and experienced. I'm in medical research, and if I don't understand the human context my work came out of and is fed back to, my work will be disconnected from what it's there for.
- The farther one explores the history of science (particularly biology) - in its cultural, philosophical, and linguistic contexts - the more intimate connections to the humanities one discovers. A modern-day *redivivus* of such relationships will benefit many areas of biology, especially those most perceptively relevant to the human condition.
- I think all areas would, so this question seems a bit artificial
- Neuroscience and anything to do with the brain, for obvious overlap in content. Almost all environmental and conservation biology as much of this has a heart-felt idea about conservation at its back and that is best expressed by the humanities rather than the sciences.
- Health because it is not just the absence of disease
- Any areas because research founding as well as biology advancement applications need public engagement (ethics + sociology + communication)
- All to some extent.
- I think *people* would be better, and probably do more humane science with perhaps more benign influence on economics and politics, if they engaged more in alternative ways of thinking and were less focused on their science. But I don't think their science would be 'better' (in the senses of, for example, following less blind alleys, ignoring fewer important questions, having greater predictive power, giving better explanations, enabling cleverer engineering, being clearer)
- Probably all of them – interdisciplinary contacts and engagement are always a good thing. My areas of particular interest (palaeoenvironments) already have considerable engagement with archaeology and, to a lesser extent, environmental history.
- All of them can in different ways.

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