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Introduction: towards future archives and historiographies of 'big biology'

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The 20th-century has seen the progressive rise of 'big science', especially after 1945. In the last seventy years, research has increasingly been conducted by large, interdisciplinary teams spanning different countries and institutions, and attracting generous funding by both public and private actors (Galison and Hevly, 1992). The first paradigmatic example of this way of doing science was the Manhattan Project to build the atomic bomb that eventually ended World War II. After this, biological research gradually grew and acquired the dimensions of 'big science', to the extent that in the 1990s the Human Genome Project was called 'the Manhattan Project of biomedicine' (Lenoir and Hays, 2000; Kevles, 1997). Historians have been rightly sceptical about these alleged shifts in scale, pointing to the coexistence of both large and small-scale models of doing biology throughout the 20th century (Pestre, 2003; Gaudillière, 2009; Bud, in this issue). However, recent biological research presents historically-specific contours that require attention at both the level of sources and of scholarly narration (Hilgartner, 2013; Aronova, Baker and Oreskes, 2010; Davies, Frow and Leonelli, 2013). In the life sciences, the rise of large-scale models has been driven less by the cost of gigantic experimental infrastructure than in the physical sciences. Rather, the driver here has been the complexity of biological systems, the study of which requires a diversity of practices, theoretical perspectives and experimental methods, at many different levels from the molecule to the organism.

This has resulted in the rise of the scale and disciplinary scope of biological research projects, involving large numbers of very diverse participants and generating huge masses of data. How to document these projects and write their history is a source of preoccupation for both historians and archivists. Humanities are being pushed towards scaling up small data to become a big data science, as data-driven research seems to hold promise for managing overabundant and heterogeneous evidence, especially within biology (Leonelli, 2012; Schreibman et al, 2004). Yet in the humanities as in the social and natural sciences, critiques challenge data-driven strategies and warn against theoretical deficit (de Chadarevian, 2009; Scheinfeldt, 2012; Carandini, 2015; Fisher, 2015). The authors contributing to this special issue all took part in a symposium jointly organised in October 2013 by the Wellcome Library and the Department of Science and Technology Studies at University College London, entitled 'Making the History of the Postwar Life Sciences', the goal of which was to explore whether it is desirable to transform biomedical history into a data-driven endeavour and the

alternatives to this course of action. The special issue came out of the desire to further develop some of the ideas that were fruitfully discussed during the meeting.

In their essays, the authors set out to explore the connections and interplay between historiographical and archival issues raised by the contemporary transformation of the life sciences into big science enterprises. Reflecting on narrative models, the nature and availability of sources, and the construction of archives, they challenge overly simplistic 'big data' strategies and propose a number of alternative methods for navigating 'big biology'. Despite the diversity of their objects and perspectives, the essays draw out a number of salient cross-cutting themes relevant to this overarching goal.

1. New sources for broader scientific narrations

The authors all highlight the importance of opening up the scope and remit of the scientific archive – of what counts as sources – for achieving a more inclusive definition of what 'doing science' encompasses. Broadening as an overall strategy may sound paradoxical coming from a joint effort that proposes alternatives to 'big data'. However, for reconstructing complex pictures, a selective focus on diverse small pieces may be more fruitful than the indiscriminate accumulation of masses of similar data (Subrahmanyam, 1997; Secord, 1993). In addition to questioning the adequacy of 'big science' as a specific post-World War II category, historians have criticised the view of recent science as characterised by an 'explosion of information.' Earlier periods also produced an overabundance of scientific records, many of which could not be indefinitely stored (Hughes, 1997; Müller-Wille and Charmantier, 2012). This suggests that the role of historians, and of humanities researchers more generally, may be working with a limited but meaningful set of evidence and focus their scholarship on the range and richness of the narratives that can be extracted from these records rather than on their number.

In this special issue, Susan Lindee addresses the problematic transition between microhistories and more comprehensive accounts to track the development of post-1945 human genetics and genomics. Her essay shows how microhistories can become the sources that build a scaffold for bigger picture narratives. She proposes risk as a category that emerged from her previous case studies and which allows the creation of a unified account of genetic research from the atomic bomb to the Human Genome Project. This account does not derive from the accumulation of 'big data', but rather from looking at pre-existing and manageable datasets with new eyes.

Miguel García-Sancho and Christine Aicardi address the problem of extracting meaning from historical datasets. Their essays propose narrative models for finding selective points of entry into big biology projects and navigating the multiple and dispersed records they produce. García-Sancho uses the administrative archives of big science projects as alternatives to individual scientists' papers. He singles out "the synthetic voice of the invisible administrator", as an actor who brokers between different epistemic communities and enables historians to harmonise disparate accounts. Using the life of the late Francis Crick as case study, Aicardi focuses on his role as an influencer, arguing that this was an integral part of his way of 'doing science'. She suggests that "'following the cross-worlds influencers' may be a fruitful heuristic for historians probing the rhizomic and genealogic entanglements of modern big bioscience."

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Different sources and points of entry into science result in different understandings of scientific practice. Norberto Serpente argues against a narrow conception of what doing science entails and proposes an alternative approach where pedagogy and experimentation are not segregated. This broader understanding leads him to select new sources, historicising and documenting molecular images as vehicles of knowledge production in textbooks. Serpente shows that for historians of ideas, there is value in interrogating such vehicles for the production of scientific knowledge, as well as in taking into account multimedia archives that include images as well as text. These archives allow looking at science as an artisanal endeavour that is disseminated by artists in cooperation with scientists. Soraya de Chadarevian reflects more broadly on recent changes in scientific practice, historiographical trends and archival strategies and evaluates the possible place of diverse categories of sources – paper records, digital files, material artifacts and oral histories – in the archives of contemporary life sciences.

Where de Chadarevian's reflections are driven by her historian's experience, Jenny Shaw brings an archivist's perspective to the same question and shows how genomics as big collaborative science is challenging traditional archival theory. She argues for a move away from traditional archival approaches to science (generally focused on retired famous scientists) towards trying to identify and capture records of significance both at the daily routine level of scientific work and beyond the purely scientific sphere. Sara Peres broadens further the notion of what may count as an archive. Focusing on genebanking and how it has been envisioned as a strategy for 'genetic conservation' of plants, she defends the view that it is analogous to archiving, since it enables the preservation of diverse genotypes, embedded in seeds, for future use.

Opening up the scope of sources and archives to novel media raises many issues. De Chadarevian and Shaw both address the problems posed by digital archives: problems which are not specific to contemporary science but rather to contemporary archives and which require new strategies for the curation and conservation of digital material. They also consider the issue of the place of objects – things – in archives, which brings into view the increasing overlap between the concerns of archivists and curators (see also Robert Bud's commentary piece). In Peres's essay, which analyses a different kind of material repository, the blurring between roles converges to the point that it becomes identification. She shows that the plant biologists who envisioned and designed the seed-storing genebanks that she has studied gradually became archivists. Another category of sources discussed in the essays is that of oral histories and interviews. The value they present for contemporary history is implicitly accepted in the essays written by Aicardi, Lindee, Peres, and Serpente, whose historical studies have all involved interviews. De Chadarevian and García-Sancho reflexively interrogate the methodological issues that contemporary historians face when combining oral histories with conventional archival material, as well as the benefits this may bring.

Ironically, broadening the scope of the sources, actors and activities used for documenting contemporary 'big biology' can also underline how archives reveal many things but hide others, and more generally, the limits and constraints facing both historians and archivists. The historian is at the mercy of external factors, shaping what it is possible to research, which has a huge impact on historiography. Some factors relate to the tacit norms of what is socially and professionally acceptable to record in particular settings. For instance, Lindee's essay highlights the absence, in archival records, of emotionally charged interactions between clinicians and patients. Other factors are linked not to the creation of records but to their availability. The way in which García-Sancho

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approaches the limitations of individual collections amounts to political work: locating 'black zones' in terms of sources and working to open them up, or at least contour them. The hoped-for result is a greater plurality of sources, which implies plurality of historiography. There are, however, archival sections that will never open and de Chadarevian suggests that the expansion of secrecy motivated by private commercial interests and military classification could be a key problem in the historiography of recent bioscience. Confronting this issue from an archival perspective, Shaw suggests that the approach adopted for the Human Genome Archive Project could be appropriate for identifying and preserving records, even when their owners are unable or unwilling to deposit them in archives. However, these may still be subject to access restrictions, which themselves may affect research.

2. The informational worldview and genetics as history

The proliferation of born-digital sources[1] relate to dematerialisation and more broadly, to the rise since World War II of a pervasive informational worldview across all life sciences (Fox Keller, 1995, 2002; Kay, 2000). Taken together, the essays of de Chadarevian, Peres and Shaw demonstrate that framing the life sciences within an informational worldview has made possible specific forms of archiving while preventing others. Serpente reacts against the dominance, within the life sciences' informational worldview, of the written text and advocates for the image. As he argues, images constitute a different source of information that may complement the traditional written record of the archive and allow for a broader historical reconstruction. However, the inclusion of images in archives – especially digitally-born ones – poses specific cataloguing and interpretative problems that, as de Chadarevian and Shaw show, are difficult to solve.

The emergence of this informational worldview was, to a large extent, the result of the colonising influence of physics in biology before and after World War II (Abir-Am, 1982). In this regard, it is striking that the approach that the Human Genome Archive Project adopted was partly inspired by previous archival initiatives developed by the American Institute of Physics. This and other large-scale physics institutions and technologies – namely CERN and particle accelerators – were the big science models from which the Human Genome Project first borrowed (Lenoir and Hays, 2000). The recurrent influence of physics in both laboratory biology and biological archives highlights intriguing similarities between scientific cultures and archival practices and, particularly, between genetics and history, something that has already been suggested by historians (Palladino, 2003; Santesmases et al, 2013) and that this special issue builds upon.

In her contribution, Lindee argues that modern genetics was and remains a risk assessment science, which is temporally embedded as a form of both prediction and historical reconstruction. A great deal of the current success of ancestry companies – which sequence part of the genome of customers in search of their family pedigrees – is due to the fascination that history and the unknown past exerts among the public. Peres shows that the conception of 'genetic capital' as information is an important step towards dematerialisation, and further, that it is key to the understanding of genebanking as archiving. Her essay highlights how the way in which genebanks have been conceived and assembled brings them closer to biobanks and historical archives than to

[1] Born-digital sources are sources which original form is digital, in contrast to digitized sources.

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projects of conservation: genebanks are aimed at use and intervention rather than 'conservation' in the environmentalist sense of the word, and are imbued with a potential for acting on the future. In this sense, they are a paradigmatic example of past acting on a particular imaginary of the future, which is a defining characteristic of archiving processes (Daston, 2012).

The way genebanks are conceptualised takes for granted a future end to natural evolution, where variability and diversity have ceased to occur naturally– partly due to the predatory activity of humans – and scientists have to engineer evolution through intervention into a passive and time-frozen repository of stored seeds. This interventionist motivation points to the inherently political dimension behind any archival project. The identification of what is to be kept and what to be forgotten decisively shapes the image of the past and the foundation for future action in societies. García-Sancho's contribution traces the roots of these politically-informed archives from before there was a talk of 'big data' or of biology as an information science. He advocates for the active participation of historians in this collective memory-building process, in line with other scholars who have argued for an increased engagement of historians of science with the recent past (Söderqvist, 1997; Doel and Söderqvist, 2006; Bud, in this issue).

3. Proactivity

The push for reflexivity in the humanities and social sciences is leading historians to increasingly interrogate their role as researchers and their relationship with the natural sciences. This has been fostered by funding calls – particularly within the European Union – that advocate for embedding historical, philosophical and sociological scholarship into broader research problems that are also addressed by the natural sciences, such as aging or global warming. The move has been received with scepticism by some researchers, who consider it a potential threat to the independence of the humanities and the social sciences (Levidow, 2014; Calvert, 2014). However, being embedded in the discussions and laboratory activities of the natural sciences enables historians and social scientists to develop a less reactive and more interventionist approach to their objects of study.

This reflexive and proactive approach has also permeated the world of archives, as Shaw's contribution to this special issue shows. Her choice of strategy for the Human Genome Archive Project comes as a reaction against reactive cataloguing and blind trust in the scientists who own the records. The proactive archivist self-consciously defines herself in complete opposition to the tradition of the passive curator who did not make selecting decisions. Not only does she make selecting decisions in choosing what to keep and what to discard in a particular collection: Shaw also scopes and decides on the perimeter of the scientific project in respect of the archive, surveys laboratories, approaches scientists and engages with extra-scientific actors, such as patient organisations or advocacy groups. Her archive is linked up with those of other collecting institutions to establish networked and complementary repositories.

Shaw's reservations about passive collecting resonate with Aicardi's circumspection regarding the biographies and autobiography of Francis Crick. In her essay, Aicardi warns against the limitations of the retrospective memories of scientists and the way these are propagated when they become the basis of public discourse or archival selection. Reactive archivists or trusting biographers perpetuate this version of history by exclusively basing their work on interviews with the scientist or the archive

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he or she has curated. Aicardi shows that a different interpretation of Crick's life significantly widens both the testimonies that are collected and the archival materials that are found. Her argument echoes other historians' critiques of the limitations of memory (Gaudillière, 1997), and the distinction between first and second order accounts (Abir-Am, 1985). Proactivity in history, as García-Sancho argues in his contribution, involves designing a second order account whose aims and motivations are different from the first order account of scientists.

García-Sancho thus proposes a proactive historian who mirrors Shaw's proactive archivist. He encourages historians of science to intervene in their field, as with Peres' genebank curators, and reinforces the parallel between history and genetics. García-Sancho challenges the value that historians of science have traditionally attributed to the perspective of time for sorting what counts from what does not in history, and urges them to make their voices heard in the politics of scientific memory. His essay shows that the exercise in reflexivity that historians of science have engaged in has progressively led to accepting the symmetrical subjectivity of both historians and scientists, and tries to conceptualise this insight and make it performative for contemporary historians' work.

This proactive historian appears to inhabit a liminal space between the recent past and the present, or between history and anthropology. The growing questioning of the past-present divide can be seen as a long-term consequence of the 'practice turn' in historiography which, as discussed by de Chadarevian, has led to interest in new sources – material artefacts – and methodologies – oral histories. From this perspective, an anthropologist embedded in a natural science project could be regarded as an extreme instance of proactive historian: collecting the testimonies of scientists and sharing the laboratory equipment at the moment in which these discourses and practices cross the boundary between present and past.

4. Conclusion: collaborative horizons vs data accumulation

The essays in this special issue demonstrate that a proactive approach to recent big science offers an opportunity for historians to expand their intellectual horizons. The multiplication of actors, institutions and sources in big science projects paves the way for collaboration between historians and those responsible for the curation of scientific objects, images and archival records. The theoretical and methodological concerns of these curators are getting closer to those of historians, both seeking independence and a distinctive voice in the management of the ever-increasing accumulation of scientific information. Historians and archivists may collaborate in the use of oral history as a tool to probe the scope and depth of a scientific collection before its cataloguing. This may help both of these actors to press scientific institutions for broader transparency and reforms in their "memory practices" (Bowker, 2005).

Hybridising archivists and historians may result in *better sources* – rather than *new sources* – becoming available for research. Ongoing collaborations between the authors of this special issue have resulted in a broader awareness by the Wellcome Trust of the historical significance of its corporate records. These records were largely produced by administrators and do not strictly sit in the personal collections of any particular prominent scientist. Interest from historians and an improved communication with archivists have helped the latter to request their cataloguing at the

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Trust. The new materials will greatly complement the collections already available at the Wellcome Library.[2]

These experiences suggest that an answer to documenting and historicising recent 'big biology' may be a brand of multidisciplinary and collaborative humanities. These new humanities would overcome the confines of history and academia, and lead the past and present of biomedicine to new horizons, questioning their work-as-usual routines and curating records that go beyond the accumulation of big data. Embedding different traditions, finding novel approaches to what counts as 'doing science' and proactively engaging with imagined futures have been described by many as the new challenges of the historical and social study of science (Jasanoff and Kim, 2009; Felt, 2014). The essays in this special issue propose various strategies relevant to achieving this goal.

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[2] See http://wellcomelibrary.org/collections/digital-collections/makers-of-modern-genetics/ (last accessed September 2015).

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