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A Global History of Research Education

Disciplines, Institutions, and Nations, 1840–1950

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Introduction

Ku-ming (Kevin) Chang and Alan Rocke

Few would question the value of advanced research today. Considered key to the health and wealth of a nation, research universities receive ample support, especially when global university rankings draw countries into a new level of international competition. Our age has come to assume that an academic career, characterized by the pursuit of new knowledge, starts with a doctorate, generically known as the PhD. Doctoral education prepares the student for a career in academia or industrial research and development, and culminates with the presentation of novel research results in a dissertation that is based on years of original research in a specialized field. This established pattern of research education, taken for granted today, first emerged in parts of the West only in the nineteenth century, and even later in the other parts of the world. This volume studies the emergence and development of research education across disciplines in major areas of the globe—Europe, North America, Latin America and Asia—over the second half of the nineteenth and the first half of the twentieth centuries.

The period that this volume studies saw many fundamental changes in the history of higher education as as well as the history of science. It was an age of reform. Previously across Europe the university served to pass on traditional knowledge and prepare students for the traditional professions. After the French Revolution, European universities began to diverge from the more or less homogeneous structure that they had shared since the Middle Ages. Germany, the kingdom of Prussia especially, reformed its system of higher education by making original research imperative for professors and by providing research training to students. France and Britain held on to different systems of higher education as these modern nation-states asserted their national differences. In the middle and later decades of the nineteenth century, when the virtues of German universities became apparent, they and other European and North American countries began to reform their universities more or less

Ku-ming (Kevin) Chang and Alan Rocke, *Introduction* In: *A Global History of Research Education: Disciplines, Institutions, and Nations, 1840–1950*. Edited by: Ku-ming (Kevin) Chang and Alan Rocke. *History of Universities* XXXIV/1, Oxford University Press (2021). © Oxford University Press.
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according to the German model. The pursuit for new knowledge was thus embraced as a core value of the university.

It was thus an age of institutional transformation. The university developed into the uncontested institution in which scientific researchers were trained. Previously, researchers could have received advanced training at institutions other than universities. In the eighteenth century, for instance, members of the Royal Academy of Sciences in Paris often began their career as a pupil in the academy and then worked their way up to become associates and then salaried members. These members received no university education. Even in the nineteenth century, many noted British and American scholars began their training and finished their careers in independent research institutions, museums, or libraries. By contrast, developments during the age under study have led us to expect all academics or research scientists to have received graduate university training before their careers begin.

It was an age of innovation. Ingenious discoveries were made, great scientists celebrated, and new research institutions founded. It was also a period of specialization. A remarkable number of new disciplines—anthropology, sociology, linguistics, statistics, and paleontology, among others—were established in this period. Established fields then began to subdivide into further specializations, for instance, chemistry into organic, physical, and biological chemistry. Finally, it was an age of academic globalization, even if not on a scale comparable to today. Non-Western societies in many parts of the world introduced universities at home, and constantly sent students to study in the West, assigning to them the task of transplanting at home the knowledge and institutions that transformed Western countries into great powers.

Considering the importance of research education today, it is not surprising that it has been the subject of intensive scholarly analyses. Some scholars have examined the system of a particular country, such as Arthur Levine, *Educating Researchers* (2007), Ronald G. Ehrenberg, *Educating Scholars: Doctoral Education in the Humanities* (2010), and Jonathan Cole, *The Great American University: Its Rise to Preeminence, Its Indispensable National Role, Why it Must Be Protected* (2009). Other studies are cross-national or comparative: for example, Burton R. Clark, ed., *The Research Foundations of Graduate Education: Germany, Britain, France, United States, Japan* (1993), and Philip G. Altbach and Jorge Balán, eds., *World Class Worldwide: Transforming Research Universities in Asia and Latin America* (2007). There are also important studies on the qualification for the academic profession, including Burton R. Clark, *The Academic Life: Small Worlds, Different Worlds* (1987), Philip G. Altbach, ed., *The*

International Academic Profession: Portraits of Fourteen Countries (1996), and Anthony Welch, ed., *The Professoriate: Profile of a Profession* (2005). However, these analyses of doctoral education and academic profession rarely go back before World War II, devoting minimal attention to the history of the academic profession and research education.

This is not to say that histories of universities are in short supply. Standard works on individual institutions (Berlin, Oxford, Cambridge, Johns Hopkins, Harvard, Princeton and many others) and national systems of higher education are numerous. Among the most important ones are those by Friedrich Paulsen, R. Steven Turner, and Charles McClelland for German universities, Louis Liard, George Weisz, and Lawrence Brockliss for France, Stanley James Curtis and R. D. Anderson for Great Britain, and Roger Geiger, John Thelin, James Turner and James Axtell for the United States. Synthetic or comparative histories of universities are also available. These include R. D. Anderson's *European Universities in the Nineteenth Century* (2004), the four-volume *History of the University in Europe* published by Cambridge University Press (general editor Walter Rüegg), Sheldon Rothblatt and Björn Wittrock, eds., *The European and American University Since 1800: Historical and Sociological Essays* (1993), Ana Simões, Maria Paula Diogo, and Kostas Gavroglu, eds., *Sciences in the Universities of Europe, Nineteenth and Twentieth Centuries* (2015), and Rainer Christoph Schwinges, ed., *Humboldt International: der Export des deutschen Universitätsmodells im 19. und 20. Jahrhundert* (2001). The last-cited work even includes Japan and China, thus extending its attention beyond Europe and North America.

In addition to the histories of academic institutions, there are many important works on individual scientists and disciplines (Justus Liebig in chemistry, Leopold von Ranke in history, and Emile Durkheim in sociology, for instance). Others pay close attention to scientific training in an individual discipline, such as Gert Schubring, *Seminar, Institut, Fakultät: Die Entwicklung der Ausbildungsformen und ihrer Institutionen in der Mathematik* (1983), Kathryn M. Olesko, *Physics as a Calling: Discipline and Practice in the Königsberg Seminar for Physics* (1991), Andrew Warwick, *Masters of Theory: Cambridge and the Rise of Mathematical Physics* (2003), or David Kaiser, *Pedagogy and the Practice of Science: Historical and Contemporary Perspectives* (MIT Press, 2005). In fact, several contributors of this volume have published leading research on the history of individual scientists and disciplines.

The present special issue/volume constitutes an effort to present a comparative and global history of research education that has so far not been available. The contributors survey or compare cases of a diversity and breadth that has rarely been attempted. Indeed, few previous works have examined China, India, Japan, and Latin America in one volume, and few have covered such a great number of disciplines as this volume does. Moreover, each of the following comparative or case studies in this volume is original in its own right. They either first ask the question (for example, regarding the connection between research training and disciplinary identity, as in Chapter 1; or the 'unruly' disciplinary character of statistics, as in Chapter 7), or conduct the first comparative studies of the implementation of research education for an individual discipline (mathematics, for example, as in Chapter 4). They may develop a new line of inquiry based on the author's previous research (such as John Joseph's chapter on the disciplinary identity of linguistics that draws from his biographical study of Ferdinand de Saussure). Or they may constitute the first case studies that examine the developments of research education in individual disciplines in non-Western societies. Collectively, they complement and fruitfully complicate the available literature in three major areas: institutions, disciplines, and the roles of nations or states. They move beyond present literature in tracing the spread of the research ethos across Europe and the Atlantic, and even to societies in South and East Asia.

The primary subject of all the chapters is the foundation of research education in countries across the globe. We are careful to use the term 'research education' in ways that reflect national or institutional differences. Though today we readily identify doctoral education with graduate study and research training, neither identification was universally the case in the nineteenth century. In Germany, though doctoral study did indeed require training in research, the *Doctor philosophiae* (D.phil.) was the first degree after secondary education, and in that sense it was not strictly speaking a graduate degree. In contrast, the French *doctorat d'état* was a graduate degree (after the *licence* and the *agrégé*)—but research was not an essential requirement for the degree until at least the middle of the century. In Britain, short graduate programs (those for the Bachelor of Science, now obsolete, and the Master of Science) and degrees that acknowledged a record of publications (Doctor of Science, known as DSc., and Doctor of Letters, known as DLitt.) were not available until late in the century, and the Doctor of Philosophy degree not until the First World War. None of these degrees were a *sine qua non* for an academic career until even later in the twentieth century. Strictly speaking, Britain therefore had no doctoral education until the establishment of the PhD. If research education was available, it was accommodated at the undergraduate or at most the master's level, or it was informal. This was also true in British colonies like India. Likewise, Japan and its colonies established graduate school but provided no formal education for it. Though they established doctoral degrees, they did not require it for an academic career. China had no doctoral programs at all until around 1980. By contrast, American universities adopted the PhD earlier than their British counterparts (which had previously been their model). They introduced this degree as one above the Bachelor of Arts, making it a true graduate degree. They also required for this degree resident study of several years and a dissertation based on original research. Thus, for a considerable part of the period surveyed in this volume, although original research and publications of its result were increasingly desirable, or even required, for an academic career almost everywhere, 'graduate curricular study' in a strict sense was not applicable to Germany, France, and Japan, while resident doctoral education was not available in the French and British Empires and China.

It is for these reasons that we describe our subject as 'research education' rather than doctoral education (unless it is appropriate in specific contexts to do otherwise), for it fits all cases in this survey. There is no doubt that we place an emphasis on research training that was provided in the university, while staying well aware that research did not take place exclusively in universities in this period. This emphasis is justifiable, since over this period specialized training in the university transformed into a qualification that was required (or at least welcomed) by academia and industry alike that centered on advanced research. After this transformation, the PhD that provides education in research has become the highest degree that academia can accord and the badge that all academics wear for their career. In this sense research education is the highest education.

As the chapters in the volume will collectively show, the period under study also coincided with the decline of religion in the university. This is especially true for European universities, which started in medieval Europe essentially as Christian seminaries with allied training in medicine or law, but in which the faculty of theology was almost always the most powerful faculty. In the early modern period, and even more in the nineteenth century, secular pursuits strengthened in the university, while the faculty of philosophy, to which the disciplines in the humanities and most natural sciences belonged, became the model for all the other faculties for its rigor and prestige in academic research. In France and some other European countries (such as the Netherlands), the faculty of philosophy was split into the faculties of letters and sciences, whereas in the Unites States it was the graduate school, instead of the undergraduate college, that represented the advanced intellectual pursuits of the university. But the results seemed to converge in all Western countries towards the secularization of university education.

Our sensitivity to institutional cultures leads us to investigate, comparatively, different 'instruments of research', the second theme that runs across all chapters. Several chapters in this volume consider major instruments of research, such as the seminar, the laboratory, fieldwork, and statistics, based on our contributors' archival work and close biographical analyses. Others point out less formal, and less studied, instruments of research. At Oxford and Cambridge, students interested in advanced study benefited from conversations in the dining hall, tutorials in colleges, essay questions in honour exams, and thesis contests for college scholarships. In France, junior humanists relied heavily on correspondence with their supervisors in Paris, since they often taught in the provinces. American, Asian, and even a notable number of European scholars took advanced study trips aboard before or after the receipt of their doctorates. All the chapters in this volume heed the different uses and local adaptations of these instruments. Along with the instruments of research we also analyze research education into different modes, as will be made clear in the conclusion.

The third major theme treated by the authors of this volume comprises the research training for individual disciplines. There are, to be sure, too many disciplines to cover in a single volume. We select representative disciplines in textual studies (classical studies, philology, and history), laboratory sciences (chemistry), theoretical sciences (mathematics and physics), field sciences (archeology, paleontology, and language studies), clinical science (medicine), and even areas of studies that were not or could not be fitted into a single discipline, such as statistics.

One crucial and little-explored issue in that relationship is *inter*-disciplinarity. Previous studies on research education have mostly focused on a particular discipline. We jointly compare a wide spectrum of disciplines, and deliberately include both the humanities and natural sciences, which together constitute modern academia.

In addition, we examine the relationship between research training and disciplinary identity. Academic disciplines constantly shape professional identities by the training that young scholars receive. They—philology, history, and mathematics, for example—solidify their identities by training advanced students in the skills, methods and questions that they consider essential. We also consider the proliferation of disciplines in the age of expansion of higher education, showing that new disciplines, such as linguistics, forged a new identity with the training in new materials (dialects or indigenous languages, for example), new methods (e.g. fieldwork), and new technologies (such as the kymograph and the phonograph). We even explore the reproduction of disciplinary identity and the multiplication of research teaching beyond local and national settings.

We have striven to include cases in the widest possible variety of countries or societies. As summarized above, in the century of nationalism higher education in Europe developed different national features, which several chapters of this volume examine. Outside Europe, we include investigations of non-Western societies in Latin America, South Asia, and East Asia that have risen to be prominent actors in global economies and higher education—while acknowledging that Russia and Muslim countries are not represented in the volume due to length constraints. Some of these non-Western societies were sovereign states, which could choose their own systems of higher education despite political, economic, and cultural limitations. The result of their choice was always an amalgamation of different elements of foreign and domestic origins. We will see that colonized peoples often first experienced the conflict between traditional learning and Western education, and when they requested more and better access to higher education, they invariably faced racial discrimination. When higher education became available, it was usually introduced in the model of the imperial metropole.

Amid nationalism, imperialism, and colonialism, we also indicate a degree of internationalism. As will be seen in the chapters, this internationalism is reflected in the large flows of international students, missionary institutions of higher education, and philanthropic programs in non-Western countries. In an extreme case, colonized Koreans used the missionary-supported Severance Medical College and Hospital as a shelter for medical education and research to defy the discriminatory control of the colonial authorities. Many chapters in this volume are comparative or transnational (or both) in themselves. The concluding chapter especially provides a summary analysis of all the chapters in a global perspective. True to this historical internationalism, and to the global spirit of our age, we have striven to make this volume a global history of the origins, dissemination, multiplication, proliferation, and local adaptations of research education.

This special issue starts with James Turner's analysis of the formation of disciplines and research training, exploring the possibility of a causal relationship. He covers subjects and themes central to this volume, though not all contributions consider the causal relationship between scientific training and disciplinary identity. Then comes Kasper Risbjerg Eskildsen's study of the historical seminar in Germany and its role as a model for historians in other European and American countries. Chapter 3, by Alan Rocke, presents an international comparison of chemical education and research in nineteenth-century Europe, starting with the case of Justus Liebig at the University of Giessen. Karen Parshall offers a similar comparison for mathematics, though placing an emphasis on the learning experience of the American mathematical community. Next, Janet Howarth, based on a close analysis of the careers of members of the British Academy, presents a synthetic account of their training. Then Daniela Barberis analyzes the training for emerging social sciences in France, which, like England, did not provide formal training that required resident study; her focus is on Émile Durkheim and the junior scholars around him. In Chapter 7 Theodore Porter demonstrates what the author calls the 'unruly character' of statistics that did not fit into a disciplinary mold.

In his chapter, John Joseph traces the extraordinary trajectory of Ferdinand de Saussure's study amid those of ordinary German and French students in the field that eventually became linguistics. Chapter 9 compares research training in language studies in four major Western countries. These two chapters therefore delineate the development of a discipline across World War I, a watershed of sorts for international politics as well as academia.

The rest of the volume investigates the beginning of research training in non-Western countries. In Chapter 10, Ana M. Alfonso-Goldfarb, Márcia H.M. Ferraz, and Silvia Waisse offer a concise survey of higher education in Latin America, ending with a close study of the first generation of Brazilian research chemists. Yoshiyuki Kikuchi studies laboratory teaching and training in Meiji Japan in Chapter 11. Then John Mathew and Pushkar Sohoni review the scientific teaching and research in Colonial India, taking Bombay as their example. Chapter 13, by Danian Hu, examines the undergraduate and master's teaching, which supported students to take up research, at the Department of Physics at Yenching University in Republican China. Hsiao-pei Yen investigates the start of paleographical research and fieldwork, also in Republican China, in Chapter 14. Next, In-sok Yeo surveys the training of medical researchers at the imperial university and the missionary medical college in colonial Korea. Wei-Chi Chen, Wan-yao Chou, and Ku-ming (Kevin) Chang analyze the formal and informal research training in Southeast Asian history and ethnology during Taiwan's colonial rule and a few post-war years. The volume closes with a conclusion that summarizes the major findings of the contributions to the volume.

As no one author can cover all the different disciplines and countries, we have assembled here a group of specialists who are interested in comparative and global studies. Most of them met at the Academia Sinica in Taipei, Taiwan, in a two-day conference in December 2015, which established the groundwork for this volume. We organized a program that comprised diverse senior as well as junior historians of the humanities and the social and natural sciences. The present volume is the product of the conference and the subsequent vigorous exchanges and revisions. It is thus a joint product not only of written studies, but also of in-person discussions and collaboration.

We hope that this addresses the interests of at least four groups of readers. This first is of course the readership of the *History of Universities*, since it is first and foremost a history of research universities. By extension we hope it also addresses the concerns of government officials, educators, college students, and the public at a time when no country or university can ignore global university rankings. This collection of essays presents an analytical account of the genesis of modern research universities and academic disciplines in representative countries and regions, and tells the history of the foundation on which global rankings of research universities are based.

Another group of readers consists of scholars and students of the history of the humanities and science, and of science and technology studies. The history of science has become a discipline in its own right, and the closely related field(s) of science and technology studies have gained academic programs or research centers that bring together historians, social scientists, natural scientists, and engineers. The history of the humanities as a field, growing rapidly, has won its own journal and society. It thus has its semi-independent readership, though sometimes overlapping with that for the history of science.

Finally, this project addresses the community of global studies. The expansion of higher education across Western and non-Western countries was an integral part of what is now called the first wave of globalization (ca. 1870–1914). The internationalism of higher education described above is just an example that demonstrates that the pursuit for research education, by junior scholars or governments sovereign and colonial alike, was interwoven with many other dimensions of globalization, thus warranting a prominent place in global studies. It will be pointed out in the conclusion of this volume, however, that the globalization of research education was not always at the same pace as economic globalization. Still, the patterns distilled from the study of this period can then be compared with those of academic exchange in the second and third ages of globalization.

In sum, our goal with this volume has been to enrich our understanding of modern higher education in its historical, institutional, disciplinary, national, and transnational contexts, to fruitfully complicate the history of science and the humanities that has often been based on studies of individual scientists, disciplines or countries, and to augment global studies with cases on research education and academic exchange. We hope that it will generate productive dialogues with the readerships in these areas, and continue healthy internationalism in academic pursuits, analyzed in this volume, at a time when the global spirit is under attack.

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1

Discipline Formation and Research Training: Chicken or Egg?*

James Turner

Introduction

Each of the chapters in this collection inquires into how education for research developed in a specific discipline or cluster of disciplines. So at the outset it may be useful to stand back from any one discipline and ask a meta-question that pertains to all. What is the relationship between the development of training specifically for research and the appearance of modern disciplinarity as such? Even though unspoken, this link between disciplinary-mindedness and disciplinary training lies behind each of the following studies of particular disciplines. I throw up my hands at the ancient paradox of which came first, the chicken or the egg. But it might prove illuminating to try to unravel a similar riddle in the history of academic knowledge: did disciplines precede training for research in them, or vice-versa? I have neither the learning nor the hubris to tackle the wide ranges of time and space that my fellow contributors cover in this volume, and I doubt in any case that evidence has yet been assembled that would enable a worldwide investigation into links between disciplinarity and education for research. So, a demure modesty forced upon me, I shall limit my reconnaissance to narrower terrain that for a quarter century I have mapped various bits of.

In the United States and United Kingdom, during the late nineteenth and early twentieth centuries, modern academic disciplines appeared, based in universities. At about the same time, specialized training in those disciplines also commenced. In both countries, such training for research

* I thank Professor Caroline Winterer of Stanford University for her incisive suggestions about a first draft of this chapter and the attendees at the conference 'Training of Research Scholars: Institutions, Disciplines, and National Cultures' at the Academica Sinica, Taipei, December 2015, for helpful comments on a second draft.

James Turner, *Discipline Formation and Research Training: Chicken or Egg?* In: *A Global History of Research Education: Disciplines, Institutions, and Nations, 1840–1950*. Edited by: Ku-ming (Kevin) Chang and Alan Rocke. *History of Universities* XXXIV/1, Oxford University Press (2021). © Oxford University Press.
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took place after students had earned their first university degree. In the US research training typically took place within a formal degree program, in the UK often through less formal mentorship. Post-graduate fellowships frequently supported training in both the US and UK. (These patterns are worth noting because, even as research training was becoming commonplace across the globe, frameworks for it varied widely.) Different disciplines formed at different times. But, in every case I know, instruction in research in the discipline began very close in time to the discipline's formation. This coincidence in time is manifest in the literature, whether one looks at general histories of higher education, such as Roger Geiger's recent book on American higher education, or histories of specific disciplines, such as Peter Novick's classic study of the US historical profession—even though such authors rarely, if ever, comment on the coincidence.[1]

To rephrase the query, now in this more limited, English-speaking, north Atlantic context: Which came first, the discipline or advanced training in it? At first the question seems silly because the answer looks so obvious. The discipline *must* have come first. How could anyone train people to pursue research in a discipline that did not yet exist? But think for a moment. A *field of study* is not necessarily a *discipline* in the modern academic sense. At least in principle, advanced education might evolve in a field before that field became a discipline.

So we must first ask what constitutes a discipline. Why does the question matter? Consider the present status of disciplinarity. Disciplines are so integral to modern academic knowledge that they fade into the landscape, and often the character of disciplinarity itself (as distinct from the qualities of a particular discipline) does not seem to need explication. An excellent recent history of *inter*disciplinarity devotes much time and intelligence to defining interdisciplinarity but never sees a need to explain the *disciplinarity* that logically precedes interdisciplinarity.[2] Disciplines are just *there*.

Yet the birth of modern disciplinarity was unprecedented and momentous. Discipline-formation transformed all academic knowledge, from the natural sciences to the human sciences. It splintered knowledge into newly distinct, separate provinces. So it does need to be explained, its nature and

[1] Roger L. Geiger, *The History of American Higher Education: Learning and Culture from the Founding to World War II* (Princeton, 2015), especially Chap. 8; Peter Novick, *That Noble Dream: The 'Objectivity Question' and the American Historical Profession* (Cambridge, 1988), *passim*. I cannot think of a historian who has paid attention to this issue of timing, though my knowledge of these literatures is hardly exhaustive and my memory belongs to a 70-something.

[2] Harvey J. Graff, *Undisciplining Knowledge: Interdisciplinarity in the Twentieth Century* (Baltimore, 2015).

origin understood. This job may be especially urgent today when interdisciplinarity is the Hallelujah Chorus sung by university administrators and when disciplinarity has come under growing criticism, particularly perhaps in the humanities, for allegedly promoting hyperspecialization and blocking a broad view of interrelated problems. What exactly are we academics talking about when we talk about—or rant about—disciplines and interdisciplinarity? The question is complex and delicate, with a history still surprisingly obscure, considering how much ink has been spilled in arguing about it. Again, I mean not the much-written-about historical background of specific disciplines—'the rise of English studies' or the 'history of sociological analysis'—but the history of our modern notion of disciplinarity as such.[3]

For scholars writing (or reading) in English, semantic confusion may hide the radical change that disciplinarity brought. The word *discipline* has been used in academic contexts for centuries. It could mean *instruction*, but it could also mean *a branch of knowledge*. Already around 1400 Geoffrey Chaucer used *discipline* in the latter sense in his *Canterbury Tales*.[4] But this long persistence of the word in academic usage obscures the discontinuity created when disciplinary specialization took off in the nineteenth century, especially the later nineteenth century. Comparing earlier uses of *discipline* with more recent usage makes the novelty easier to see. Textual philologists in the sixteenth and seventeenth centuries, for instance, agreed broadly on the kinds of problems to address and on methods to resolve them. They also developed distinctive tools for keeping track of information (such as commonplace books) and for spreading knowledge (such as commentaries and editions).[5] These shared traits made textual philology a discipline. But such early-modern disciplines in no way monopolized a scholar's time and energy. One individual might study ancient Roman archaeology, the Bible, and medieval English literary texts. Disciplines around 1900 also agreed on their problems and methods. They, too, developed distinctive technologies for organizing data (like files of index cards) and for broadcasting knowledge (like discipline-specific journals). Yet modern disciplines grew much more strictly divided. By the 1920s vanishingly few—if

[3] D. J. Palmer, *The Rise of English Studies: An Account of the Study of English Language and Literature from its Origins to the Making of the Oxford English School* (London, 1965); Tom Bottomore and Robert Nisbet, (eds.), *A History of Sociological Analysis* (New York, 1978).

[4] *Oxford English Dictionary*, s. v. *discipline*; Geoffrey Chaucer, 'The Canon's Yeoman's Tale', line 700.

[5] See, for samples of this early-modern world of learning, Ann M. Blair, *Too Much to Know: Managing Scholarly Information before the Modern Age* (New Haven, 2010); Anthony Grafton, *Joseph Scaliger: A Study in the History of Classical Scholarship*, 2 vols. (Oxford, 1983–93); Peter N. Miller, *Peiresc's Europe: Learning and Virtue in the Seventeenth Century* (New Haven, 2000).

any—scholars would try to edit Roman poets, *Paradise Lost*, and the New Testament, as the Cambridge philologist Richard Bentley did in the early eighteenth century, or to publish on ancient Greek temple architecture, Ralph Waldo Emerson, and Dante, as the Harvard professor Charles Eliot Norton did in the late nineteenth.[6]

The triumph of disciplinarity was not inevitable. It did not inexorably flow from the piling up of more and more information, so that (as I often hear) eventually these data just had to be divided into manageable heaps arranged by subject matter. People have always had 'too much to know', to steal the title of Ann Blair's masterful book on scholarly information-management in Europe before the modern age.[7] Disciplinarity is one way, not the only way, of organizing massive information flow. Nor did the rise of the research university demand that scholars and scientists now pledge allegiance to a single modern discipline. The anatomist and historian Elliott Coues, the paleontologist and ethnologist William Dall, the anthropologist and ornithologist Henry Henshaw, the geologist and archaeologist William Holmes, the meteorologist and astronomer Cleveland Abbe, the theologian and experimental psychologist George Ladd, the archaeologist and geologist Newton Winchell, the economist and sociologist William Graham Sumner, the bacteriologist and archaeologist Theophil Prudden, the zoologist and art historian Edward Morse all flourished in the era when research universities came to dominate the academic landscape, just to cite several examples who appear in the *American National Biography Online*. In fact, there is good reason to believe that two *different* ideals of research competed in the new research universities. One was the disciplinary specialization still familiar to us. The other might be called a paradigm of 'common erudition'. Both demanded deep research, both deprecated dilettantism. Both required thorough learning, both valued real expertise. But where one ideal posited little or no connection between specialized areas of knowledge, the other continued to regard the map of knowledge as undivided and to insist that a scholar or scientist could work responsibly in two widely separated locations on it. The struggle over the research ideal did not pit ignorant 'generalists' against erudite 'specialists' but involved two opposed notions of how research should be carried on.[8] Contingent events not yet well understood, rather than inexorable fate, eventually brought victory to the disciplinary specialists.

[6] Kristine Louise Haugen, *Richard Bentley: Poetry and Enlightenment* (Cambridge, MA, 2011), 130–49, 170–81, 188–95, 205–10, 219–29; James Turner, *The Liberal Education of Charles Eliot Norton* (Baltimore, 1999), 295, 310, 333–4, 398, 488, 489, 492.

[7] Blair, *Too Much to Know.*

[8] James Turner, 'The Forgotten History of the Research Ideal', in Turner, *Language, Religion, Knowledge: Past and Present* (Notre Dame, IN., 2003), 95–106.

What qualities, then, define these new-model disciplines, our disciplines? First, their practitioners normally see themselves as expert in a single area of knowledge. That is, scholars and scientists regard their discipline as set apart from other disciplines, pursuing different subjects with different methods. Second, modern disciplines have institutional walls, such as academic departments, to divide them. These walls have leaked ever since they were built; yet historians, astronomers, and sociologists do hobnob mostly with members of their own clan when sharing their research or discussing teaching in their discipline (as distinct from when griping about the university administration or arguing over how to tweak the college's curricular requirements). Third, modern disciplines develop a scholarly infrastructure that fosters dialogue within the discipline and discourages communication across disciplinary lines. Disciplines construct learned societies like the (US) College Art Association, where art historians read papers to each other; and they spawn disciplinary publications such as the (UK) *Economic Journal*, where economists write for each other. These last two traits—institutional walls and disciplinary infrastructure—follow from the first. If professors did not understand themselves as belonging to a single specialized discipline, they would create neither university departments nor journals devoted exclusively to that discipline.

Where did learned men and women get this idea of directing their energies to a single discipline? The question matters. Attacks on disciplinarity today focus on the scholarly weaknesses arising from self-dedication to a single, insulated field of knowledge—and defenses of disciplinarity invoke the strengths entailed in just such a focus. The question also brings us back to the relationship between discipline-formation and advanced training in scholarship.

I have only begun to nose around in the history of disciplinarity. Indeed, every piece of evidence that follows derives from research I undertook on other aspects of the history of academic knowledge. In this research the novelty—and puzzling origin—of disciplinarity kept intruding, even though I was not looking in that direction. But, ipso facto, my information is limited and unsystematic. I know the history only of disciplines in the humanities and humanistic social sciences in the English-speaking world, and that only partially and tentatively.

If you do not see where to head, you can only take a leap in the dark. I am going to hazard a hypothesis about the link between discipline-formation and advanced training in research, derived from two case studies. The first involves a pair of anthropologists at Oxford just after 1900. The second concerns graduate education in the last quarter of the nineteenth century at America's first thoroughly research-oriented university.

Two cases amount to anecdotes, not data; but anecdotes can set us thinking about why disciplinarity developed when and as it did.

The first case centers on an Oxford student and her mentor. The student was Barbara Freire-Marreco (1879–1967), who in 1908 was awarded the first diploma for postgraduate study in anthropology.[9] Her mentor was John Linton Myres (1869–1954), who helped to create the diploma program just mentioned.[10] Consider Myres first.

A British social anthropologist today would regard Myres as a founder of her discipline. Besides shaping the program at Oxford, in 1901 he initiated the Royal Anthropological Institute's monthly journal, *Man*. Later he served as president of the Institute (1928–1931).[11] In 1912 he co-edited the fourth edition of *Notes and Queries on Anthropology*, a standard reference. In 1923 he published a book on Neolithic and Bronze Age cultures, in 1934 another on the ethnology of prehistoric Indo-European peoples.[12] He was a recognized authority on Ice Age humans in Europe.[13] In the 1920s he headed the Folk-Lore Society.[14] An anthropologist to the core.

But wait! As a young fellow of two Oxford colleges, Myres worked mainly on early Greek archaeology.[15] In 1907 he moved to Liverpool University as professor of Greek and lecturer on ancient geography. He returned to Oxford in 1910 as Wykeham Professor of Ancient History. In 1914 he delivered the inaugural Sather Lectures in Classical Literature at the University of California. A second invitation to give these eminent lectures in 1927 resulted in his magnum opus, *Who Were the Greeks?*[16] Late in life, Myres wrote a book titled *Herodotus: Father of History* and another called *Homer and His Critics*, not to mention a technical study of ancient

[9] When I first encountered Freire-Marreco in the Bodleian Library's manuscript collections well over a decade ago, it was nearly impossible to learn anything about her from secondary sources. Happily there is now a diligently researched biography: Mary Ellen Blair, *A Life Well Led: The Biography of Barbara Freire-Marreco Aitken, British Anthropologist* (Santa Fe, NM, 2008). Unnoted information about Freire-Marreco comes from this book.

[10] For Myres, see principally John Boardman, 'Myres, Sir John Linton (1869–1954)', *Oxford Dictionary of National Biography*, http://www.oxforddnb.com/view/article/35180. All information about Myres not otherwise noted comes from this article.

[11] Earlier, Myres had been secretary of the Institute. *Man* was renamed the *Journal of the Royal Anthropological Institute* in 1995.

[12] Information about Myres's publications comes either from WorldCat or the Hathi Trust digital catalog.

[13] R. M. Fleming to J. L. Myres, June 17, 1930, MS. Myres 14, f. 40, Myres Papers, Bodleian Library, Oxford University.

[14] Alison Petch, 'Barbara Freire-Marreco (Mrs. Robert Aitken)', in *England: The Other Within*, Pitt-Rivers Museum, Oxford University, http://england.prm.ox.ac.uk/englishness-Barbara-Freire-Marreco.html.

[15] Myres was a fellow of Magdalen College (1892–95) and then of Christ Church (1895–1907).

[16] Joseph Fontenrose, *A Brief History of the Sather Professorship*, http://www.classics.berkeley.edu/people/sather/history.

Greek drama.[17] He served as president of the Hellenic Society and chairman of the British School at Athens, major institutions for classical studies. Now he looks like a classicist, pure and simple.

In fact Myres was neither classicist nor anthropologist, in the modern disciplinary sense. He was, rather, a holdover from an era before disciplinary lines hardened. While professor of Greek in Liverpool, he also lectured on the 'systematic [archaeological] excavation of Wales' and 'the antiquities of British Honduras', among numerous other subjects.[18] Myres made a hash of disciplinary divisions as we now understand them. In this he resembled other important scholars of the later nineteenth century, such as his older Scottish contemporary William Robertson Smith (1846–1894), who contributed to biblical criticism, to anthropology, to sociology, to the comparative study of religion—and also published in mathematics and physics.[19]

When Myres first encountered Barbara Freire-Marreco around 1904 or 1905, the UK had no well-defined discipline of anthropology for him to belong to, even if he had wanted to.[20] Anthropology was by then deemed (sometimes grudgingly) a proper university subject. And in 1905 there did exist institutions—the Anthropological Institute and its journal *Man*—that in retrospect *appear* disciplinary.[21] But appearances deceive. Anthropology still lacked the professional specialization associated with a modern discipline. Anthropology was only a hobby for most members of the Anthropological Institute—including its president at the time. (William Gowland, the Anthropological Institute's president in 1905–06, was a professor of metallurgy who, after working for years as a metallurgist in Japan, published on Japanese prehistoric archaeology—as well as on a school of painters in modern Kyoto. He seemed to be interested in all

[17] The last mentioned book was *The Structure of Stichomythia in Attic Tragedy* (1952). The Merriam-Webster Dictionary defines stichomythia as 'dialogue especially of altercation or dispute delivered by two actors in alternating lines (as in classical Greek drama).' *Herodotus: Father of History* appeared in 1953; *Homer and His Critics* was published posthumously in 1958.

[18] J. L. Myres to Barbara Freire-Marreco, March 27, 1908 (draft), MS. Myres 16, f. 61, Myres Papers.

[19] The best biography is Bernhard Maier, *William Robertson Smith: His Life, His Work, and His Times* (Tübingen, 2009). It stresses his Old Testament criticism more than his other achievements (appropriately for a book published in a series titled Forschungen zum Alten Testament). I hope to write a small book about Smith within the next several years.

[20] Freire-Marreco's correspondence with Myres makes clear that she had been his pupil, presumably in Greek, when an undergraduate at Lady Margaret Hall.

[21] The Anthropological Institute of Great Britain and Ireland became the Royal Anthropological Institute of Great Britain and Ireland in 1907. Organized in 1871, its roots stretched back to the Aborigines' Protection Society, founded in 1837, mostly by Quakers with a background in abolitionism. Among them was Henry Christy, who years later would awaken Edward Tylor's ethnological interests.

things Japanese, rather than specifically in anthropology.[22]) The birth of the journal *Man* is revealing. Since 1869 a magazine called *The Academy* had functioned as Britain's organ of scholarship in all fields outside mathematics and the natural sciences. But in 1896 an American businessman bought *The Academy* and turned it into a less academic, more 'literary' publication. Myres hatched *Man* to fill the void. The Egyptologist Flinders Petrie suggested the title *Man* 'as the counterpart of the [journal] "Nature" which exists already'. Just as *Nature* surveyed the natural sciences, *Man* would cover scholarship concerning the human world—'all archaeology, anthropology, some history (down to French Revolution, say) and some psychology & folklore'. But, no sooner than imagined, this sweeping conception starved to death in the emerging ecosystem of academic disciplines. 'To avoid collision' with existing specialized journals, *Man* excised 'practically all the "history", and a large part of the "archaeology" ' (the classical part). When the first issue came out in 1901, psychology had also vanished; and *Man* carried the subtitle *A Monthly Record of Anthropological Science*. It covered only topics by now understood to pertain to anthropology, like prehistoric archaeology, ethnology, and folklore. The wreck of Myres's original plans produced the accidental semblance of disciplinary specialization.[23]

Myres's pupil Barbara Freire-Marreco—though only ten years younger—turned out a very different type of scholar. She started much as her mentor had, with an undergraduate diploma in classics.[24] Upon graduation, Myres, with no further training, won a fellowship at Magdalen College and began to excavate and publish. In 1906 Freire-Marreco likewise applied for a research fellowship, at Somerville College. Her application proposed a book on tragic drama and the cult of the dead from ancient Greece to modern European folk culture: a project combining what would later be the disciplines of comparative literature, classics, and

[22] M. C. Curthoys, 'Gowland, William (1842–1922)', *Oxford Dictionary of National Biography* online, http://www.oxforddnb.com/view/article/58551.

[23] William Crooke to J. L. Myres, January 30, 1897, and Myres to Havelock Ellis [draft], n.d. [late November or early December 1896], MS. Myres 59, ff. 12–13, ff. 14–15, Myres Papers. *The Academy* was at first published monthly and then semimonthly but became a weekly in 1874. The businessman was John Morgan Richards. His daughter, Pearl Craigie, was a popular novelist (writing as John Oliver Hobbes), which may help to explain the *Academy*'s literary turning under her father's ownership. My account of *Man*'s beginnings comes, slightly modified, from James Turner, *Philology: The Forgotten Origins of the Modern Humanities* (Princeton, 2014), 342.

[24] Freire-Marreco received a *diploma* in classics in 1905 after undergraduate study at Lady Margaret Hall, since women were not yet awarded *degrees* at Oxford, while in 1892 Myres had gotten his *degree* in *literae humaniores*, popularly called 'Greats', the Oxford term for classics.

anthropology. But Somerville turned her down.[25] The next summer she was hired to compile the bibliography in a Festschrift honoring the pioneering anthropologist Edward Tylor.[26] When Oxford's new, mostly postgraduate diploma program in anthropology opened to students that fall, Freire-Marreco was one of the first four to enroll—and the first to finish.[27] In Oxford she studied physical anthropology with Arthur Thomson and social anthropology with R. R. Marett; at home on her own she read in a field called 'Ethics and Social Institutions'; then she went to London University to study for a term with the sociologist L. T. Hobhouse, who 'let me do a very long essay on "Primitive Forms of Society" '.[28] At the end of one academic year she passed the examination for the diploma with distinction.

The diploma program focused exclusively on anthropology; and this experience apparently gave Freire-Marreco the impression that such specialization was the ideal for anthropologists. As she was winding up the program, she began to help Myres with editing *Notes and Queries on Anthropology*.[29] (Eventually she rose to become co-editor of the book.) In 1909 she published her 'diploma paper' (that is, thesis) in *Man*. That same year, at last, she won the Somerville College research fellowship. This time her research topic was strictly anthropological: 'the nature of [the] authority of chiefs and kings in uncivilized society'.[30] Her only quandary was which 'uncivilized society' to focus on.[31] That was settled when 'people'—which people, she did not say—began telling her 'how wrong it w[oul]d be to enjoy an anthropological scholarship without fieldwork'. She decided

[25] Barbara Freire-Marreco to J. L. Myres, April 30, May 10, 11, 16, and 19, and June 14, 1906, and Myres to Freire-Marreco, May 10, 18, and 21, 1906 (all drafts), MS. Myres 16, ff. 1–32, Myres Papers; Blair, *Life Well Led*, 30–9. Freire-Marreco hoped to find in the cult of the dead the real ('non-Dionysiac') origins of tragedy. Her correspondence with Myres contains a hint that Jane Harrison may possibly have lurked in the background of this project.

[26] Freire-Marreco to Myres, August 9, 1907, MS. Myres 16, ff. 41–43, Myres Papers; Northcote W. Thomas (ed.), *Anthropological Essays Presented to Edward Burnett Tylor in Honour of his 75th Birthday, Oct. 2, 1907* (Oxford, 1907), 375–409. By this time Freire-Marreco had also developed an interest in Neolithic ceramics.

[27] Alison Petch, 'Anthropology Diploma Students 1907 on', in *The Invention of Museum Anthropology, 1850–1920*, Pitt-Rivers Museum, Oxford University, http://web.prm.ox.ac.uk/sma/index.php/articles/article-index/341-oxford-diploma-students-1907–1920.html. A first degree was not formally required for admission to the program, but most of the early students had one.

[28] Freire-Marreco to Myres, December 6, 1907, and March 28, 1908, MS. Myres 16, ff. 53–54 and 62–64, Myres Papers.

[29] J. L. Myres to Barbara Freire-Marreco, March 27, 1908 (draft), MS. Myres 16, f. 61, Myres Papers.

[30] Petch, 'Freire-Marreco'. The diploma paper was 'Notes on the hair and eye colour of 591 children of school age in Surrey'.

[31] Barbara Freire-Marreco to J. L. Myres, June 16, [1909], MS. Myres 16, ff. 77–78, Myres Papers.

to investigate some Native American societies 'still in working order'.[32] Her choice mattered because in the United States anthropology had fully formed as a specialized discipline by the 1890s.[33] Myres put Freire-Marreco in touch with the American anthropologist Alice Fletcher, who suggested she study the Pueblo Indians of the Southwest. On her way to New Mexico in 1910, Freire-Marreco stopped to talk with leading anthropologists on the east coast, to 'get some idea of the kind of work they are doing'.[34] She apparently met with no one *but* anthropologists.[35]

She arrived in northern New Mexico toward the end of June. In early July, at Alice Fletcher's injunction, she moved into a summer-session camp of the School of American Archaeology in Santa Fe, run by the anthropologist Edgar Lee Hewett, a professional friend of Fletcher. The camp lay some twenty miles northwest of Santa Fe, in Frijoles Canyon on the Parajito Plateau of the Jemez Mountains. (Frijoles Canyon is now within Bandelier National Monument, near Los Alamos.) There the camp students were excavating Ancestral Puebloan structures, and there Freire-Marreco met young anthropologists and got a two-month crash-course in Puebloan culture. She apparently did not take part in the excavations, but Indians from local pueblos did; and Hewett helped her make contacts in the nearby pueblos of Santa Clara and San Ildefonso. In early September, when the camp folded its tents, she moved into Santa Clara Pueblo. There she stayed for four months, visiting other pueblos and sojourning briefly with once-nomadic Indians in Arizona.[36] During some six months of fieldwork she stayed in regular contact with American anthropologists working in the region. A second stint of fieldwork in 1913 cemented cooperation with colleagues in the Southwest and allowed her to visit more leaders of the discipline elsewhere in the US. Her research resulted

[32] Barbara Freire-Marreco to J. L. Myres, July 5, [1909], MS. Myres 16, f. 82, Myres Papers. Freire-Marreco's emphasis.

[33] There is a large literature on the early history of anthropology in the US. For a very brief, fairly recent account of the early professional period, see Sydel Silverman, 'The United States', in Fredrik Barth et al. (eds.), *One Discipline, Four Ways: British, German, French, and American Anthropology* (Chicago, 2005), 258–63.

[34] Freire-Marreco, report to Somerville College fellowship committee, 1911, quoted in Blair, *Life Well Led*, 63.

[35] To judge from her correspondence. For details see Blair, *Life Well Led*, 62–6.

[36] Barbara Freire-Marreco to J. L. Myres, 31 August 1910, MS. Myres 16, ff. 92–3, Myres Papers. She left Santa Clara for Arizona in late November, then returned to Santa Clara just before Christmas and stayed until leaving for home in early February. The School of American Archaeology was later renamed the School of American Research and today is known as the School of Advanced Research. Hewett is perhaps best remembered as chiefly responsible for the Antiquities Act of 1906.

in a monograph, *Ethnobotany of the Tewa Indians* (1916), co-written with two anthropologists she had met in New Mexico.[37]

Her ethnological interests later shifted to topics more easily pursued in England, although she kept up with Americanist publications. Freire-Marreco married in 1920 and never held a permanent academic post, though for a while she lectured at Somerville College and the London School of Economics as a recognized expert on Pueblo Indians. From 1912–1929 she also edited *Notes and Queries in Anthropology* for the Royal Anthropological Institute. For the rest of her life she engaged with ethnology, mostly through the Folklore Society. Until the eve of her death in 1967 she wrote frequently for the journal *Folklore*.[38] Unlike Myres, she never worked in any discipline but anthropology.

Before commenting further on her, I shall cross the Atlantic to look at early graduate education at the Johns Hopkins University.[39] As soon as it opened in 1876, Hopkins stood out as the most research-intensive university in the United States. Postgraduate training for research in the humanities and social sciences centered on the seminar, or 'seminary' as then called.[40] Hopkins seminars differed widely in pedagogical method.[41] But they shared a single-minded focus on one and only one field of study. At a time when Charles Eliot Norton at Harvard was lecturing on art history to undergraduates, teaching a seminar-like advanced course on Dante, editing the seventeenth-century English poet John Donne, and organizing the Archaeological Institute of America, the Hopkins seminars modeled a different approach: real scholars stuck to one field.

Detailed records survive for three early seminars: the Greek seminary during the years 1877–92; the German seminary for the academic year 1889–90; and the so-called 'Journal Meetings' of the English Seminary from 1895 to 1903.[42] Basil Gildersleeve's Greek seminar—by far the best

[37] The title is a little misleading. Strictly speaking, Tewa is not the name of a people, but the language spoken by the Indians Freire-Marreco lived with in New Mexico.

[38] Petch, 'Freire-Marreco'.

[39] The best study of the early history of Johns Hopkins remains Hugh Hawkins, *Pioneer: A History of the Johns Hopkins University, 1874–1889* (Ithaca, NY., 1960).

[40] The Latinate *seminarium* was also used. Seminars featured as well in mathematics and in some of the natural sciences along with laboratories.

[41] Hawkins, *Pioneer*, 224–32.

[42] Greek Seminary Minutes, Nov. 21, 1877-May 29, 1879, and October 8, 1879-May 25, 1892 (two bound volumes; binding of first volume is wrongly stamped Nov. 21, 1878-May 29, 1879), record group 04.040, subgroup 1, series 7, box 1; Minutes of the Second Section of the Teutonic Seminary, of the Johns Hopkins University, October 1889, bound volume in Records of Department of German (1889–1987), record group 04.100, subgroup 1, series 1, box 1; Minutes of the Journal Meetings of the English Seminary of the Johns Hopkins University (1895–1903), bound volume in Records of Department of English, record group 04.130, series 4, box 1; Johns Hopkins University Archives.

documented—focused annually on a different ancient Greek author. Each member of the seminar developed a research paper connected with that author. For instance, in 1878–79, the seminar centered on the second-century CE satirist Lucian. Weekly meetings in autumn were devoted to Lucian's language: analysis of vocabulary, grammatical forms, and the like. Students also began to prepare a research paper on some aspect of Lucian's works (rhetorical, philosophic, religious, and so forth). Beginning in February, presentation and discussion of these student papers dominated meetings.[43] At no point did any scholarship beyond classical studies sneak into the seminar—not even, say, an article on modern literary satire that might cast light on an ancient satirist. In contrast, in 1880 Gildersleeve founded the *American Journal of Philology*. He intended it to cover 'the whole cycle of philological study' from 'Comparative Grammar' to 'the Teutonic languages'.[44] His seminar students got a much narrower idea of scholarship than his journal readers.

The two other seminars, apparently less rigorous than Gildersleeve's, were equally exclusive in subject matter. The 'Journal Meetings' of the English seminar required its members to critically review recent journal articles and books. All these concerned English language and literature.[45] In Henry Wood's German seminar, student papers mostly summarized research by scholars elsewhere, especially German professors. The papers were hardly cramped in scope; one ranged from the medieval Siegfried stories through the nineteenth century. The *topics*, however, never ventured beyond German language and literature.[46] Yet the professor who ran the seminar had only a few years earlier shifted his own research from English literature to German![47] Again, seminar students got a more disciplinary training than their teacher embodied.

There is no reason to think Johns Hopkins unusual in keeping graduate students focused on a single field of study. The PhD program in history at Brown University in this period was equally unrelenting in requiring

[43] Greek Seminary Minutes, Nov. 21, 1878 [1877]-May 29, 1879, 51 (October 3, 1878), 89 (February 27, 1879).

[44] B. L. Gildersleeve, 'Editorial Note', *American Journal of Philology* 1 (1880), 2. He explicitly told an inquirer from Cornell that the 'country is not yet ready' for a specialized 'Journal of Classical Philology', and 'still less' for 'a Journal of English Philology'. B. L. Gildersleeve to James Morgan Hart, June 6, 1879, in Ward W. Briggs, Jr. (ed.), *The Letters of Basil Lanneau Gildersleeve* (Baltimore, 1987), 84.

[45] Minutes of the Journal Meetings of the English Seminary, *passim*.

[46] Topics included 'Grimm's Dictionary and [the] Beginnings of German Lexicography'; 'West Germanic Versification'; and 'the Alemannic dialect.' Minutes of the Second Section of the Teutonic Seminary, 27 (April 10, 1890), 9 (November 1889), 23–5 (March 27, 1890), 33 (April 24, 1890).

[47] Wood moved from an appointment in English to one in German in 1884. Hawkins, *Pioneer*, 162, 166.

graduate students to study history alone.[48] Likewise, Princeton's classics seminar, organized in 1898–99, stuck strictly to classical studies.[49] I have a very haphazard knowledge of several archives bearing on early graduate education at Harvard, Yale, Michigan, and Texas, picked up in research about other questions. This limited information suggests that the pattern was general.

What are we to make of these two case studies? In both, the disciplines involved had not completely gelled. Though scholarly specialization was growing, John Myres was far from the only scholar who published respected work in what now seem distinct disciplines. I mentioned Charles Eliot Norton at Harvard. We could add many names—like the Scot Andrew Lang (classical scholar, historian of Scotland, anthropologist) or the Canadian-American Simon Newcomb (astronomer, mathematician, economist).[50] None of these men had more than a general undergraduate education. Even Gildersleeve, who did get a German PhD and limited his own scholarship to ancient Greek language and literature, was not fully disciplinary in mind-set: the journal he founded aspired to cover the entire, vast range of philology.

Then, in roughly the generation after Myres and Gildersleeve, scholars turned into modern, specialized disciplinary ones. What happened? The emergence of advanced, postgraduate training offers a plausible explanation. Freire-Marreco's mentor Myres exemplified pre-disciplinary scholarship. But her own training as an anthropologist, both in Oxford's diploma program and in her fieldwork among disciplinary anthropologists in America, provided a very different model. So she spent her career living the disciplinary ideal. Her case is particularly compelling because she was doubly an outlier: a woman, who never held a regular academic job. Still disciplinarity guided her life as a scholar. The students educated in the new seminars at Hopkins likewise learned to think of scholars as properly working in only one field. Their graduate education modeled this new

[48] J. Franklin Jameson, 'Graduate Studies in History at Brown University, 1887–1897' (printed brochure in folder containing his letters to H. B. Adams), Herbert Baxter Adams Papers, MS. 4, Series 1, Box 9, Johns Hopkins University Archives.

[49] Records of the Classical Seminary of Princeton University from December 14th 1898 to 19[08] (bound volume with loose pages inserted including a few items post 1908), University Archives, Academic Department Records, Department of Classics, vol. 2, 17–25; Department of Rare Books and Special Collections, Princeton University Library. 'Classical studies' here includes Sanskrit, then commonly a part of graduate training in classics. Thus, the seminar library also held materials on Indo-European comparative philology, which belonged to the discipline of classics as long as Sanskrit did.

[50] Lang lived from 1844 to 1912 and, except briefly in early life, never held an academic post. The largely self-taught Newcomb, 1835–1909, worked mostly in federal scientific institutions but did also serve as professor of mathematics and astronomy at Johns Hopkins University from 1884.

disciplinary ideal—even when the professor leading the seminar did not. In less than two decades classical scholars trained in Gildersleeve's seminar helped to turn his broad-gauged *American Journal of Philology*—and the American Philological Association it served—into nearly exclusive venues for research in classics.

Research training alone cannot *explain* the emergence of disciplinarity. Discipline formation was a complex process. It took decades. Multiple factors must have played into it. For instance, universities now existed within a modern industrial economy; maybe its specialized division of labor encouraged disciplinary specialization. Consider, too, that in the nineteenth century institutions arose to set doctors, lawyers, engineers, and similar professionals apart as distinct, status-conscious groups; possibly professors emulated them. After about 1850 British and American college curricula began to switch from generalized courses for all students to specialized programs for different interests; were professors following suit (or vice-versa)? But in the end mature disciplinarity appeared rather suddenly. The invention of research training may have been the catalyst that made it gel. If so, then research training is the place to start healing any ills disciplinarity now suffers.

To understand better the impact of disciplinary graduate education, it may help to glance at a couple of contemporaries of the Johns Hopkins seminarians who arrived at professional careers in universities via an older route, like the one traveled by J. L. Myres and Charles Norton. Recall that both Myres and Norton became influential university-based scholars with no formal preparation beyond an undergraduate degree (though in Norton's case a quarter century intervened between his bachelor's degree and his professorship).

Norton's approach to preparing students for research careers differed radically from the one that Myres pioneered in 1907 and that Johns Hopkins introduced only a couple of years after Norton started teaching at Harvard in 1874. Harvard began awarding the PhD, upon completion of a dissertation, in 1873.[51] Yet Norton—committed though he was to research and to the university as its home—never directed a dissertation. He mistrusted the disciplinary type of specialization linked with the dissertation—and with the seminar training at Johns Hopkins. (Ironically, Johns Hopkins sent a budding art historian to study with Norton for a semester—supported by his Hopkins fellowship!—before the young man waded into seminars in Baltimore.[52]) Norton feared disciplinary graduate

[51] Harvard awarded this first PhD in mathematics: https://www.gsas.harvard.edu/dean_and_administration/a_short_history.php (accessed July 13, 2016: this page no longer exists).

[52] This was Waldo Pratt. Turner, *Liberal Education of Norton*, 285–6.

education as intellectually and morally narrowing.[53] He certainly saw the need to form scholars, but he practiced a looser mode of apprenticeship than that on offer in PhD programs. He typically mentored promising students in scholarship as undergraduates and continued when they started professorial careers.

The results are illuminating. His style of 'advanced training for research'—his mentorship—encouraged students to stretch their scholarly wings far beyond any single discipline; and breadth showed in the results. Take a couple of examples. George Woodberry studied under Norton as an undergraduate. After graduating in 1877, he got a job as professor of English and history at the new University of Nebraska, where Norton advised him long-distance. Fired in 1882 along with several other professors in a political ambush, Woodberry returned to the Boston area as a free-lancer. There he wrote a history of wood-engraving; a solid biography of Edgar Allan Poe; poetry (admired in its day); and scholarly essays aimed at general readers, on topics ranging from classical Greek sculpture to Darwin's autobiography (with a strong bias toward English poetry). His scholarship landed him at Columbia University in 1891, first as professor of literature and then, in 1899, as head of Columbia's new department of comparative literature—before he unexpectedly resigned in 1904 to return to independent writing. His scholarly and poetic output was large and varied.[54] Arthur Richmond Marsh was another undergraduate protégé of Norton's, graduating in 1883. After a year as a lecturer at Harvard, Marsh became assistant professor of English at another college on the plains, Kansas University. Norton arranged publication opportunities for Marsh back east that stretched his scholarly range as far back as ancient Greek art. In 1891 Marsh returned to Harvard as *its* first (assistant) professor of comparative literature—indeed the first in the US. (Did Norton have a hand in the appointment?) Marsh published relatively little but was promoted to full professor in 1899. Not long thereafter, he resigned and went into the cotton brokerage business.[55]

[53] Ibid, 253–60, 282–6, 338–44, 368.

[54] Ibid, 269, 287, 294, 331; Vincent Freimarck, 'Woodberry, George Edward', *American National Biography Online*; George Edward Woodberry, *Studies in Letters and Life* (Boston and New York, 1890); Louis V. Ledoux, *The Poetry of George Edward Woodberry: A Critical Study* (New York, 1918), 14–15; K. K. Ruthven, *Ezra Pound as Literary Critic* (London, 1990), 6. Woodberry also cited the historian Henry Adams as an important influence on him when an undergraduate.

[55] Turner, *Liberal Education of Norton*, 342; *Harvard Crimson*, April 3 and June 16, 1883; *Quinquennial Catalogue of the Officers and Graduates of Harvard University* (Cambridge, MA, 1905), 28, 66, 253; 'The K.U. Poets of Yester-Year', *Graduate Magazine of the University of Kansas* 21 (November 1922), 5–6; Marsh, review of Charles Waldstein's *Essays on the Art of Pheidias*, *American Journal of Archaeology* 2 (1886), 182–7; Ruthven, *Pound as Literary Critic*, 6. For Marsh's conception of the new field, see Arthur Richmond Marsh, 'The

The parallels are curious. Both Woodberry and Marsh ranged far more widely in their scholarship than a Johns Hopkins PhD might have. This breadth may explain why both of them were tapped to pioneer the new field of comparative literature, which required the ability to navigate among a variety of national literatures, ancient and modern. Norton's protégés could manage that. Gildersleeve's and Wood's students probably could not. Yet Woodberry and Marsh both bailed out of the university and turned their energies elsewhere. No evidence survives to explain why. Had the grip of disciplinary specialization already tightened enough to make the two men give up on an academic career? Norton did mentor other students who became successful Harvard professors. Irving Babbitt nominally taught French literature, but his several books wandered far beyond it.[56] Charles Grandgent made his greatest reputation as a Dante scholar; but he, too, published in other areas, especially early in his career.[57] So it was possible, with enough persistence and erudition, for a non-disciplinary scholar to make his way in the early twentieth-century research university. Still, one wonders if Norton's version of 'advanced training for research' trained his students for a dying world, leaving them ill at ease in the new one a-borning.

However one answers that question, the triumph of disciplinarity after 1900 is patent, and its pervasiveness in research training equally obvious. My hypothesis is that, in the Anglo-American context, research-oriented graduate education actually precipitated disciplinarity. This guess may or may not point in the right direction. Only extensive research in multiple contexts can decide. I hope eventually to contribute to that work. Meanwhile, these preliminary speculations suggest a very large—and up to now unasked—question about how the modern organization of academic knowledge came to exist.

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Comparative Study of Literature', *Publications of the Modern Language Association of America* 11 (1896), 151–70. I cannot find a biographical article on Marsh, and the few available details of his life have to be pieced together from a large number of scattered, allusive references in online sources.

[56] Turner, *Liberal Education of Norton*, 344–5; David Hoeveler, 'Babbitt, Irving', *American National Biography Online*. Babbitt encountered Norton in his advanced course on Dante when Babbitt was studying for a master's degree in classics at Harvard. It seems likely, though I am not sure, that he also took one or more of Norton's art-history courses as an undergraduate in 1885–89.

[57] Grandgent lacks an article in the *American National Biography*, but see the obituary in *Speculum* 15 (1940), 379–81. His frequent appearances in the first two decades of the *Publications of the Modern Language Association of America* (1886) show his range of scholarly interests.

2

Virtues of History: Exercises, Seminars, and the Emergence of the German Historical Discipline, 1830–1900

Kasper Risbjerg Eskildsen

Character and Discipline

Students who during the 1860s wanted the best and most scholarly history education in the world knew where to go: a modern three story townhouse, built in neoclassical style, on Bahnhofstraße 8, just outside the old city gates of Göttingen.[1] Here the medievalist Georg Waitz lived, and once or twice a week, in the evening from six and eight, housed a small reading group or, as such classes were called at the time, exercises [*Übungen*].[2] The group, consisting of about a dozen students, would sit

[1] Bärbel Schwager, *Das Göttinger Auditoriengebäude von 1862/65: Ein Beitrag zur Universitätarchitektur im 19. Jahrhundert und zur Hannoverschen Variante des Rundbogenstils* (Frankfurt am Main, 1995), 310–1. Some of the arguments in this article have previously been presented in German in Kasper Risbjerg Eskildsen, 'Private Übungen und verkörpertes Wissen: Zur Unterrichtspraxis der Geschichtswissenschaft im neunzehnten Jahrhundert', in Martin Kintzinger and Sita Steckel, (eds.), *Akademische Wissenskulturen. Praktiken des Lehrens und Forschens vom Mittelalter bis zur Moderne, Schriften der Gesellschaft für Universitäts -und Wissenschaftsgeschichte* (Bern, 2015), 143–61. Unless otherwise noted, all translations are my own.

[2] Hartmut Boockmann, 'Geschichtsunterricht und Geschichtsstudium in Göttigen', in Hartmut Boockmann and Hermann Wellenreuter (eds.), *Geschichtswissenschaft in Göttingen: Eine Vorlesungsreihe*, (Göttingen1987), 161–85, esp. 175–8. For descriptions of Waitz and his teaching style by his former students, see Ferdinand Frensdorff, 'Georg Waitz', in Freiherr von Rochus Liliencron et al. (eds.), *Allgemeine Deutsche Biographie*, 40 (Leipzig, 1896), 602–29, Gabriel Monod, 'Georges Waitz', *Revue historique* 11/31 (1886), 383–90, Hermann Grauert, 'Georg Waitz', *Historisches Jahrbuch. Im Auftrage der Görres-Gesellschaft*, 8 (München, 1887), 48–100, Ludwig Wieland, 'Georg Waitz', *Abhandlungen der Königlichen Gesellschaft der Wissenschaften zu Göttingen*, 33 (1886), 1–15, and Dietrich Schäfer, *Mein Leben* (Berlin, 1926), 75–7. For his own description of his teaching practices, see Georg Waitz, *Die historischen Übungen zu Göttingen: Glückwunschschreiben an Leopold von Ranke zum Tage der Feier seines funfzigjährigen Doctorjubiläums. 20. Februar 1867* (Göttingen, 1867).

Kasper Risbjerg Eskildsen, *Virtues of History: Exercises, Seminars, and the Emergence of the German Historical Discipline, 1830–1900* In: *A Global History of Research Education: Disciplines, Institutions, and Nations, 1840–1950*. Edited by: Ku-ming (Kevin) Chang and Alan Rocke. *History of Universities* XXXIV/1, Oxford University Press (2021). © Oxford University Press. DOI: 10.1093/oso/9780192844774.003.0003

together around a large round table by the couch in his study. Normally one student would present a paper and afterwards Waitz and the other students commented. Waitz was not the most inspiring lecturer and even his devoted disciples admitted that he lacked 'pedagogical talent' and 'the Socratic gift' for seeing and unlocking the inner potential of each student.[3] But the few students who were allowed to enter the study nonetheless considered the exercises a life-changing experience. As the French historian Gabriel Monod later explained:

> One left these lessons not just better instructed, not just with clearer ideas and a better ordered mind, but also with love and respect for truth and scholarship, with understanding for the price that they cost and with resolution to work for them. One sensed that Mr. Waitz put his entire soul into this informal and direct teaching, that he wanted to accomplish a moral as well as an intellectual work, that he wanted to form men as well as scholars, that he gave the best of himself.[4]

Waitz and his students often described the exercises in Göttingen as a direct continuation of Leopold Ranke's famous exercises on the Medieval Saxon Kings and Emperors, which he offered at the University of Berlin during the 1830s. Ranke's exercises were themselves indebted to an older Enlightenment tradition of history education. According to this tradition, the primary purpose of history education was not to teach history, understood as a well-established body of knowledge about the past, but rather to prepare students to investigate the past. This demanded that the students acquired methodological skills, but also that they changed personally and morally.[5] This acquirement of skills and moral character was tested and exercised by doing scholarly work. Thus, the students in Waitz's exercises should not just read historiographical works or listen to lectures, but also write independent research papers and engage in reciprocal scholarly critique. The most important outcome, however, was not the papers themselves, but the personal transformation that the process of research and critique resulted in. The exercises, as Monod reported, aimed at forming 'men as well as scholars'.[6]

[3] For example, Weiland, 'Georg Waitz', (cit. n. 2), 12–13.

[4] Monod, 'Georges Waitz', (cit. n. 2), 383–4.

[5] Kasper Risbjerg Eskildsen, 'Christian Thomasius, Invisible Philosophers, and Education for Enlightenment', *Intellectual History Review* 18/3 (2008), 319–36 and 'Inventing the Archive: Testimony and Virtue in Modern Historiography', *History of Human Sciences* 26/4 (2013), 8–26. Also, on eighteenth-century philological exercises, William Clark, 'On the Dialectical Origins of the Research Seminar', *History of Science* 27 (1989), 111–54; Carlos Spoerhase and Mark-Georg Dehrmann, 'Die Idee der Universität: Friedrich August Wolf und die Praxis des Seminars', *Zeitschrift für Ideengeschichte* 5/1 (2011), 105–17.

[6] For a discussion of the moral significance of epistemic virtues for Monod and Waitz, see also Herman Paul, 'The Virtues of a Good Historian in Early Imperial Germany: Georg

Institutionalizing the Disciplines

In some important ways, Waitz was behind his time. During the second half of the nineteenth century, German higher education changed dramatically. An increasing number of students entered university, raising from about twelve thousand students in 1859/60 to about sixty thousand in 1914, and, in response, professors institutionalized and standardized instruction.[7] One important aspect of this transformation was the introduction of new textbooks on the methods, practices, and techniques of research.[8] Thus, German professors standardized and formalized older oral and tacit educational traditions, such as those of Waitz's 'informal and direct teaching', and made these available in print to a much larger student audience. Equally important was the proliferation of institutionalized seminars, where students had access to source editions, journals, supervision, and exercises, and sometimes also had their own workspace. Such seminars were already introduced at German universities during the eighteenth century, and had then primarily served the education of clergymen and secondary school teachers in philology. During the second half of nineteenth century, they were introduced in all disciplines and at all German universities.[9] The main purpose of these seminars remained vocational training, but they increasingly also focused upon research methodology.[10] When Ranke's former student Heinrich von Sybel established a historical

Waitz Consted Example', *Modern Intellectual History* 15/3 (2018), 681–709, and Camille Creyghton, Pieter Huistra, Sarah Keymeulen, and Herman Paul, 'Virtue language in historical scholarship: the cases of Georg Waitz, Gabriel Monod, and Henri Pirenne', *History of European Ideas* 42/7 (2016), 924–36. Also, on the significance of moral and epistemic virtues in late nineteenth-century humanistic scholarship, Kasper Risbjerg Eskildsen, 'Scholarship as a Way of Life: Character and Virtue in the Age of Big Humanities', *History of the Humanities* 1/2 (2016), 387–97.

[7] Konrad H. Jarausch, *Deutsche Studenten, 1800–1970* (Frankfurt am Main, 1984), 129.

[8] On the natural sciences, David Kaiser, (ed.), *Pedagogy and the Practice of Science: Historical and Contemporary Perspectives* (Cambridge, 2005).

[9] For an overview, Konrad H. Jarausch, 'Universität und Hochschule', in Christa Berg (ed.) *Handbuch der deutschen Bildungsgeschichte,* vol 4: 1870–1918. Von Reichsgründung bis zum Ende des Ersten Weltkriegs, (Munich, 1991), 313–45, Bernhard vom Brocke, 'Wege aus der Krise: Universitätsseminar, Akademiekommission oder Forschungsinstitut. Formen der Institutionalisierung in den Geistes und Naturwissenschaften 1810-1900-1995', in Christoph König and Eberhard Lämmert (eds.), *Konkurrenten in der Fakultät. Kultur, Wissen und Universität um 1900*, (Frankfurt am Main, 1999), 191–218, and 'Die Entstehung der deutschen Forschungsuniversität ihre Blüte und Krise um 1900', in Rainer Christoph Schwinges (eds.), *Humboldt International: Der Export des deutschen Universitätsmodells*, (Basel, 2001), 367–401. Also, Gert Schubring, 'Kabinett – Seminar – Institut: Raum und Rahmen des forschenden Lernens', *Berichte zur Wissenschaftsgeschichte* 23/3 (2000), 269–85.

[10] Also, Kathryn M. Olesko, 'Commentary. On Institutes, Investigations, and Scientific Training', in William Coleman and Frederic L. Holmes (eds.), *The Investigative Enterprise. Experimental Physiology in Nineteenth-Century Medicine*, (Berkeley, 1988), 295–332.

seminar in Munich in 1857, he even divided it in two sections. The first section offered 'education in methodological research and critique', while the second section delivered 'preparation of future gymnasium teachers'.[11]

When late nineteenth-century scholars celebrated German universities as the source of modern research education, they normally had these institutionalized seminars in mind. German universities published detailed descriptions of the seminars, their organization, architecture, the sources and books in the libraries, and the format of the exercises. Foreign scholars travelled to Germany to investigate the institution. In the historical discipline, one influential example is the travel notes of the Belgian historian Paul Fredericq. In 1881, Fredericq visited several German universities – Berlin, Halle, Leipzig, and Göttingen – to observe modern historical education. Fredericq published his travel notes in *Revue de l'instruction publique en Belge* in 1882 and later in a collected volume, together with similar observations from Holland, Belgium, Britain and France.[12] These notes were also translated into English and published in Herbert Baxter Adams' *Johns Hopkins University Studies in Historical and Political Science*. Another example is the Danish historian Kristian Erslev, who in 1885 visited the exercises of several Berlin professors to document their teaching style and later inquired about the teaching style at other German seminars.[13] Many scholars around the world also described their seminars as copies of German seminars. In 1883, for example, G. Stanley Hall collected and published several detailed descriptions of American historical seminars, many of which mentioned German inspirations.[14]

[11] H. Günter, 'Das historische Seminar', in Karl Alexander von Müller (ed.), *Die wissenschaftlichen Anstalten der Ludwig-Maximilians-Universität zu München*, (Munich, 1926), 193–9, 194. Also, Volker Dotterweich, *Heinrich von Sybel. Geschichtswissenschaft in politischer Absicht (1817–1861)* (Göttingen, 1978), 255–88.

[12] Paul Fredericq, *L'Enseignement supérieur de l'histoire. Notes et impressions de voyage* (Gent: J. Vuylsteke, 1899). On Fredericq and his notebooks, also Jo Tollebeek, 'A Stormy Family. Paul Fredericq and the Formation of an Academic Historical Community in the Nineteenth Century', *Storia della Storiografia* 53 (2008), 59–73 and *Fredericq & Zonen. Een antropologie van de moderne geschiedwetenschap* (Amsterdam, 2008).

[13] MS. Kristian Erslev, Tyske Universitetsstudier, Breve, 19, Diverse, Ny kgl. Samling, 4604, 4, Det Kongelige Bibliotek, Copenhagen,

[14] G. Stanley Hall, *Methods of Teaching History* (Boston, 1883). Also, for an international overview, Frank Hadler, Gabriele Lingelbach and Matthias Middell, (ed.) *Historische Institute im internationalen Vergleich*, (Leipzig, 2001) and, on the introduction of historical seminars in the US, Gabriele Lingelbach, *Klio macht Karriere: Die Institutionalisierung der Geschichtswissenschaft in Frankreich und den USA in der zweiten Hälfte des 19. Jahrhunderts* (Göttingen, 2003), Bonnie G. Smith, 'Gender and the Practices of Scientific History. The Seminar and Archival Research in the Nineteenth Century', *The American Historical Review* 100/4 (1995), 1150–76, and Anthony T. Grafton, 'In Clio's American Atelier', in Charles Camic, Neil Gross und Michèle Lamont (eds.), *Social Knowledge in the Making*, (Chicago, 2011), 89–117.

When late nineteenth-century historians celebrated the modern German university, they did not refer to Wilhelm von Humboldt, the establishment of the University of Berlin in 1810 or the ideas of German idealism. The 'Humboldt University', as Sylvia Paletschek and others have documented, is a construction of the twentieth century.[15] They instead referred to the gradual institutionalization of history education, which started during the 1830s and especially increased from 1870s and onwards.

Not everyone, however, agreed that the institutionalized seminars were the best way to secure the unity of teaching and research. Ranke never taught in a seminar and the University of Berlin was one of the last major German universities to introduce a historical seminar. Waitz detested and resisted the development and, according to one colleague, remained 'marvelously unchanged'. He loudly complained about the many new graduates and compared German universities to 'dissertation factories'.[16] History professors, he admonished, now had 'the task to warn, yes to scare away, rather than to attract, those who want to dedicate themselves to the study of history'.[17] In the institutionalized seminars, he complained, one could learn 'method, but not the spirit and art of history writing'.[18] For students, who cherished the coming of a more egalitarian and meritocratic age, Waitz was hardly the man of the day. One critical observer, for example, barked at 'the sacrosanct solemnity of Waitz's room' and the cultish seclusion and uniformity of his disciples. 'Waitz', he claimed, 'was worshipped by his students, untouchable to the highest degree, already his surroundings [*Dunstkreis*] hallowed, his word an oracle, which one spread with a secretive whisper'.[19]

Despite Ranke's and Waitz's opposition to the institutionalized seminars, even the advocates of institutionalization emphasized the importance of tradition from Ranke as well as the central role of Waitz within the Ranke school. The disagreement between Ranke, Waitz, and their contemporaries was primarily about the methods of instruction and not

[15] Sylvia Paletschek, 'Verbreitete sich ein "Humboldtsches Modell" an den deutschen Universitäten im 19. Jahrhundert', in Rainer Christoph Schwinges (ed.), *Humboldt International: Der Export des deutschen Universitätsmodells*, (Basel, 2001), 75–104, and 'Die Erfindung der Humboldtschen Universität: Die Konstruktion der deutschen Universitätsidee in der ersten Hälfte des 20. Jahrhunderts', *Historische Anthropologie* 10 (2002), 183–205.

[16] Georg von Below and K. Vogel, 'Briefe von K. W. Nitzsch an W. Schrader (1868–80)', *Archiv für Kulturgeschichte* 10 (1912), 49–110, 59.

[17] Waitz, *Die historischen Übungen*, (cit. n. 2), 7. See also Georg Waitz, *Friedrich Christoph Dahlmann: Gedächtnisrede gehalten in der Aula der Universität Kiel am 13. Mai 1885* (Kiel, 1885), 5, and Fredericq, *L'Enseignement supérieur* (cit. n. 12), 46.

[18] Waitz, *Friedrich Christoph Dahlman* (cit. n. 17), 5.

[19] Julius von Pflugk-Harrtung, 'Heinrich von Sybel', *Westermanns illustrierte deutsche Monatshefte*, 64 (1888), 331–46, 341.

about the goals of instruction. Becoming a historian, all agreed, meant becoming a special kind of person, with certain virtues, and thereby joining a 'family' of scholars. This personal transformation was not only important for the internal coherence of the discipline, and for establishing trust and credibility among professional historians, but also for the historian's relationship to the past. To many nineteenth century historians, the epistemic virtues of the Ranke school offered a road into the past. The private exercises that Ranke and Waitz offered in Berlin and Göttingen had open this road and thereby set an example for the later seminars.

Epistemic Virtues as a Road to the Past

When nineteenth-century historians celebrated Ranke as the founder of the historical discipline, they seldom referred to his first published monograph, *Geschichten der romanischen und germanischen Völker* of 1824, or the introductory remark that the historian should write: 'How it really was' [*wie es eigentlich gewesen*]. They instead, as mentioned, pointed to his teaching practices in Berlin and especially his exercises on the history of the Saxon Kings and Emperors, which started with an 1834 prize completion on the Saxon King Henry I. Ranke arranged for the publication of his student's papers in *Jahrbücher des Deutschen Reichs unter dem Sächsischen Hause*, which appeared over a period of three years from 1837 to 1840. In his introduction to the first issue, written by Georg Waitz, Ranke emphasized that the *Jahrbücher* should be considered as the product of an educational experiment. All students, he argued, should be divided in two major groups, which needed different kinds of education. The largest group consisted of those who studied for personal edification or for vocational training and only needed to attend lectures. For a smaller group of students, who felt an 'inner calling' to research, lectures were not enough. These students needed 'a closer introduction to actual academic matters' and 'guidance to individual activity'. The training for independent academic work, Ranke admitted, had 'for a fairly long time' been offered in seminars and exercises. But, in Ranke's personal experience, students tended to work too independently. Even if they discovered something new, they ended up with 'dispersed papers',[20] which were not suitable for publication. Ranke therefore coordinated their efforts and focused upon one century of German history, after Henry I became King of East Francia

[20] Leopold Ranke, (ed.), *Jahrbücher des Deutschen Reichs unter dem Sächsischen Hause*, 1/1 (Berlin, 1837), vii and ix.

(or Germany) in 919, which conventionally was given as the foundation of the Saxon house and, thus, of the Holy Roman Empire.

Waitz did not enroll his students in collaborative research, as Ranke had done with the *Jahrbücher*, but his intention was still that the exercises should result in publishable scholarly works. Many of the papers appeared as articles in *Forschungen zur deutschen Geschichte*, which Waitz edited, and in other scholarly journals. Some were published as monographs.[21] Both in style and content the works of Waitz' students reminded of the *Jahrbücher*. They primarily concerned political and legal history and usually followed a chronological order, some noting the year in the margins and with bold print. They constantly referred to their sources in the text as well as in numerous critical footnotes. Several works also contained excurses and appendixes with printed sources and further critical discussions. A couple of works, which were defended as doctoral dissertations, even carried the programmatic subtitle 'critically investigated' [*kritisch untersucht*].[22]

The primary purpose of these writings was not to make the past come alive, but rather to show command of the methods and morals of the Ranke school. This command especially came to expression in the students' dealings with the chroniclers, scribes, and historians of the Middle Ages. The past was an alien and strange place to which one did not have immediate access, but only could approach through careful studies of the sources. Without knowledge about the written sources and their authors, there could be no knowledge about the past. This insight into the mediated nature of our historical knowledge also justified the need for professional historians and modern 'critical' historical scholarship. As the Berlin historian, Johann Gustav Droysen in 1868 described the merit of the 'critical school' in modern German historiography:

> Maybe the greatest merit of the critical school in our science [*Wissenschaft*] . . . is having gained acceptance for the insight that the foundation of our studies is the examination of the 'sources', from which we create. Hereby the relationship of history [*Historie*] to the pasts [*Vergangenheiten*] has been brought to the scientific decisive point . . . that the pasts no longer lie immediately before us, but only in a mediated way, that we cannot "objectively" construct the pasts from the "sources", but only an interpretation [*Auffassung*], a view [*Anschauung*], and a counter image [*Gegenbild*] of [these pasts], that the so acquired interpretations and views are all, what it is possible for us to know

[21] Waitz, *Die historischen Übungen zu Göttingen* (cit. n. 2), 8.

[22] Wilhelm Junghans, *Die Geschichte der fränkischen Könige Childerich und Chlodevech, kritisch untersucht* (Göttingen, 1857) and Rudolf Usinger, *Die dänischen Annalen und Chroniken des Mittelalters, kritisch untersucht* (Hannover, 1861).

about the past, that therefore 'history' [*die Geschichte*] is not there externally or realistically, but only thus mediated, thus researched, and thus known.[23]

Historians Past and Present

Waitz's students could be quite judgmental in their discussions of past chroniclers, scribes, and historians. If the past was only available in a mediated way though the sources, the sources themselves had survived. Reading these sources, often in manuscript form, the students had immediate access to the authors. They treated the Medieval writers as if they were contemporaries and closely scrutinized their vices and virtues. They also used these moral insights to interpret the texts and determine their credibility. This method of determining the credibility of a historical account had Ancient roots, but acquired new importance within the Ranke school. When Ranke published *Geschichten der romanischen und germanischen Völker* in 1824, he added an appendix, *Zur Kritik neuerer Geschichtsschreiber*, which discussed the sources. The appendix contained no new archival discoveries, but instead a thorough reexamination of well-known printed sources. Ranke carefully described the personal history of each writer and investigated if and how their personal interests and loyalties colored their accounts. He openly condemned writers who did not live up to standards of modern history writing and especially those who wrote in the rhetorical style of the Ancients. Waitz's students followed similar critical procedure. In their judgment of past chroniclers, scribes, and historians, they almost seem to have worked with shared catalogue of epistemic virtues and vices.

One example is Hermann Hildebrand's dissertation on the twelfth century chronicle of Henry of Livonia. The dissertation was defended in Dorpat, but had first been presented in Waitz's exercises in Göttingen and Waitz considered it as a product of his school. Hildebrand not only attempted to understand Henry's background and motivations to write, but also included a chapter on his 'credibility' [*Glaubwürdigkeit*].[24] Henry, Hildebrand argued, based the account of the events of his time upon personal experiences as well as those of contemporary eyewitnesses. To know his credibility, it was therefore only necessary to determine his 'carefulness' [*Sorgfalt*], 'exactness' [*Genauigkeit*] and 'love of truth' [*Wahrheitsliebe*].[25] Hildebrand afterwards listed several qualities in Henry's account, which were connected to these virtues. Most importantly, while Henry's

[23] Johann Gustav Droysen, *Grundriss der Historik* (Leipzig., 1868), 79–80.
[24] Herman Hildebrand, *Die Chronik Heinrichs von Lettland. Ein Beitrag zu Livlands Historiographie und Geschichte* (Berlin, 1865), 46.
[25] Ibid, 46.

viewpoint colored his account, this 'viewpoint had in itself no influence upon the transmission of the facts'.[26] He had never invented 'actual untruths' about his enemies or positive stories about his friends.[27] A much harsher judgment can be found in Karl Wittich's treatment of Richer of Reims. If Henry of Livonia embodied certain virtues, Richer exemplified vices:

> every page testifies to his carelessness [*Leichtsinn]*, his vanity [*Eitelkeit*], alongside this a remarkable addiction [*Sucht*] to pragmaticizing, in his own way to decorate the content of his dry, often fragmented and abstruse, sources, then further a nearly laughable liking for the outer form, often imitated from the Ancients. How in love of this [form], the truth is even intentionally sacrificed, how he instead of telling what has happened – if according to his opinion – himself wants to invent and to interest: thus, we may indeed just consider his work as a kind of historical novel [*Geschichtsroman*].[28]

Virtues Past and Present

Waitz did not lecture his students on the virtues and vices of history writing. He instead taught them to appreciate virtues, such as carefulness, exactness, and love of truth, and to detest vices, such as carelessness, vanity, and love of form, through his personal example and especially through his engagement with their papers. Several students emphasized that they could not have written these papers without Waitz's help. The monographs were often dedicated to Waitz, for example 'in grateful veneration' or to the 'highly venerated teacher'.[29] Others contained longer, remarkably similar, praises of Waitz, which normally thanked him for his 'supportive participation' [*fördernde Theilnahme*], acknowledged their profound debts, and ensured their unending loyalty. [30]

When Waitz's former students described the educational experience in Göttingen, they also often emphasized the parallels between the methods

[26] Ibid, 47. [27] Ibid, 47.

[28] Karl Wittich, 'Richer über die Herzoge Giselbert von Lothringen und Heinrich von Sachsen', *Forschungen zur deutschen Geschichte* 3 (1863), 105–41, 108.

[29] For example, Junghans, *Die Geschichte der fränkischen Könige* (cit. n. 22), Carl Simonis, *Versuch einer Geschichte des Alarich Königs der Westgothen* (Göttingen, 1858), Eduard Winckelmann, *Geschichte Kaiser Friedrich des Zweiten und seiner Reiche, 1212–35* (Berlin, 1863).

[30] For example, August Kluckhohn, *Geschichte des Gottesfriedens* (Leipzig, 1857), iv., Usinger, *Die dänischen Annalen*, 6, August von Druffel, *Kaiser Heinrich IV. und seine Söhne* (Regensburg, 1862), unpag., Theodor Knochenhauer, *Geschichte Thüringens in der karolingischen und sächsischen Zeit* (Gotha, 1863), ix-x., Hildebrand, *Die Chronik Heinrich von Lettland* (cit. n. 24), unpag, and Arnold Busson, *Die Doppelwahl des Jahres 1257 und das römische Königthum Alfons X. von Castilien* (Münster, 1866), vi.

of instruction and the virtues of inquiry. Monod remembered how Waitz listened attentively to the presentation and then started pulling out small pieces of paper, one after another, filled with microscopic hand-written notes, from the pocket of his vest, and 'examined every point of the paper with meticulous rigor, combined with a larger respect for the thought and work of another'.[31] Thus, his teaching style exhibited the carefulness and restraint necessary for proper historical research. The training should prevent students from extending their judgment too far, or beyond the sources, and teach them academic humility. Ludwig Weiland, who also studied in Göttingen during the 1860s, similarly claimed that Waitz

> influenced his pupils, as the example of the faithful father influences his sons. The confident calm and cool objectivity, with which he handled and treated every question, retained the pupils, to themselves unknowingly, from preferring their conjectures to findings created from the sources [and] drove the conviction into them that there is a boundary to our knowledge.[32]

Thus, according to the students, Waitz's way of teaching exemplified virtues of history writing. The students learned how to regiment themselves and their writings not just by mirroring themselves in writers of past, and discussing their conclusions about these writers with their follow students, but also by following the example of Waitz as a teacher. The process of mutual identification and emphatic understanding, between professor, students and past writers, should transform the character of the students and thereby turn them into historians.

Institutionalized Exercises

During the second half of the nineteenth century, as mentioned, practical exercises were increasingly offered in institutionalized seminars. The first historical seminar had been founded in 1832 in Königsberg and similar institutions were opening fast at other German universities.[33] Even at the

[31] Monod, 'Georges Waitz' (cit. n. 2), 383.

[32] Weiland, 'Georg Waitz' (cit. n. 2), 12–3.

[33] Hans-Jürgen Pandel, 'Von der Teegesellschaft zum Forschungsinstitut. Die historischen Seminare vom Beginn des 19. Jahrhunderts bis zum Ende des Kaiserreichs', in Horst Walter Blanke (ed.), *Transformationen des Historismus*: *Wissenschaftsorganisation und Bildungspolitik vor dem Ersten Weltkrieg*, (Hartmut Spenner, 1994), 1–31, and 'Die Entwicklung der historischen Seminare in Deutschland', in Werner Freitag (ed.), *Halle und die deutsche Geschichtswissenschaft um 1900*, (Halle, 2002), 25–36. Also, Hermann Heimpel, 'Über Organisationsformen historischer Forschung in Deutschland', *Historische Zeitschrift* 189/1 (1959), 139–222, esp. 140–50, Paul Egon Hübinger, *Das historische Seminar der rheinischen Friedrich-Wilhelms-Universität zu Bonn* (Bonn, 1963), and Markus Huttner, 'Historische Gesellschaften und die Entstehung historischer Seminare – zu den Anfängen institutionalisierter Geschichtsstudien an den deutschen Universitäten des 19. Jahrhunderts',

forefront of historical research and within the 'critical school', scholars embraced the seminar institution, as the example of Sybel's Munich seminar shows. At Ranke's University of Berlin, Droysen in 1860 complained that the university lacked a seminar and therefore was falling behind other universities.[34] In 1882, one of Ranke's former students, Julius Weizsäcker again proposed a Berlin seminar and reported to the ministry that: 'The reason that that such wishes for the historical sciences only appear so late is not that there is no pressing need or that there has not been [a pressing need] for a long time.'[35] The new seminars sometimes received considerable financial and institutional support. One extreme example is the historical seminar in Leipzig. The seminar occupied the entire third floor of a university building. The director, Carl von Noorden, had a study and each student had a desk with a lockable drawer and gas lighting. The students could also consult a well-stocked working library with atlases and encyclopedias as well as geographical, paleographical, and epigraphical materials.

The institutionalized seminars were not as exclusive as Ranke's and Waitz's exercises. They were not just intended for a small group of future researchers, but should also accommodate the growing number of students at German universities. For example, when the Berlin seminar finally opened in January 1885, Weizsäcker accepted no less than 42 new students.[36] The students in the seminars were often in the beginning of their studies and had not received any philological or historical training beforehand. Professors could not expect them to seek out unknown medieval manuscripts in foreign archives before writing their papers. One brochure for new students in Noorden's Leipzig seminar, probably from the early 1880s, declared that the practical exercises 'at our university primarily are taught so that they are understandable by themselves for those who have no other qualifications than a gymnasium degree'.[37] The brochure further recommended students to attend courses that would be helpful in their future work. Those who wanted to become teachers in German secondary schools should not give 'excessive attention' to auxiliary sciences and did not have to attend many exercises. They should,

in Frank Hadler, Gabriele Lingelbach and Matthias Middell (eds.), *Historische Institute im internationalen Vergleich*, (Leipzig, 2001), 39–83.

[34] Ibid, esp. 39–43.

[35] Max Lenz, *Geschichte der Königlichen Friedrich-Wilhelms-Universität zu Berlin*, 3, Wissenschaftlichen Anstalten (Halle, 1910), 255.

[36] Ibid, 255–7.

[37] *Historisches Seminar an der Universität Leipzig. Ratschläge für das Studium der mittleren und neueren Geschichte* (N.p, n.d.). Copy in Kristian Erslev, Breve, 19, Tryksager, Ny kgl. Samling, 4604, 4, Det Kongelige Bibliotek, Copenhagen.

according to the brochure, 'apart from schooling in the principal historical methods, acquire certain and broad historical knowledge'.[38]

In the seminars, German professors therefore also had to rethink their teaching practices. One interesting example is Wilhelm Arndt's exercises in Leipzig. As a student in Göttingen, Arndt participated in Waitz's exercises. In 1861, he defended his dissertation on Medieval history and, as several others of Waitz's former students, went to work at the *Monumenta Germaniae Historica*. At the 25th anniversary of Waitz's exercises, Arndt dedicated his *Kleine Denkmäler aus der Marovingerzeit* to his old teacher and sentimentally described his time in Göttingen as 'a sunshine, which still throws its warming rays into my life'.[39] However, when Arndt in 1876 became extraordinary professor of historical auxiliary sciences in Leipzig, he did not continue Waitz's style of teaching. He instead taught in Noorden's historical seminar and there developed a new kind of practical exercises. Unlike Ranke and Waitz, Arndt did not expect that the students prepared beforehand, but instead at the start of each session presented a question, which they could answer solely with the printed source-editions in the seminar library.[40] He changed the theme and question every week and tried to convey an overview of Medieval history. The students also were not supposed to write or to present papers during the semester, but only to participate in the discussions in class. Noorden's exercises in Leipzig seem to have resembled Arndt's. Like Arndt, Noorden did not expect his students to write independent papers, but instead asked all students the same questions and based the exercises upon printed sources in the seminar library.[41] Another example is Weizsäcker's seminar in Berlin. When Kristian Erslev in 1885 visited the newly established seminar, he noted that Weizsäcker based his exercises upon exemplary quotes from sources, which he handed out to students in hectograph-copies at the beginning of class. Instead of having the students work through the material themselves, he asked questions directly to the around forty persons in the room and only demanded 'a couple of words as answer'.[42]

[38] Ibid.

[39] Wilhelm Arndt, (ed.), *Kleine Denkmäler aus der Merovingerzeit* (Hannover, 1874), v.

[40] [George Burton Adams], 'Historical Seminar Methods at Leipzig', *The Nation,* 1265, 26. September 1889, 252 and Fredericq, *L'Enseignement* (cit. n. 12), 28.

[41] Wilhelm Maurenbrecher, 'Lebensbild C. v. Noordens', Wilhelm Maurenbrecher (ed.), *Historische Vorträge von Carl von Noorden*, (Leipzig, 1884), 1–52, about the exercises, 38–40.

[42] MS. Kristian Erslev, Tyske Universitetsstudier, Breve, 19, Diverse, Ny kgl. Samling, 4604, 4, Det Kongelige Bibliotek, Copenhagen. Erslev's travel journal includes two hectograph copies from Weizsäcker's exercises on June 24th and July 1st 1885.

Virtues and Seminars

In 1913, the Austrian historian Wilhelm Erben published the first overview history of the research seminar.[43] In this paper, Erben also outlined an account of the emergence of the modern research university, which still is repeated today and even has gained new influence, after the limited importance of Wilhelm von Humboldt for nineteenth-century German universities has become clear. According to this account, the research university was not the product of the German idealism, but rather of a process of increasing institutionalization. The theological and philological seminars, which were introduced long before 1810 at the Enlightenment reform-universities of Halle and Göttingen, as well as early scholarly societies transformed into the research seminars of the nineteenth century. During the late nineteenth and early twentieth century, these again transformed into research institutes. Institutionalization lessened the importance of individuals and guaranteed continuity and predictability, and thereby secured disciplinary conformity and scholarly progress. However, Erben was also very familiar with the other tradition of private exercises. He was a former student of Theodor von Sickel, who himself was a renowned expert on Medieval diplomatics and a close friend of Georg Waitz. Later Erben published the correspondence between Sickel and Waitz. In his 1913 paper, he also recognized the particular importance of Ranke and Waitz for the historical discipline and noted Waitz' opposition to the institutionalized seminars. At the very end of the paper, Erben cautioned his readers not to forget the benefits of the older tradition. While the seminars secured 'the constant movement of the machine', the success of modern German scholarship also depended upon 'voluntary working-community of teachers and students'.[44]

The 'voluntary working-community of teachers and students', may have played an important role in the process of disciplinary formation for several reasons. Personal bonds established trust within the discipline and guaranteed adherence to shared epistemic virtues. The increasing importance of archival research within the historical discipline may have made such virtues especially important.[45] For historical research, as argued in this paper, they may also have served another epistemological function. While historians emphasized that the past was strange and alien place,

[43] Wilhelm Erben, 'Die Entstehung der Universitäts-Seminare', *Internationale Monatschrift für Wissenschaft, Kunst und Technik* 7 (1913), 1247–64, 1335–48.

[44] Ibid, 1324.

[45] Kasper Risbjerg Eskildsen, 'Leopold Ranke's Archival Turn: Location and Evidence in Modern Historiography', *Modern Intellectual History* 5/3 (2008), 425–53, and 'Inventing the Archive' (cit. n. 5).

they attempted to reach the past through a moral examination of the writers of the past. The working-community between teachers and students also became a working-community between the historian and the past. This approach to the past remained important throughout the nineteenth century and was imported into the seminars and textbooks of the late nineteenth century. Maybe therefore, late nineteenth historians described the rise of the Ranke school and the rise of the historical seminars as interconnected developments. Unlike Waitz, they were convinced that the methods and morals of the Ranke school survived within the institutionalized framework of the seminars. Wilhelm Arndt's students in Leipzig, for example, emphasized the unbroken continuity from Berlin and Göttingen and described Arndt as the 'principal heir of Waitz'.[46] Shortly after Ranke's death in 1886, one of his former students, the Munich professor Wilhelm von Giesebrecht, even declared that while Ranke 'never spoke of a seminar himself' his exercises had nonetheless 'become the seminar for all those seminars, which we now have at our universities'.[47] Similar remarks can be found in the works of foreign observers, such as Paul Fredericq and Kristian Erslev.[48] Thus, at least according to these nineteenth-century historians, the progress of historical scholarship depended not only upon institutionalization, but also upon the continuation of the teaching tradition of Ranke and Waitz within the institutionalized seminars. The historical discipline was not only an institutional, but also a moral community.

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[46] Heinrich Geffcken, 'Arndt, Wilhelm', in Freiherr von Rochus Liliencron et al. (eds.), *Allgemeine Deutsche Biographie*, 46 (Leipzig, 1902), 39–41.

[47] Wilhem von Giesebrecht, *Gedächtnissrede auf Leopold von Ranke* (Munich, 1887), 11.

[48] Fredericq, *L'Enseignement supérieur* (cit. n. 12), 42, and Kristian Erslev, 'Ranke og Waitz', *Politiken*, 28. May 1886, unpag.

3

The Rise of Academic Laboratory Science: Chemistry and the 'German Model' in the Nineteenth Century

Alan Rocke

It is no less true for being a cliché that the practices, cultures, and geography of the laboratory sciences in Europe were transformed during the course of the nineteenth century. One change centers on professionalization of the field. In 1800, the various laboratory sciences could scarcely be described as established academic fields, nor was science a profession per se, one marker of which is the fact that the English word 'scientist' had not yet appeared. By contrast, by 1900 there were well-developed university curricula, officially sanctioned undergraduate and graduate degrees, disciplinary journals, societies, and (most importantly) jobs, inside and outside of academia, in various scientific disciplines. The social and professional norms of academic science had also been transformed, for the 'research mandate' had become firmly established, and, for the laboratory sciences at least, the research group rather than the sole worker was now the operative entity, both for research practice as also for education and training. A third kind of change had to do with the trajectories of science in the leading countries of Europe. French science certainly had the greatest prestige in the year 1800, with Britain and Germany following behind. By the end of the century, Germany had gained a clear overall lead, in the case of chemistry even approaching something like global hegemony.

The following essay treats the causes and contexts of these transformations, with particular attention to the 'German model' of advanced education and research that is thought to have been so influential, and focusing on the branch of science in which that model is usually said to have first

Alan Rocke, *The Rise of Academic Laboratory Science: Chemistry and the 'German Model' in the Nineteenth Century* In: *A Global History of Research Education: Disciplines, Institutions, and Nations, 1840–1950*. Edited by: Ku-ming (Kevin) Chang and Alan Rocke. *History of Universities* XXXIV/1, Oxford University Press (2021).
 DOI: 10.1093/oso/9780192844774.003.0004

appeared, chemistry.[1] To begin, I cite some quantitative measures that suggest the kind of geographic shifts that took place, with particular reference to France and Germany. Christoph Meinel's statistical study of all the papers published by 200 prominent nineteenth-century European chemists is revealing. From 1800 to 1825, only about half as many chemistry articles per year were published in German journals as in French ones. Starting about 1825, however, chemical articles began to appear in Germany at a rate about 25% greater than in France. Between 1850 and 1865 this proportional advantage increased to about 40%. Then in the late 1860s the German rate exploded to more than double that of the French, and in the early 1870s three and a half times more chemical articles were published per year in Germany than in France. Edward Frankland's study of publications during a single calendar year, 1866, is consistent with these numbers. He found that during that year, more than three times as many 'original [chemical] investigations' appeared in German as in French journals, and the British record of publications that year was even worse than the French. Frankland's purpose in conducting the study was to alert the British Parliament to what he, a German-educated academic chemist himself, regarded as a disturbing and ever increasing preeminence of German science.[2]

The rise over the course of the nineteenth century of academic chemical laboratories for teaching and research formed the context for these trends. To put it simply—really too simply, in fact, as we will see—academic laboratories became essential and expected features of university science teaching and research first in a particular country and in a particular branch of science, namely in *German chemistry*; that pattern then spread to other sciences within Germany, and to other countries. How did all this happen?

Origins of the German Model

We need to add complexity to the simple picture we have sketched by summarizing some of the fine research that has been done on this subject over the last generation. The rise of laboratory science in European universities has deep history in eighteenth-century France, whose intellectual

[1] Some of the material that follows is taken more or less directly, but in revised form, from Rocke, *Nationalizing Science: Adolphe Wurtz and the Battle for French Chemistry* (Cambridge, MA, 2001), and from Rocke, 'Origins and Spread of the "Giessen Model" in University Science', *Ambix*, 50 (2003), 90–115.

[2] Christoph Meinel, 'Structural Changes in International Scientific Communication', *Atti del V convegno di storia e fondamenti della chimica* (Perugia, 1993), 47–61; Edward Frankland testimony, 14 February 1871, *First and Second Reports from the Royal [Devonshire] Commission on Scientific Instruction*, British Parliamentary Papers (London, 1872), 25:372.

leaders were inspired in part by Enlightenment ideals of empiricism and utility. In the *ancien régi*me and especially during the Napoleonic era, preexisting institutions included predecessors of the *grandes écoles* and also of research institutions such as the Collège de France and the *Muséum d'Histoire Naturelle*, and laboratories were provided in some of these institutions. In general, Napoleon designed a system intended to promote centralized state control, and social utility. In a strict sense the French universities actually disappeared, having been functionally replaced by a single bureaucratic entity called the '*Université de France*', and what were called *Facultés*.[3] French academic careers during the nineteenth century labored under a tripartite fragmentation comprising, first, the faculties, the most prestigious of which was the Sorbonne in Paris, all of which were intended strictly as didactic teaching institutions, hence devoid of laboratories; second, the *grandes écoles* devoted to practical training for professions that were of particular interest to the state; and third, research institutions. Such functional fragmentation, along with centralization in Paris and insufficient salaries, led leading savants to accumulate multiple simultaneous positions, the monopolizing practice known as *cumul*.[4]

The transformations with which we are concerned had important roots in the eighteenth-century German lands, as well, especially the important example of the University of Göttingen, founded in 1737 by the Elector of Hanover, who was also King George II of Great Britain. Göttingen benefited from the tie to Enlightenment Britain for an infusion of classical liberal ideas, as well as the unusual freedom allowed to its professors, and the emphasis given to research. That progressive atmosphere contrasted with the parochially corporative, didactic, narrowly professional, and often poverty-stricken character of most of the other 34 universities across the various German states. The irony is that in Britain itself, Oxford and Cambridge were mired in similar hidebound conditions as the German

[3] The Université de France designated France's entire system of secondary and higher education, all bureaucratically centralized in the Ministry of Public Instruction in Paris; the Facultés were the instructional units comprising the various schools of medicine, law, letters & sciences, etc., in the national higher education system run by the Université.

[4] Louis Liard, *L'enseignement supérieur en France* (Paris, 1894); Antoine Prost, *Histoire de l'enseignement en France, 1800–1967* (Paris, 1968); Robert D. Anderson, *Education in France, 1848–1870* (Oxford, 1975); François Leprieur, 'La formation des chimistes français au XIX^{e} siècle', *La recherché* 10 (1979), 732–40; Robert Fox and George Weisz (eds.), *The Organization of Science and Technology in France, 1808–1914* (Cambridge, 1980); G. Weisz, *The Emergence of Modern Universities in France, 1863–1914* (Princeton, 1983); R. Fox, 'Science, the University, and the State in Nineteenth-Century France', in G. Geison (ed.), *Professions and the French State, 1700–1900* (Philadelphia, 1984); Harry Paul, *From Knowledge to Power: The Rise of the Science Empire in France, 1860–1939* (Cambridge, 1985); and R. D. Anderson, *European Universities from the Enlightenment to 1914* (Oxford, 2004).

universities; it was to Scotland that Continental reformers looked, especially Edinburgh.[5]

The Napoleonic wars brought a caesura for the German states. Even before liberation, Prussia, under the leadership of Wilhelm von Humboldt, began a movement in higher education by establishing a new university in Berlin. Under the influence of classical liberal ideas as well as Romantic currents of philosophical idealism, this movement advocated professorial research as well as teaching, and mandated a degree of freedom for professors and students that became a watchword for German university life throughout the century. The movement ultimately became known as neohumanism, characterized by conspicuous philhellenism allied to the elevated holistic educational philosophy associated with the pregnant German words '*Bildung*' and '*Wissenschaft*.'[6]

But as much as this new set of ideas was designed deliberately to contrast with the centralized French system of higher education, German neohumanists came to embrace Enlightenment strains in addition to Romantic ones. Especially in the sciences at the new Berlin university, an empiricist epistemology derived from Kant and others, and an experiential pedagogical philosophy derived from Enlightened reformers such as Heinrich Pestalozzi, gradually led newly hired professors there to rely less exclusively on didactic lectures and offered an entrée to seminar- and laboratory-based instruction. This trend can be seen especially with the professorial recruitments by the Prussian *Kultusminister*, Altenstein, after the German states were liberated from French hegemony.[7]

[5] Friedrich Paulsen, *Geschichte des gelehrten Unterrichts auf den deutschen Schulen und Universitäten* (Leipzig, 1885); Paulsen, *Die deutschen Universitäten und das Universitätsstudium* (Berlin, 1902); R. Steven Turner, 'University Reformers and Professorial Scholarship in Germany, 1760–1806', in L. Stone (ed.), *The University in Society*, 2 vols. (Princeton, 1974), ii. 495–531; Charles McClelland, *State, Society, and University in Germany, 1700–1914* (Cambridge, 1980); K.-E. Jeismann and P. Lundgreen (eds.), *Handbuch der deutschen Bildungsgeschichte*, 3, 1800–1870 (Munich, 1987); and Anderson, *European Universities* (2004).

[6] In addition to the sources in the previous note, see also R. Steven Turner, 'The Growth of Professorial Research in Prussia, 1818–1848, Causes and Context', *Historical Studies in the Physical Sciences* 3 (1971), 137–82; Turner, 'The *Bildungsbürgertum* and the Learned Professions in Prussia, 1770–1830: The Origins of a Class', *Social History* 13 (1980), 105–35; Turner, 'The Prussian Professoriate and the Research Imperative', in H. N. Jahnke and M. Otte (eds.), *Epistemological and Social Problems of the Sciences in the Early Nineteenth Century* (Dordrecht, 1981), 109–21; and Turner, 'Universitäten', in Jeismann and Lundgreen (eds.), *Handbuch*, 221–49.

[7] Karl vom Stein zum Altenstein hired for the new university in Berlin (among others) Eilhard Mitscherlich, Heinrich Rose, Gustav Rose, Johann Christian Poggendorff, Heinrich Dove, and Gustav Magnus. He also attempted, without success, to hire Jacob Berzelius. See Max Lenz, *Geschichte der königlichen Friedrich-Wilhelms-Universität zu Berlin*, 3 vols. (Halle, 1910–1918), i. 305ff., 570f., and ii. 1, 3ff., 224ff., 509f.; Frederick

As a consequence, a strong countercurrent favoring empirical practice arose among even those who were most committed to the nominally idealist neohumanist creed. That countercurrent was most visible in the science of chemistry. The chief representatives of the founding generation of German academic chemistry in the *Vormärz* were Justus Liebig (1803–1873), Friedrich Wöhler (1800–1882), and Robert Bunsen (1811–1899), and behind them the older dominant figure of the Swedish chemist Jacob Berzelius (1779–1848). All four of these men exhibited ardent empirical commitments, coupled with distinct orientations toward medical, pharmaceutical, or technological utility. Significantly, neither Liebig, Wöhler, nor Bunsen spent the most active portions of their careers in Humboldtian Prussia, but rather in Hesse, Hanover, and Baden. In fact, in 1840 Liebig famously attacked the Prussian chemists as representatives of *altmodisch* reaction.[8]

Indeed, Liebig provides the best single exemplar for these themes, in all their complexity and internal tensions. He fashioned his laboratory institute at the University of Giessen following the model of earlier pharmaceutical boarding schools that had emphasized laboratory practica. His institute, founded in 1826 in a disused army barracks, was at first a private establishment like those of his pharmacist predecessors, but in 1835 it was taken over by the university. Liebig demanded intensive laboratory practica for all of his students. He argued that the all-day practicum was not intended to 'train' at all, but to educate. Chemistry, he affirmed, was not merely soap-boiling and drug compounding, but a true science, allied not just with the other natural sciences but also with humanistic disciplines as well. He ardently believed that the best way to teach in any discipline was to supplement didactic lectures with hands-on practice. This claim cut against the instinctive neohumanist derogation of utility, for, paradoxically (so Liebig argued), applications would emerge fastest among those who had in this way learned how to think, especially how to apply their pure understanding to practical tasks, leaving in their wake those who had been trained merely by rote.[9]

Gregory, 'Kant, Schelling, and the Administration of Science in the Romantic Era', *Osiris* 5 (1989), 17–35; and Gregory, 'Kant's Influence on Natural Scientists in the German Romantic Period', in R. Visser et al. (eds.), *New Trends in the History of Science* (Amsterdam, 1989), 53–66.

[8] J. Liebig, *Ueber das Studium der Naturwissenschaften und über den Zustand der Chemie in Preussen* (Braunschweig, 1840); R. Steven Turner, 'Justus Liebig versus Prussian Chemistry: Reflections on Early Institute Building in Germany', *Historical Studies in the Physical Sciences* 13 (1982), 129–62.

[9] J. B. Morrell, 'The Chemist Breeders: The Research Schools of Liebig and Thomas Thomson', *Ambix* 19 (1972), 1–45; Bernard Gustin, 'The Emergence of the German

Liebig thus successfully performed a rhetorical balancing act between neohumanist *Bildung* and utilitarian laboratory practice, between German idealist and French empiricist philosophies. It was a novel pedagogy with a great future. Moreover, this new pedagogy worked hand-in-glove with the invigorated promotion of university research that was closely associated with Humboldtian reforms, for in his laboratory Liebig put to work a subset of his clientele, his most advanced students and postdocs. His groups of young chemists were simultaneously completing their scientific education, while pushing forward a research agenda—Liebig's agenda, but also their own. Starting in the late 1830s, Giessen was thus the site of the earliest identifiable instance of such a teaching-cum-research university laboratory institute.[10] Liebig's practices also strengthened the research mandate more generally, which was then spreading across the German academic landscape.

These occasionally conflicting elements were at the heart of what became known as the German model of higher education and research, whose disparate themes included neohumanist idealist philosophy with its creed of pure *Wissenschaft*, empiricist/objectivist laboratory or seminar pedagogy, the (conflicted) appeal to practice, group research tied to advanced education, and the research mandate. But what should be considered as the essential elements of the 'German model' has been subject, as we will see below, to various interpretations and local modifications, ever since these international discussions over the most effective forms of higher education and research arose in the late nineteenth century. It has become ever clearer from recent historical research that the national context into which the German model was imported was always determinative, and that the specific strains of Humboldtian neohumanist philosophy were invariably modified or even ignored. That was the case even in *Vormärz* Germany, and even in Prussia itself after Humboldt's

Chemical Profession, 1790–1867', Ph.D. dissertation, (Chicago, 1975); Turner, 'Liebig versus Prussian Chemistry'; Christoph Meinel, '*Artibis Academicis Inserenda:* Chemistry's Place in Eighteenth- and Early Nineteenth-Century Universities', *History of Universities* 7 (1988), 89–115; Joseph Fruton, 'The Liebig Research Group: A Reappraisal', *Proceedings of the American Philosophical Society* 132 (1988), 1–66; F. L. Holmes, 'The Complementarity of Teaching and Research in Liebig's Laboratory', *Osiris* 5 (1989), 121–64; William H. Brock, *Justus von Liebig: The Chemical Gatekeeper* (Cambridge University Press, 1997); Ernst Homburg, 'Two Factions, One Profession: The Chemical Profession in German Society 1780–1870', in D. Knight and H. Kragh (eds.), *The Making of the Chemist: The Social History of Chemistry in Europe, 1789–1914* (Cambridge, 1998), 39–76; W. H. Brock, 'Breeding Chemists in Giessen', *Ambix* 50 (2003), 25–70.

[10] For a precise chronology and an analysis of these events, see esp. Holmes, 'Liebig's Laboratory', and A. J. Rocke, *The Quiet Revolution: Hermann Kolbe and the Science of Organic Chemistry* (Berkeley, 1993), 9–34. See also the discussion below concerning Friedrich Stromeyer at Göttingen.

death. In short, it seems that the post-1815 German model was not very neohumanistic, after all.[11]

Organic Chemistry and the 1830 Nexus

Of course, my statement that Liebig is the best single exemplar representing this movement—whatever name one applies to it— comports with mythology that has prevailed for the last 150 years. The contributions of such scholars as Bernard Gustin, Jack Morrell, Steven Turner, William Brock, Frederic L. Holmes, Ernst Homburg, and several others have significantly modified that picture, without however effacing its most essential features. I don't wish to ratify the naïvely teleological 'great man' picture of Liebig self-consciously forging a lonely new path to the future—which has been rightly refuted—but rather to understand how and why Liebig found himself occupying such a central position in these sea changes, and how and why the international Liebig mythology arose. Morrell rightly emphasized several factors that played well into Liebig's hands. Using the further research of the last generation, I want to focus attention on a small number of those factors, some of which have hitherto been insufficiently appreciated.

Namely, we can now see that four crucial events happened virtually simultaneously, all four of these events (amazingly) datable within three years either side of the year 1830. The first of these, appropriately stressed by Morrell, was Liebig's personal acquisition in 1832 of a journal in which he could (and did) publish his and his students' research results at will. Liebig's *Annalen der Pharmacie* (in 1840 renamed *Annalen der Chemie und Pharmacie*, and after Liebig's death *Justus Liebigs Annalen der Chemie*) became the leading journal in the field within a few years after Liebig took it over. A personal organ for publication was critically important for the leader of a research group in those years. Not only did he and his circle have unrestricted access for research publication, but he also used the

[11] Margaret Rossiter, *The Emergence of Agricultural Science: Justus Liebig and the Americans, 1840–1880* (New Haven, 1975); Owen Hannaway, 'The German Model of Chemical Education in America: Ira Remsen at Johns Hopkins', *Ambix* 23 (1976), 145–64; Gert Schubring (ed.), *'Einsamkeit und Freiheit' neu besichtigt: Universitätsreformen und Disziplinenbildung in Preussen als Modell für Wissenschaftspolitik im Europa des 19. Jahrhunderts* (Stuttgart, 1991); R. C. Schwinges (ed.), *Humboldt International: Der Export des deutschen Universitätsmodells im 19. und 20. Jahrhundert* (Basel, 2001); Marc Schalenberg, *Humboldt auf Reisen? Die Rezeption des 'deutschen Universitätsmodell' in den französischen und britischen Reformdiskursen (1810–1870)* (Basel, 2002); Geert Vanpaemel, 'The German Model of Laboratory Science and the European Periphery (1860–1914)', in A. Simões, M. P. Diogo, and K. Gavroglu (eds.), *Sciences in the Universities of Europe, Nineteenth and Twentieth Centuries* (Dordrecht, 2015), 211–25.

journal as a bully pulpit to self-promote, editorialize, harangue, and occasionally even insult. It was a significant element in the rapid rise of the Giessen institute in the 1830s and 1840s.

The other three events all relate to a field to which Liebig devoted his fullest efforts, namely organic chemistry, which was poised for explosive growth in 1830. Before going further, I want to suggest a sense of the nature of that growth. In 1820 there existed a little more than a thousand known chemical substances, 90% of which were inorganic compounds. That changed dramatically over the course of the following decades, which saw an explosion in the number of organic compounds. Today, well over 99% of all the millions of known chemical compounds are organic.[12] The difference, of course, is that unlike inorganics, organic compounds have carbon-based skeletons that can form stable distinct molecules containing scores, hundreds, or even thousands of atoms. Simple combinatoric analysis suggests the nearly infinite variety of substances that were (and are) possible. It is also important to note that it was organic chemistry that provided the engine of growth in new chemical industries in the second half of the century. The production of synthetic dyes, drugs, food additives, explosives, and a variety of important new artificial materials was enormously stimulated when the science of organic chemistry allowed researchers to manipulate molecules with ever greater power and certainty.

The ascendancy over European chemical publications by Germans, and the ascendancy over the index of known substances by organic compounds, were connected, since German chemistry was generally oriented toward the organic field from the 1830s on, and became ever more concentrated in that area during the second half of the century. A deliberate multi-pronged campaign by Liebig was partly responsible for this German predilection for organic chemistry. As a young man, Liebig had worked in the Paris laboratory of the great French chemist Joseph Louis Gay-Lussac. Gay-Lussac, who specialized in the science of gases and held the Sorbonne chair of physics, told the 20-year-old Liebig, 'You must occupy yourself every day with organic chemistry; that is what we lack.'[13] Liebig followed his teacher's advice.

[12] Joachim Schummer, 'Scientometric Studies on Chemistry', *Scientometrics*, 39 (1997), 107–23, 125–40.

[13] In a long toast given in French at a Paris dinner on 22 April 1867, Liebig recalled the words of his mentor, spoken 43 years earlier: ' "Il faut vous occuper", me disait-il, "tous les jours de la Chimie organique, voilà ce qui nous manque."' Cited from the Roger Gay-Lussac MS Collection by Maurice Crosland, *Gay-Lussac: Scientist and Bourgeois* (Cambridge, 1978), 278. An English version is 'Liebig's Recollection of Gay-Lussac and Thenard', *The Laboratory*, 1 (1867), 285.

So the second of my four formative events ca. 1830 is the emergence of the phenomenon that was the key to recognizing this explosive potential of organic chemistry: isomerism. At the beginning of the nineteenth century, chemists implicitly assumed that a substance's elemental composition determined its identity. For that reason some were mystified in the 1810s and 1820s by the discovery of instances that violated that correlation, such as glucose versus starch, acetic acid versus cellulose, wax versus spermaceti, and distinct species of sugar with identical compositions. It was the collision between the youthful discoverers of another case of such chemical twins, Wöhler's cyanic acid and Liebig's fulminic acid, that brought the issue to a head. In 1830 Berzelius focused attention on this phenomenon, named it 'isomerism', and argued for its generality and importance; he suggested that differing arrangements of the atoms in the molecules could provide an explanation of such chemical twins.[14]

Isomerism was not unknown in the inorganic chemical realm, but the great majority of instances of that phenomenon known already in 1830 were organic compounds. And the example of the sugars immediately suggested that it was not just a question of twins (i.e., *two* isomers for a given composition); rather, a single composition might correspond to three, four, or really any number of possible distinct substances. In 1829 Wöhler could privately express relief that a purported second species of cyanic acid was a fiction, so that one might eliminate at least one organic compound from the already rapidly expanding handbooks. By the 1860s chemistry students were 'frightened' by the numbers of new substances, and the stupefying proliferation was 'becoming enough to make [even Liebig] mad'.[15] In fact, in 1862 we find Marcellin Berthelot calculating that a single organic compound, sorbitol, must have 1.4 quintillion possible isomers; the number of printed books that would be required even simply to list them all, he wrote, would require a library as big as Paris itself.[16]

Suddenly, it was no longer sufficient for chemists to compile a putatively complete list of just a few dozen substances, all derived from organic nature and each with a unique composition, collectively serving as a minor

[14] J. Berzelius, 'Ueber die Zusammensetzung der Weinsäure und Traubensäure... nebst allgemeinen Bemerkungen über solche Körper, die gleiche Zusammensetzung, aber ungleiche Eigenschaften haben', *Annalen der Physik* [2] 19 (1830), 305–35; J. R. Partington, *A History of Chemistry*, 4 (London, 1964), 203, 256, 258–60, 272, 751.

[15] Wöhler to Liebig, 8 June 1829, in A. W. Hofmann (ed.), *Aus Justus Liebig's und Friedrich Wöhler's Briefwechsel*, 2 vols. (Braunschweig, 1888), i. 4; Liebig to Hofmann, 24 January 1868, in E. Heuser and R. Zott (eds.), *Justus von Liebig und August Wilhelm Hofmann in ihren Briefen* (Mannheim, 1988), 45.

[16] M. Berthelot, 'Sur les principes sucrés', *Leçons de chimie et de physique professées en 1862* (Paris, 1863), 248–9.

adjunct to the 'real' chemistry of inorganic earths, oxides, acids, bases, and salts. Suddenly, the sky was the limit for organic chemistry. From 1830 on, the new phenomenon of isomerism opened eyes and minds to the radically expanded possibilities for the science of organic chemistry. This is the world that the farsighted Gay-Lussac had glimpsed.

My third nearly simultaneous event was the development of a means of understanding and heuristically manipulating—that is to say, of mastering, exploring, and teaching—this potentially limitless body of substances and reactions. I am referring to the introduction and development of chemical formulas as paper tools, a subject that was introduced and has been well studied by Ursula Klein. In the work of Dumas, Berzelius, Liebig, and Wöhler in the period from 1827 to 1833 we see for the first time written formulas being used in a generative fashion to construct and to justify the theoretical modeling of chemical compounds and their reactions. This was a new epistemic technique that went far beyond mere shorthand representation. The formulas were being used—as they are still used today—as true paper tools, in the fullest sense of the word 'tool'. Klein has further pointed out that it was precisely organic chemistry for which this epistemic technique was crucial, for organic reactions are dynamic in a way that inorganic reactions are generally not, and tend to produce confusing cascades of products. The heuristic manipulation of formulas gave chemists a handle on the complexities with which they were forced to deal, and provided a productive theoretical tool to create endless ideas for investigation, and endless new substances to create.[17]

All of this would have played to a slow tempo, however, without our fourth event, namely Liebig's invention in the fall of 1830 of a modified method of combustion analysis for organic substances that was fast, simple, and precise; so simple and precise, in fact, that even junior chemists could readily master the technique and produce analyses that routinely passed muster. Morrell stressed the importance of Liebig's invention of his so-called Kaliapparat for the ascendancy of the Giessen laboratory; recent research in the laboratory of Melvyn Usselman has thrown important new light on just how transformative the innovation really was. Usselman's historical replications were actually performed by two of his undergraduate chemistry students, like those in Giessen, who scrupulously followed Liebig's published directions. Astonishingly, these replications of 1830s-era analyses achieved routine accuracy that rival current professional

[17] Ursula Klein, 'Paving a Way through the Jungle of Organic Chemistry', in M. Heidelberger and F. Steinle (eds.), *Experimental Essays – Versuch zum Experiment* (Baden-Baden, 1998), 251–71; Klein (ed.), *Tools and Modes of Representation in the Laboratory Sciences* (Boston, 2001); Klein, *Experiments, Models, Paper Tools: Cultures of Organic Chemistry in the Nineteenth Century* (Stanford, 2003).

standards for elemental organic analysis. Moreover, an important and unexpected feature was revealed: Usselman and his students found that Liebig's procedure provides a variety of sensual feedback information that confirms, during the course of the analysis, whether or not that analysis would be reliable. If the sample were sufficiently pure to start with, and if the feedback indicated a good run, then the outcome could almost certainly be trusted as a single precise datum.[18]

This experience offers an important historical insight. Since Liebig and his students knew (ceteris paribus) that they could place immediate confidence in the quality of retained data from the Kaliapparat, good analyses could often be achieved with three, two, or even one sample run. This efficiency of effort must have greatly accelerated productivity. All this helps to explain why Liebig's lab so quickly became a mass-production factory of new results in the burgeoning field of organic chemistry. To put it simply, from the late 1830s on, the work in Giessen was generally done by *teams* consisting of students and senior researchers; it was good data; and it came fast. Now, it is certainly true that chemical analysis is only the last stage in the process of introducing a new substance into the chemical literature. But analysis was probably what chemists would call a 'rate-limiting step' for much of organic chemistry in these glory years of scientific productivity.

Liebig was at the very center of the nexus for every one of these four developments: a proprietary journal in which to publish at will; the emergence of isomerism; formulas as paper tools; and fast, simple, reliable chemical analysis. Equipped with this newly improved analytical method, and empowered by a productive new theoretical approach to the exploration of organic reactions and compounds, Liebig and other organic chemists in the second third of the nineteenth century discovered themselves in possession of a 'kit' that would enable them to master the dismaying proliferation of new organic substances. The first institutional laboratory that achieved a significant approach to such mastery was Liebig's in Giessen.

The Rise of the Giessen Laboratory: Was It Really New? Was It Really First?

Let us pause for some further qualifications. We have known for many years now that Liebig's Giessen laboratory, contrary to his later representations, was far from the first in Germany to offer practical exercises as part of a course of chemical study. A partial list of his predecessors in this regard

[18] Melvyn Usselman et al., 'Restaging Liebig: A Study in the Replication of Experiments', *Annals of Science*, 62 (2005), 1–55.

would include the universities in Göttingen, Tübingen, Jena, Landshut, Breslau, and Bonn.[19] And we have already noted that Liebig's initial idea upon his arrival in Giessen in 1824 was not to develop a university research school at all, but rather to create an institute devoted to pharmaceutical training, similar to well-established concerns in Erfurt, Jena, and elsewhere. Furthermore, Liebig's route to the 'German model' included significant elements of serendipity and chance. At the end of his detailed examination of the gradual development of Liebig's enterprise during the 1830s, Holmes summarized his conclusions:

> Liebig took each formative step in this development in response to immediate opportunities or problems . . . [H]e probably did not foresee in detail the pattern of systematic training and group investigations, the strong symbiotic relation between teaching and research, that was to take shape by 1840.[20]

However, Liebig realized no later than 1838 that he had grasped the lion's tail, for in the summer semester of that year he had 33 Praktikanten, a very large number from whom he could and did recruit advanced research collaborators. By 1843, in a newly enlarged space and with a new branch laboratory for beginners, there were no fewer 68 practicum students, and by this time he had a well established senior research group, including foreigners and guest workers who had been attracted by Liebig's rising reputation. Liebig cleverly drew attention to his dramatic success by writing two arresting polemical articles on 'the state of chemistry in Austria' (1838) and 'the state of chemistry in Prussia' (1840). By this time, his laboratory had gained worldwide fame; it had become the 'Mecca of chemistry', and was regarded (not just by Liebig himself) as a distinctly new phenomenon.[21]

But was it truly new? Ernst Homburg has recently investigated the role of an unjustly neglected figure in this story, namely Friedrich Stromeyer (1776–1835), a respected older chemist at the University of Göttingen.[22] From 1810 until his death in 1835 Stromeyer ran a highly successful university chemistry practicum. More than twenty of Stromeyer's former Praktikanten later became professors at European universities, technical institutes, or mining academies, including three famous names: Leopold Gmelin in Heidelberg, Mitscherlich in Berlin, and Bunsen in Marburg

[19] Turner, 'Liebig versus Prussian Chemistry'; Homburg, 'Chemical Profession'; Homburg, 'The Rise of Analytical Chemistry and its Consequences for the Development of the German Chemical Profession (1780–1860)', *Ambix* 46 (1999), 1–32; Rocke, 'Giessen Model', 100.

[20] Holmes, 'Liebig's Laboratory', 163.

[21] Ibid, 146–62; Turner, 'Liebig versus Prussian Chemistry'; Brock, *Liebig*, 65–70.

[22] Homburg, 'Rise of Analytical Chemistry'; Homburg, 'Chemical Profession'.

and later Gmelin's successor in Heidelberg.[23] Despite his remarkable career, and his contemporary renown, Stromeyer's name is little known to prosperity, partly due to Liebig's exaggerated and self-promoting rhetoric.

Stromeyer is probably the single best contender for the 'Giessen model' before Liebig. However, his practicum differed in some crucial respects from Liebig's, and the differences can help us to understand more clearly what was distinctive about the latter. Stromeyer's subject was inorganic chemical analysis, his clientele was mostly medical students, and he made no attempt to combine teaching and research. For all of these reasons his practicum had little relationship to the great organic-chemical nexus of ca. 1830 described above. Stromeyer did believe, probably correctly, that he had been the first to introduce a regular university-sanctioned chemistry practicum in the German lands[24]—his model was probably the Ecole Polytechnique in its earliest incarnation—but he never made any wider pedagogical or philosophical claims for it.[25]

The fact that group research was absent from Stromeyer's pedagogy is not surprising. Stromeyer's students worked on inorganic samples that were *known* 'unknowns'; the practicum consisted solely of analysis training with no admixture of actual experimentation, so students were not normally exposed to truly unidentified materials. Liebig's case was different. As he found that student organic analyses with his Kaliapparat could be virtually as good as his own, it was a natural step for him to begin

[23] However, it should be noted that Gmelin was educated by his famous father and by his cousin, in addition to Stromeyer, and he spent nearly a year learning from Gay-Lussac and Vauquelin in Paris. Similarly, Mitscherlich was decisively influenced by his period in Stockholm with Berzelius. Bunsen, too, spent nine months in Paris, and was strongly influenced by contacts with Berzelius, Liebig, and Wöhler. In short, of the three personalities who were Stromeyer's most illustrious pupils by far, it is not possible to say that it was Stromeyer's imprint that was most decisive. One of the many merits of Homburg's essays is to direct appropriate attention, regarding the sources of the rise of German chemistry, to French and Swedish chemists during the period around 1780–1825. This very point is relevant not only for Stromeyer's most famous students, as we note here, but also regarding Stromeyer himself, who was educated partly in France.

[24] F. Henrich, 'Zur Geschichte des chemischen Unterrichts in Deutschland', *Chemiker-Zeitung* 47 (1923), 585–7; Georg Lockemann, 'Der chemische Unterricht an den deutschen Universitäten im ersten Viertel des neunzehnten Jahrhunderts', in J. Ruska (ed.), *Studien zur Geschichte der Chemie* (Berlin, 1927), 148–58; G. A. Ganss, *Geschichte der pharmazeutischen Chemie an der Universität Göttingen* (Göttingen, 1937), 46–64; G. Lockemann and R. Oesper, 'Friedrich Stromeyer and the History of Chemical Laboratory Instruction', *Journal of Chemical Education* 30 (1953), 202–4.

[25] Even Stromeyer's partisans carefully qualified their arguments. After cogently disputing Liebig's self-serving exaggerations, Lockemann still regarded Liebig as the 'true founder' of laboratory instruction in Germany, because of the totality of his accomplishments and because of his great influence ('Unterricht', 157). Similarly, Henrich, who argued keenly for Stromeyer's importance, was careful to state that Liebig expanded and developed the model established first in Göttingen, in particular toward the education of future *research* chemists ('Geschichte', 587).

to make use of some of those hands—the more practiced students, and guest workers—in advancing a broad research front. Connected with this, the explosion of new compounds on which to operate provided a great incentive to create research groups that included students and what we now call postdocs and other non-enrolled visitors. Only *groups* could make substantial progress in such a large and fast-moving field.

What really made all the difference, I emphasize once more, was that Liebig's endeavors were in the field of *organic* chemistry. To chemists at the beginning of this period, organic chemistry (to use Wöhler's famous metaphor from 1835) appeared as a trackless tropical jungle, bursting with exotic wonders, but into which one scarcely dared to enter.[26] Liebig's troops, and those who were inspired by his leadership, rapidly began to bushwack pathways into that wilderness. These developments gained power not just through productive theoretical practices, but also through a new laboratory culture, with all the relatively easily scalable apparatus and equipment of the modern (19th-century) chemical laboratory—a point to which we will return, with further elaboration, in the next section.

The Model Pursued in Other German States

After Liebig's close friend Wöhler was hired at Göttingen (1836), he used the laboratory left him by Stromeyer, and like his predecessor he taught a regularly rostered Praktikum. Although the Göttingen Universitätsarchiv does not hold course enrollment data before 1842, we can use other kinds of evidence to follow the earliest years of Wöhler's Göttingen career.[27] Wöhler's trajectory as regards practical chemical pedagogy and the gradual building of a small research group followed the same general path as Liebig's, with a lag of something like two or three years. The timing of Liebig's and Wöhler's respective trajectories—especially the use of selected students in research programs, which was genuinely novel in European science—as well as some explicit statements by Wöhler suggest that he had a clear idea regarding who the leader of this movement was. A few years after these events, Wöhler wrote to Liebig, half-seriously complaining of his own workload at Göttingen: 'You are the one who is really to blame, by raising chemistry to its great reputation through your achievements and

[26] Wöhler to Berzelius, 28 January 1835, in O. Wallach (ed.), *Briefwechsel zwischen J. Berzelius und F. Wöhler* (Leipzig, 1901), i. 604. 'Die organische Chemie kann einen jetzt ganz toll machen. Sie kommt mir vor wie ein Urwald der Tropenländer vor, voll der merkwürdigsten Dinge, ein ungeheures Dickicht, ohne Ausgang und Ende, in das man sich nicht hinein wagen mag.'

[27] For details, see Rocke, *Quiet Revolution*, 9–34, and Rocke, 'Giessen Model', 103–6.

writings, that we must slave as we do, since now the whole world wants to do chemistry. But the damage you have inflicted must be borne.'[28]

Robert Bunsen was a fellow traveler in this movement. A student of Stromeyer in Göttingen, Bunsen spent almost two years on a Wanderjahr in France, Germany, and Austria; he was much influenced by Berzelius, and learned the Kaliapparat method directly from Liebig during a visit to Giessen in August 1832. He was hired at the University of Marburg in 1839, and the following year he created a university-sanctioned Praktikum—his and Marburg's first enterprise of this character. Lockemann, an authority on the life of Bunsen and an avid admirer of Stromeyer, stated that Bunsen began his Praktikum 'following Liebig's example'. However, despite his well justified reputation as a masterly and caring instructor, Bunsen never created a Liebig-style teaching-research group; he usually worked alone, and usually on inorganic topics.[29]

Wöhler and Bunsen were the most eminent members of the German chemical community to adopt major aspects of the new model early on, but they were not alone. Otto Erdmann, a respected chemist at the University of Leipzig with no personal ties to Liebig, began a new-style practicum there in 1843. In a description of his laboratory practice in 1844, he wrote that Liebig's research school at Giessen had provided a new model that had drawn 'the most general attention' of the scholarly world, and was being rapidly emulated 'überall'. The novelties, he continued, included the idea of all-day practica, and the incorporation of a pedagogy that mixed research with instruction. This made the students 'witnesses and collaborators in the research of the professor', and encouraged them on to their own research. His new laboratory institute, he wrote, was designed to follow Liebig's pattern.[30]

We pass by Liebig's prize student August Wilhelm Hofmann (whom we will discuss later), to provide another example in Hermann Kolbe, who enthusiastically adopted the Liebig model in its most complete version when he was called to Marburg in 1851, after Bunsen was hired at Breslau.[31]

[28] Wöhler to Liebig, 10 May 1851, in Hofmann, *Briefwechsel*, i. 364. 'Du, durch die große Geltung, die Du der Chemie durch Deine Arbeiten und Werke verschafft hast, bist eigentlich Schuld, daß man sich so plagen muß, daß nun alle Welt Chemie treiben will. Indessen läßt sich der Schaden, den Du angerichtet hast, tragen.

[29] G. Lockemann, *Robert Wilhelm Bunsen* (Stuttgart, 1949), 75; C. Meinel, *Die Chemie an der Universität Marburg seit Beginn des 19. Jahrhunderts* (Marburg, 1978); Christine Nawa, 'A Refuge for Inorganic Chemistry: Bunsen's Heidelberg Laboratory', *Ambix* 61 (2014), 115–40.

[30] Otto Erdmann, 'Das chemische Laboratorium der Universität Leipzig', *Journal für praktische Chemie* 31 (1844), 65–70, on 65–6.

[31] Meinel, *Chemie an der Universität Marburg*; Rocke, *Quiet Revolution*, 108–33.

The following year Bunsen was called to Heidelberg to replace Wöhler's former teacher there, Leopold Gmelin. This began an elaborate chain of chemical-professorial successions that would fundamentally transform the German academic chemical community. In the post-1848 world the newer model quickly proliferated in academic chemical institutes throughout all the German states.[32]

As detailed above, neohumanist university reform, an invigorated research mandate, and the influence of an experientialist pedagogical philosophy stressing active learning conditioned the rise of new-style practica in Vormärz German universities, and it is not surprising that these influences were felt in other scientific disciplines, as well. In the field of physiology and as early as the 1830s, for example, Johannes Müller in Berlin and Jan Purkyně in Breslau moved beyond experiments simply as demonstrations, and were putting selected students behind microscopes and dissection apparatus. In analyzing these developments, however, Coleman cautions that this was 'but one and a still quite tentative step' toward the late-nineteenth-century academic physiological laboratory institute, for in each case it remained a 'small affair' and never realized its potential. For physiology, a better case for the new model can be made for the efforts of Jacob Henle at Heidelberg after 1843.[33]

In the field of physics, Wilhelm Weber's practicum at Göttingen (from 1833), Franz Neumann's mathematical-physical seminar at Königsberg (1834), and Gustav Magnus's practicum at Berlin (1843) have sometimes been mentioned as the earliest efforts along these lines. However, these examples do not fully compare to what was happening in chemistry in Giessen, Göttingen, Marburg, and Leipzig in the late 1830s and 1840s. The physics seminars all remained quite small, and none exhibited the full constellation of characteristics of intensive study, broad clientele, university sanction, and group research activity. Mature examples of this model in physics did not emerge until after 1848.[34]

[32] Regarding the period before 1848, Jeffrey Johnson's impressive summary of renovations and new constructions of nineteenth-century German university chemical laboratory institutes includes only Giessen (1839) and Göttingen (1842), whereas no fewer than 34 projects were carried out from 1851 to 1895; see his 'Academic Chemistry in Imperial Germany', *Isis* 76 (1985), 500–24, esp. the table on 502.

[33] William Coleman, 'Prussian Pedagogy: Purkyne at Breslau, 1823–1839', in Coleman and F. L. Holmes (eds.), *The Investigative Enterprise: Experimental Physiology in Nineteenth-Century Medicine* (1988), 15–64, on 38–40; Arleen Tuchman, *Science, Medicine, and the State in Germany: The Case of Baden, 1815–1871* (Oxford, 1993).

[34] Kathryn Olesko, 'On Institutes, Investigations, and Scientific Training', in Coleman and Holmes (ed.), *Investigative Enterprise*, 295–332; Olesko, *Physics as a Calling: Discipline and Profession in the Königsberg Seminar for Physics* (Ithaca, 1990); David Cahan, 'The Intellectual Revolution in German Physics, 1865–1914', *Historical Studies in the Physical Sciences* 15 (1985), 1–65, on 6–12.

Given the parallel influences, why were the other science disciplines in Germany behind the curve set by chemistry? We have argued above that the explosive growth of the specialty field of *organic* chemistry beginning around 1830 was a crucial background factor in the formation and development of Liebig's school, but now we need to emphasize that there were two ways in which chemistry *in general* was distinguished from its sister disciplines in the natural sciences; both pertain directly and specifically to the pedagogical question raised here.

First, Homburg has drawn attention to a late-eighteenth-century European transformation of the chemical laboratory from workshops containing imposing furnaces and large pieces of earthenware, metal, and glass, to precision workplaces with bench-top apparatus using such small analytical apparatus as blowpipes, lamps, test tubes, and reagent glasses.[35] In the light of this research, we can see that Liebig's accomplishment in the field of analysis was in a sense simply to achieve for organic chemistry what had recently been seen in the inorganic field—a dramatic improvement in routine and precise analytical procedures, coupled with a substantial reduction in the physical size of the apparatus necessary to conduct the analysis. The miniaturization and routinization that inorganic analysts had pioneered had now also emerged in organic chemistry.

So by comparison with other sciences, chemistry was henceforth intrinsically and uniquely well suited to the new pedagogical model. In comparison to the relatively complex and expensive instrumentation required of a physics laboratory, or microscopes necessary for pathology or physiology, or apparatus and dissection subjects in anatomy classes, chemists faced only quite modest challenges in scaling up from the earlier laboratories that were designed merely to support lecture demonstrations, to those much larger facilities needed for broadly-based student practica. By comparison to nearly every other field of science, chemical apparatus was relatively inexpensive, and rather easily multiplied for student use. Nearly all individual chemical apparatus were made from inexpensive materials such as glass, rubber, wood, and cork. Expensive items, such as pumps, platinum crucibles, or precision balances, could be shared by an entire laboratory. All this is not to suggest that running a chemical laboratory for student practica was ever *cheap*; just that, by comparison to other fields of science, the cost of scaling up from experiments for lecture demonstrations to experiments performed by students as a routine element

[35] E. Homburg, *Van beroep 'Chemiker': De opkomst van de inustriële chemicus en het polytechnische onderwijs in Duitsland* (Delft, 1993); Homburg, 'Rise of Analytical Chemistry'; Homburg, 'Chemical Profession'; Peter Morris, *The Matter Factory: A History of the Chemistry Laboratory* (London, 2015).

of pedagogy was generally manageable. This laboratory revolution in chemistry was one of the essential conditions that made the new pedagogy possible.

And there was a second issue favoring chemistry over its sister disciplines. Regarding the resources that states were willing to put to these purposes, it obviously mattered that chemists—especially organic chemists—were able to argue effectively for the social and technological utility of their work. Liebig was always powerfully oriented to the applicability of his research. At first this was mostly directed towards the relevance of his research to pharmacy and human physiology, although from 1840 on he also stressed plant physiology, agricultural science, and pharmaceutical and clinical medicine as fields of application for his work. All of these potential practical benefits of academic chemistry far outstripped in importance what the other sciences (excepting perhaps pathology) could lay claim to, even in terms of plausible rhetoric alone. Both the rhetoric and the reality of applications gave additional force to the perceived social promise of chemistry, and especially organic chemistry.

In a landmark book published more than forty years ago, Peter Borscheid argued that following the abortive revolutions of 1848, German princes and political elites moved to adopt elements of Liebig's prescriptions for agricultural chemistry and science pedagogy, in order to create conditions that might promote better-fed and therefore politically more docile populations. This, he argued, was a leading factor that led to the munificent financial support for academic chemistry by German princes and legislatures during the 1850s and later. To whatever degree the Borscheid thesis is correct, there is no question but that Liebig, and academic chemistry more broadly, benefited from the close association of chemistry in general, and organic chemistry in particular, with socially important applications. And there is also no question that political elites across the German lands did support university science munificently after 1848.[36]

In the 1850s and 1860s, magnificent edifices began to appear in the German university landscape to house chemistry departments.[37] For comparison, it should be remembered that academic laboratories in the early (*Vormärz*) stages of the German ascendancy were far from munificent; they had all been shoe-horned into jury-rigged spaces usually in existing buildings, often old, small, and decrepit ones. Liebig's Giessen institute had been a barracks; Wöhler's, although new, a barely adequate

[36] Peter Borscheid, *Naturwissenschaft, Staat und Industrie in Baden (1848–1914)* (Stuttgart, 1976); for a concordant perspective on Baden's science policies, see Tuchman, *Science, Medicine, and the State in Baden*.

[37] Johnson, 'Academic Chemistry'.

half-timbered house; and Bunsen's, Kolbe's, and Gmelin's were all medieval buildings. That began to change immediately after the Revolution of 1848 was defeated. As we have seen, it was sparked by a widespread sense among German political elites that investments in academic science were an essential element of a stable modernizing state, and it was fueled by competition engendered by the decentralized nature of what was collectively called 'Germany.' In that pseudo-international marketplace, and moreover with the freedoms of *Lehr-* and *Lernfreiheit* that enabled both professors and students to 'vote with their feet' all over the German-speaking lands, the price of excellence in university science steadily rose, and was just as steadily paid for by pliant princes and legislatures.[38]

So when Liebig contemplated leaving Giessen (in the Grand Duchy of Hesse), and universities in other German states began to bid for his services, the dominoes began to fall. In 1851 Bunsen was induced to leave Marburg (Electoral Hesse) for Breslau (Prussian Silesia), attracted by the promise of a new chemical laboratory to be built there; but after just three semesters there, the promise of an even more magnificent new laboratory drew him to Heidelberg (Baden). Liebig, sought in vain by both these universities, went to Munich (Bavaria) instead, with the most lavish offer of all in his pocket. Slightly later significant hires included Hofmann to Berlin in 1865, Kolbe to Leipzig also in 1865, and August Kekulé to Bonn in 1866. Each one of these transfers was accompanied by the construction of a palatial new laboratory institute, and all of them were built for chemists who pursued a single subfield, organic chemistry. Moreover, most of the great German chemists of the next generation, such as Liebig's successor Adolf Baeyer, Hofmann's successor Emil Fischer, and Wöhler's and Bunsen's successor Victor Meyer, were also '*organikers*'; they, too, were treated to large new laboratory institutes at the respective universities. And other scientific disciplines—e.g., pathology, physiology, and physics—shared in the wealth. French and British observers looked at these developments with envy and even fear.

I have yet to mention a further crucial factor in the rise of German academic chemistry, and the associated expansion of the field of organic chemistry, namely the theories of atomic valence and chemical structure. These ideas, which shed a bright new light on the mysteries of the composition of organic molecules, were developed in the 1850s and 1860s,

[38] See the references in the previous two notes; also Avraham Zloczower, 'Career Opportunities and the Growth of Scientific Discovery in Nineteenth-Century Germany', M.S. dissertation, Hebrew University, 1960, reprint, (New York, 1981); Joseph Ben-David (ed.), *The Scientist's Role in Society*, 2 (Chicago, 1984); R.S. Turner, E. Kerwin, and D. Woolwine, 'Careers and Creativity in Nineteenth-Century Physiology: Zloczower Redux', *Isis* 75 (1984), 523–9.

just at the time when those earliest grand purpose-built chemical palaces were mushrooming across the German states. Structure theory provided an astonishingly productive compass into (and through) the now exploding field, and benefiting not just academic scientific research, but also the rising fine chemical industry.

In 1865, August Kekulé, the leading figure in these theoretical developments, added another powerful theory, a molecular-structural means to understand the nature of so-called aromatic compounds. We noted earlier that well over 99% of all chemical compounds known today are organics. What we need to add is the fact that the great majority of these are aromatic compounds, and aromatics proved to be the foundation of most dyes and drugs in the new science-based chemical industries of the last third of the century. Consequently, after 1865 chemistry was given another powerful stimulus, a stimulus felt especially in the country that had so successfully pioneered the scientific understanding of organic substances.

Regarding the job market for chemists, there was a growing need for teachers of chemistry, paralleling the steady increase in the numbers of schools providing basic and advanced training in applied areas. University departments also saw growth due to the gradual splitting off of professorships in specialty fields of chemistry, including not just organic, but also inorganic, analytical, mineralogical, biological, and physical chemistry, and because of the need for additional academic personnel below the rank of *ordentlicher* Professor. There were also increased demands for food, drug, and clinical analysts, and towards the end of the century there was a real and growing market for trained chemists for industrial research, as well.[39] All of these intersecting and self-reinforcing factors made German chemistry, especially German organic chemistry, recognized around the world as ascendant.

Exportation to Other Countries

In post-Napoleonic France, the advanced degrees required for university teaching were the *agrégation* (roughly comparable to the German tradition of *Habilitation*), and the *doctorat d'état*; the former was granted simply by examination, but after about 1830 the latter required a dissertation describing original research carried out by the candidate. Such research generally required a mentor, and, for the laboratory sciences, a facility in which to work; both often posed challenges for ambitious French students. Laboratories in the *Facultés* of the *Université de France*, even in the famous Sorbonne, were few and in general seriously deficient, and even the labs at the *grandes écoles* and research institutions of the capital were starved for

[39] Homburg, 'Two Factions, One Profession'.

funding. Despite holding multiple simultaneous positions in Paris, leading *cumulards* in chemistry during the July Monarch, Second Republic, and Second Empire—luminaries such as Dumas, Gay-Lussac, Pelouze, and Regnault—spurned their official workplaces and instead chose to open private or consulting labs, where young would-be scientists sought places in which to work through individual patronage, or through their own independent means. The farsighted moves of the reformist education minister Victor Duruy brought some redress during the 1860s—especially the creation of the Ecole Pratique des Hautes Etudes, partly modeled on the German system of higher education—but further progress was stymied by Prussia's sound defeat of France in the 1870–71 war. Thoroughgoing reforms were finally seen after 1875 in the new environment of the Third Republic, including a full renovation of the Sorbonne, now equipped for the first time with proper scientific laboratories. But the damage had been done; the new Sorbonne did not open until 1894.[40]

Let us return to the late 1830s, and add some further details to this overview. Liebig's principal European rival was Jean-Baptiste Dumas in Paris, who was sorely troubled by the near-absence of state-supported academic laboratories in France, and who early on saw the handwriting on the wall. 'How very fortunate you are', he wrote to Liebig in November 1837, 'to have a battalion of eager chemists at your disposal. . . . [F]or the moment I am far from that'. Six months later, he told Liebig that he was about to open a new teaching-research laboratory, where he hoped to put about ten selected students to work. 'Only then will I be in a position to resume my experiments in competition with yours. At the moment I can't keep pace with you.'[41]

Dumas was the author of no fewer than four official reports on French higher education, commissioned by the Ministry of Public Instruction and submitted to the Orleanist government in 1837, 1840, 1846, and 1847. In each of these reports, Dumas deplored the paucity of state-supported academic labs, and urgently advocated that France should adopt reforms, several of which proposals Dumas was obviously basing on what he had learned from the practices and facilities specifically in Giessen

[40] The material in this and the following paragraphs is condensed from my treatment in *Nationalizing Science: Adolphe Wurtz and the Battle for French Chemistry* (Cambridge, MA, 2001), and sources listed therein. See also the sources cited in n. 3 above.

[41] Dumas to Liebig, n.d., but ca. November 1837 (Liebigiana IIB, Bayerische Staatsbibliothek, Munich), 'Que vous êtes heureux de pouvoir ainsi disposer d'un bataillon de chimistes zélés. J'espère vous en offrir autant quelque jour; mais pour le moment je suis loin de là.' Dumas to Liebig, n.d., but ca. May 1838 (Ibid), 'Alors seulement, je serai en mesure de reprendre des expériences en concurrence avec les vôtres. Je ne puis pas aller votre pas dans ce moment.'

(without, however, explicitly mentioning this foreign site). In one of these reports he wrote:

> The *Faculté des Sciences* [in Paris], which has allowed itself to be overtaken by Germany and England, would soon regain its rightful place . . . if it could direct a competition of well-organized efforts toward the solution of some of the problems of science, as it is practiced on the other side of the Channel and the Rhine. Today it is necessary for a university . . . not to be forced to wait for a question to be resolved by the individual work of one of its professors extended over several years, when it can do so in a few weeks under his direction by the collective effort of a dozen beginners in science . . .[42]

Faced with repeated failures of the July Monarchy to do anything positive for science, in 1838 Dumas tried, with mixed success, to emulate Liebig by opening a private lab in Paris (referred to above). In the same year Jules Pelouze, whom Liebig had mentored in Giessen and who was ardently longing to bring at least a trace of Giessen to Paris, opened his own private lab adjoining his residence at the Paris Mint.[43] In 1850 the French Liebigian Adolphe Wurtz opened a similar and rather ephemeral private teaching laboratory in Paris, and the following year yet another French former student of Liebig, Charles Gerhardt, did the same.

All four of these men told Liebig that these Parisian installations were modeled in essential respects on what he had done in Giessen; the circumstance that all of the labs were private enterprises had essentially been forced by the government's failure to act. But Wurtz's and Gerhardt's start-ups quickly failed; Dumas's lab, although influential, lasted only ten years; and Pelouze's business, although financially successful, was without significant influence. In any case, none of these was comparable to the Giessen institute; they were all private laboratory training schools rather than higher educational/research institutions. Wurtz subsequently created the only truly successful French academic teaching and research group similar to the German model, which from 1854 on was housed rather incongruously at the *Faculté de Médicine* simply because that was where Wurtz happened to be employed. Only after twenty-three years of Wurtz's pleading with government functionaries did his lab finally win official sanction by the Paris Medical School.

Although Dumas had told his superiors in the education ministry that Britain as well as Germany was outdistancing French efforts, many British

[42] This report was printed in the *Moniteur universel*, (28 October 1846), 2448–50. For more on these four reports, with citations to archival and printed sources, see Rocke, *Nationalizing Science*, 109, 127–8, 270–3.

[43] 'Giessen, Giessen, ah!' the nostalgic Pelouze exclaimed in his letter to Liebig of 25 January 1838, 'jamais matelot n'a demandé la terre avec plus d'impatience.' Bayerische Staatsbibliothek, Liebigiana IIB.

chemists were just as unsatisfied as the French, and just as anxious to apply German models. In the 1830s and 1840s, reforms were moving slowly at Oxbridge. There was better reason for hope at the modernist University College London, where Thomas Graham taught. Graham sought Liebig's recommendation, then hired Giessen-educated George Fownes; when Fownes died at a young age, Graham again asked for Liebig's advice, then hired the likewise Giessen-educated Alexander Williamson. It was at UCL that the first purpose-built academic laboratory in Britain, the Birkbeck Laboratory, was opened in 1845.

Nearly simultaneously with the opening of the Birkbeck Lab was founded the private Royal College of Chemistry, also in London. Liebig's advice was once more avidly sought, including by the German-born Prince Consort, and this time the hire was not just a Briton who happened to be educated at Giessen, but an actual German student of Liebig, namely August Wilhelm Hofmann, who imported the Giessen system bodily into the Royal College of Chemistry.[44] Hofmann's twenty years in London proved providential for British chemistry. Then, when private philanthropy created (as it had for the RCC in London) the nucleus of what became the University of Manchester, who was hired there to provide instruction in physical science but a leading student of Bunsen and Liebig, Edward Frankland. It is no wonder that William Brock labeled his masterly biography of Liebig, *The Chemical Gatekeeper.* Other prominent British chemists of this and a slightly later period, such as Henry Roscoe, Alexander Crum Brown, and William Henry Perkin, were, like Fownes, Williamson, and Frankland, German-educated. We recall that Frankland was ever more concerned about German chemical hegemony through the 1870s, especially after the amazing Hofmann had emigrated home to Prussia in 1865.

Ten years later, shortly after the death of Baron von Liebig, his former student Friedrich Schödler wrote:

> In the last fifty years, chemistry has enjoyed a very special advantage: it has crossed, as it were, into hitherto untouched California gold fields; one only needed to dig in order to uncover riches. . . . What once were only dozens [of academic chemists], are now just as many hundreds of them. The obvious question must be asked: is it not inevitable that chemistry will now advance with giant steps, and by this massive attack continually reveal novel and important knowledge?[45]

[44] Gerrylynn K. Roberts, 'The Establishment of the Royal College of Chemistry', *Historical Studies in the Physical Sciences* 7 (1976), 437–85; Catherine M. Jackson, 'Re-examining the Research School: August Wilhelm Hofmann and the Recreation of a Liebigian Research School in London', *History of Science* 44 (2006), 281–319.

[45] Schödler, 'Das chemische Laboratorium unserer Zeit', *Westermanns illustrierte deutsche Monatshefte*, 38 (1875), 21–47, on 30 and 45.

In studying this great change, exogenous market factors and structural social changes are obviously highly important. However, it is also crucial to pay attention to less obvious factors such as the laboratories that chemists use for education and research, and the equipment in them. Liebig's work, and the apparatus he invented, really did open doors. In nineteenth-century Europe, it was the Germans who walked through those doors first.

I do not intend to attempt even to summarize the importation of the German model to the United States, but I will close by citing the well-known circumstance that Johns Hopkins University was founded explicitly on the German model (although as happened with all imports of that model, the receiving country modified it in certain essential ways).[46] One of the first hires there was Ira Remsen, fresh from a Ph.D. from the Liebig institute in Munich. The first president of Hopkins was Daniel Gilman, who ever after looked to the German founding mythology. The Sheffield Scientific Laboratory at Yale University had acquired its first gifts as early as 1847. 'But for twenty years prior to 1847', Gilman intoned as guest speaker at the Sheffield semicentennial,

> . . . a force had been at work in a little country town of Germany destined to affect the education of Christendom, and at the same time to enlarge the boundaries of human knowledge, first in chemistry and the allied branches, then in every other one of the natural sciences. The place was Giessen; the inventor, Liebig; the method, a laboratory for instruction and research.[47]

This was the Liebig mythology, which was perhaps too uncritically adopted for decades after Liebig's death. The rise and persistence of that mythology was surely at least partly due to Liebig's genius both for chemistry, and for self-promotion. But one quality has been too little stressed: along with everything else, Liebig was supremely fortunate. He was fortunate to find himself in Germany, which had the right combination of movements just at this time; he was fortunate to find himself at the University of Giessen, whose administration did indeed endorse his activities;[48] he was fortunate to find himself close to the starting point of the branch of science to which he devoted his efforts, organic chemistry. Above all, he was fortunate to have chosen chemistry at all, and organic chemistry in particular, for (as I have argued here) organic chemistry around 1830 was uniquely positioned to provide a home for the style of research and education which Liebig so skillfully helped to develop, and which has spread so universally throughout the world.

Case Western Reserve University

[46] Hannaway, 'Ira Remsen at Johns Hopkins'.
[47] Daniel Gilman, *University Problems in the United States* (New York, 1898), 120.
[48] For which, see Brock, 'Breeding Chemists in Giessen'.

4

Training Research Mathematicians *circa* 1900: The Cases of the United States, Germany, France, and Great Britain

Karen Hunger Parshall

Introduction

In 1891, the three-year-old, New York Mathematical Society began publishing its *Bulletin* in an effort to communicate with a small but growing constituency of American research-level mathematicians. At least symbolically, this local group united a national community after 1894 when it changed its name to the *American* Mathematical Society. Its *Bulletin*, published ten times a year,[1] was primarily a venue for short research articles and book reviews, but it also aimed to keep its readers abreast of news of the emerging profession through its 'Notes' department. There, America's mathematicians could read of each other's promotions and movements from school to school as well as of mathematical news from abroad. In particular, they could stay informed, essentially semester by semester, about the research-oriented courses of study being offered at institutions both at home and, in particular, in Germany, France, and England. It was about programs in these countries that members of the emergent American mathematical research community most wanted up-to-date information. These were the countries that they viewed as the primary centers for advanced training open to and most viable for them around 1900. How, then, were would-be mathematicians trained in these four countries—Germany, the United States, France, and Great Britain, especially England—at the turn of the twentieth century?

Interestingly, this is not a question that could even have been asked a quarter-century earlier. Prior to the nineteenth century, there was no

[1] The *Bulletin* came out monthly, except during the two summer months of July and August.

Karen Hunger Parshall, *Training Research Mathematicians* circa *1900* In: *A Global History of Research Education: Disciplines, Institutions, and Nations, 1840–1950*. Edited by: Ku-ming (Kevin) Chang and Alan Rocke. *History of Universities* XXXIV/1, Oxford University Press (2021). © Oxford University Press.
DOI: 10.1093/oso/9780192844774.003.0005

formal, research-level training in mathematics.[2] In Europe, mathematical talent was fostered, for example, in the context of scientific societies—the Berlin Academy, the Paris Académie des sciences, the Royal Society of London—while in the United States, a country born only in the late eighteenth century, it was scarcely fostered at all. In some sense, advanced training in mathematics only began in the United States in 1876 with the founding of the Johns Hopkins University on what its first president, Daniel Coit Gilman, interpreted as the German model.[3] How and when did other centers for mathematical training at the higher level develop? What, if any, were their interrelations? Considering these questions from the perspective of would-be, turn-of-the-twentieth-century American mathematicians serves not only naturally to unite the United States, Germany, France, and particularly England in Great Britain for the first time in a comparative analysis of research-oriented training, but also to provide interesting insights into the implementation of that level of training on both sides of the Atlantic.[4]

The Prussian Universities as a Model[5]

As is well known, the opening decade of the nineteenth century sent shockwaves through a Prussia defeated in 1806 at Jena at the hands of Napoleon's French army. A series of political, socioeconomic, and

[2] Indeed, this was the case in other subjects as well. See, for example, Joseph Ben-David, 'The Universities and the Growth of Science in Germany and the United States', *Minerva*, 7 (1968–1969), 1–35 on 7.

[3] As Gert Schubring has argued, however, there was no one German model. Students of higher education like Gilman were actually informed by the example of the Prussian universities, particularly the University of Berlin and, after its incorporation into Prussia in 1866, Göttingen University. See Gert Schubring, 'Pure and Applied Mathematics in Divergent Institutional Settings in Germany: The Role of Felix Klein', in David E. Rowe and John McCleary (eds.), *The History of Modern Mathematics*, 2 vols. (Boston, 1989), ii. 171–220.

[4] Using the United States as the lens through which to structure this comparative analysis should in no way suggest that the United States, Germany, France, and Great Britain were the only countries at the turn of the twentieth century where educational developments in graduate-level mathematics were taking place. China, Italy, Japan, Russia, Spain, Sweden, and elsewhere could also be included in a fuller discussion. For a sense of developments outside the four countries examined here, see Karen Hunger Parshall, 'Mathematics in National Contexts (1875–1900), An International Overview', in *Proceedings of the International Congress of Mathematicians: Zürich*, 2 vols. (Basel/Boston/Berlin, 1995), ii. 1581–91 on 1582–3 and the more elaborated version 'How We Got Where We Are: An International Overview of Mathematics in National Contexts (1875–1900)', *Notices of the American Mathematical Society* 43 (1996), 287–96 on 288–9 as well as the various chapters in Karen Hunger Parshall and Adrian C. Rice (eds.), *Mathematics Unbound: The Evolution of an International Mathematical Community, 1800–1945*, AMS/LMS Series in the History of Mathematics, 23 (Providence and London, 2002).

[5] For the account here of the situation in Germany, compare Parshall, 'Mathematics in National Contexts', 1582–3 and Parshall, 'How We Got Where We Are', 288–9.

educational reforms ensued that aimed at reorganizing, strengthening, and modernizing the kingdom. Perhaps the biggest educational reform was the founding of the University of Berlin in 1810 at the suggestion of the Prussian educational reformer, Wilhelm von Humboldt, elder brother of the celebrated traveler, geographer, and naturalist, Alexander von Humboldt. In addition to overhauling primary and secondary education in the kingdom, the elder Humboldt—influenced by idealist philosophy and neohumanism—crafted a vision of higher education in which professors should both teach and engage in pure and disinterested research free from outside political or religious influences.[6] Moreover, they should add to the store of knowledge through their own efforts—at the same time that they actively trained future researchers—in order to perpetuate the advancement of knowledge. As it came to be implemented first at the University of Berlin and then elsewhere, Humboldt's vision rested on the twin principles of *Lehr- und Lernfreiheit*, the freedom of the faculty to teach and of the faculty and the students to learn and to research unencumbered. Beginning with philosophy and philology and soon extending to the natural sciences, to mathematics, and to other areas, teaching *and* research came to define the dual mission of members of Prussian and other German-speaking university faculties by midcentury.

Interestingly, in mathematics as in history (see Chapter 2 in this volume), higher-level training was first institutionalized not at Berlin, but at the University of Königsberg. The instigator in the case of mathematics was the Berlin-trained mathematical prodigy, Carl Gustav Jacob Jacobi. When Jacobi attended the University of Berlin in the early 1820s, it still offered only elementary mathematics instruction, so Jacobi taught himself from the texts of such eighteenth- and early-nineteenth-century luminaries as Leonhard Euler, Joseph-Louis Lagrange, and Pierre Simon Laplace.[7] On finishing his doctoral dissertation in 1825, Jacobi became a *Privatdozent* at Berlin before moving on to Königsberg in 1826. There, longer-term job prospects seemed better. Indeed, he almost immediately secured an associate professorship, and a full professorship followed in 1832. At Königsberg, Jacobi fully embraced the twin ideals of research and teaching. He produced prodigious amounts of new mathematical ideas, particularly in the theory of elliptic functions but also in the more applied areas of the calculus

[6] For more on this, see Lewis Pyenson, *Neohumanism and the Persistence of Pure Mathematics in Wilhelmian Germany* (Philadelphia, 1983) and Fritz Ringer, *The Decline of the German Mandarins: The German Academic Community* (Cambridge, MA, 1969).

[7] Christoph Scriba, 'Jacobi, Carl Gustav Jacob', in Charles Gillispie (ed.), *Dictionary of Scientific Biography*, 16 vols. and 2 supps. (New York, 1970–1990), vii. 50–5 on 50. On Jacobi's student days in mathematics at Berlin, see Kurt-R. Biermann, *Die Mathematik und ihre Dozenten an der Berliner Universität 1810–1933* (Berlin, 1988), 33–5.

of variations, mechanics, and the theory of first-order partial differential equations. He also enthusiastically taught the fruits of his mathematical labors to his students. It was, moreover, Jacobi who, in bringing together his most mathematically inclined colleagues and the most advanced of his students, inaugurated, in 1834, the first mathematical-physical seminar in Germany. Modeled on the philological seminar he had attended while a student in Berlin, Jacobi's seminar aimed both to expose students to open problems and to train them actively to solve them.[8] Would-be mathematicians Carl Borchardt and Ludwig Otto Hesse, both of whom went on to become mid-nineteenth-century mathematical 'names', not only matured in Jacobi's seminar but also embraced the ideal that providing such training should be part of the university professor's mission.

They were not alone in this. The seminar notion spread from mathematicians in Prussia to those in other German states over the course of the nineteenth century, again, just as it had done in the case of historians. A seminar for mathematics and the natural sciences was founded in 1839 at Halle in the then Prussian Province of Saxony; a mathematical-physical seminar started up in 1850 at Göttingen, which was then in the Kingdom of Hanover; a mathematical-scientific seminar was finally established at Berlin in Prussia in 1860; and a mathematical seminar began at Leipzig in Saxony in 1881.[9] In all of these settings, the seminar provided a key supplement to lecture courses in areas of mathematical research interest. It was a venue in which students were charged both with mastering and presenting mathematical results from the most recent literature in a given area and with actively fielding questions on those results from both their professor and their peers. Unlike the lecture hall, then, the seminar room witnessed active engagement, mathematical give-and-take designed not only to bring students to the threshold of mathematical research but also eventually to see them successfully over that threshold through the production of their own original results.[10]

At Berlin, for example, the mathematical seminar was inaugurated by Ernst Kummer and Karl Weierstrass, two of the nineteenth century's leading mathematicians. Almost immediately perceived, in the words of a key

[8] Biermann, *Die Mathematik und ihre Dozenten an der Berliner Universität*, 60.

[9] Ibid, 97–8. On the mathematical seminar at Leipzig, in particular, see Herbert Becker and Horst Schumann, *100 Jahre Mathematisches Seminar der Karl-Marx-Universität Leipzig* (Berlin, 1981).

[10] For a general description of the mathematical seminar as implemented in German universities, see Karen Hunger Parshall and David E. Rowe, *The Emergence of the American Mathematical Research Community, 1876–1900: J. J. Sylvester, Felix Klein, and E. H. Moore*, HMATH, 8 (Providence and London, 1994), 190–1. See also Wilhelm Lorey, *Das Studium der Mathematik an den deutschen Universitäten seit Anfang des 19. Jahrhunderts*, Abhandlungen über den mathematischen Unterricht in Deutschland, Band III, Heft 9 (Leipzig, 1916).

government official, as 'the most propitious development for mathematical instruction' in Prussia,[11] the seminar was augmented in 1861 by a Mathematics Club (*Mathematischer Verein*) for lectures, discussion, and the posing and solving of mathematical exercises. By 1864, with Weierstrass's elevation to a full professorship, with the effective addition (after 1862) to the teaching staff of another of the nineteenth-century mathematical greats, Leopold Kronecker, with a full complement of lecture courses, with the seminar, and with the Mathematics Club, the program in mathematics at the University of Berlin entered into what has been called its 'heroic era'.[12] It was able to provide, in the context of a two-year-long course of study, what Weierstrass termed 'an important series of lectures on the most important mathematical disciplines'.[13] Mathematicians and mathematical aspirants not only in Germany but also internationally concurred in Weierstrass's assessment. By the mid-1880s, this program was attracting upwards of 250 students a year from all over Europe, from Russia, and from the United States.[14]

The program in Berlin was, however, soon rivaled by that in Göttingen, where, after his move there from Leipzig in 1886, Felix Klein drew increasing numbers of mathematics students, both male and female, especially from the United States.[15] A first-rate researcher and a master teacher, Klein not only trained a significant percentage of what might be termed the 'first generation' of American mathematical researchers but also served as a role model for those students as they returned to the United States to animate graduate programs of their own.

In his lecture courses, Klein exposed his students to the incredibly rich world of nineteenth-century analysis and geometry as fashioned by the likes of Carl Friedrich Gauss, Bernhard Riemann, Niels Abel, Alfred Clebsch, and Karl Weierstrass. These were among the giants of nineteenth-century mathematics, and their works could be notoriously difficult to penetrate, especially for the novice. Still, in Klein's view, theirs was the work on which the future of mathematics would be built, so theirs was the work that future researchers had first to encounter in lectures and then to master both in associated seminars and as actual assistants in writing up the official sets of notes (*Ausarbeitungen*) for each of the courses. Between 1890 and 1896, for example, Klein ran seminars on topics as diverse as 'Partial Differential Equations of Physics, on Cyclides and Lamé Functions',

[11] Biermann, *Die Mathematik und ihre Dozenten an der Berliner Universität*, 99 (quoting the Kultusminister, August von Bethmann-Hollweg; my translation).

[12] Ibid, 102 (quoting the mathematician, Adolf Kneser; my translation).

[13] Ibid, 102 (my translation).

[14] Ibid, 103.

[15] On Klein at Göttingen, and especially on his role in training a generation of American mathematicians, see Parshall and Rowe, *Emergence*, 189–259.

'Hypergeometric and Automorphic Functions', 'Linear Differential Equations and Spherical Functions', the 'Foundations of Analysis for Functions of a Single Variable', and the 'Foundations of Analysis for Functions of Several Variables'. In all of them, the students prepared lectures on specific topics that often required the mastery of research papers recently published in the German mathematical literature.[16]

That this model for the advanced teaching of mathematics and for the training of future researchers was deemed exemplary to those in the emergent American mathematical community was reflected in the fact that, in 1893, the *Bulletin of the New York Mathematical Society* carried a lengthy translation of a circular written by Klein and several of his colleagues on 'The Teaching of Mathematics at Göttingen'. There, would-be American mathematicians were presented with 'a detailed scheme of the lectures and exercises which they should attend during each semester' of their higher mathematical education.[17] The Göttingen curriculum had an 'unusually great' number of courses in mathematics and mathematical physics and treated not only those subjects 'which in the present state of science, have a recognized place in academic instruction; but [also] numerous courses [which] extend into those special departments of science which have only recently been established and are still actually in process of construction'.[18] The curriculum was thus both pure and applied. Indeed, Klein, in particular, was an advocate for applied mathematics even if his more pure-mathematically oriented students tended to find this advocacy less than compelling. This mix of courses was supplemented by seminars explicitly designed 'to lead the students to independent work and to instruct them in the application of what they have learned in the lectures'.[19] By 1893 when this account of the system at Göttingen was published, however, not only had a number of American mathematicians earned their doctoral degrees there but aspects of the broader educational model that Göttingen reflected had already been imported to the United States.

The Importation of 'the German Model' to the United States

The last quarter of the nineteenth century represented a transformative period in the history of American higher education.[20] Whereas earlier in

[16] For a list of Klein's seminars between 1881 and 1896 in which American students spoke as well as for the titles of their lectures, see Parshall and Rowe, *Emergence*, 255–7.

[17] Felix Klein et al., 'The Teaching of Mathematics at Göttingen', trans. Thomas S. Fiske, *Bulletin of the New York Mathematical Society*, 3 (1893), 80–8 on 80.

[18] Ibid, 84. [19] Ibid, 87.

[20] Much has been written on the history of American higher education in this period, but Laurence R. Veysey's *The Emergence of the American University* (Chicago, 1965) remains one of the most cogent and comprehensive analyses.

the century the mission of professors at the nation's colleges had been to impart knowledge, by the century's closing quarter, the professionalization of various academic fields had brought with it a strong sense that research should also be part of that mission (compare Chapter 1 in the present volume). Concurrently, the American Civil War, fought between 1861 and 1865, had witnessed, in addition to much bloodshed, the amassing of a number of great personal fortunes that were soon directed toward philanthropic causes, among them, higher education.

In particular, railroad magnate Johns Hopkins made provisions in his will for a previously unprecedented endowment of $7,000,000 for the founding of a new university with an associated medical school in Baltimore, Maryland.[21] When, two years after his death in 1874, the Johns Hopkins University opened, it represented a new American educational experiment in the hands of its first president, Daniel Coit Gilman. A geographer by training but long a student of higher education both at home and abroad, Gilman found himself essentially free to create an institution of higher education new to the United States, an institution of a sort that America was, in his view, sorely lacking, and an institution that would make the country more competitive with Europe. His vision for the new experiment in higher education had been fundamentally shaped by his experiences in the American colleges and by his observations particularly of the Prussian and some other German-speaking universities.[22]

Gilman's Hopkins would be, first and foremost, a graduate school, modeled on Gilman's interpretation of how advanced training was fostered in the Prussian universities, but adapted to the American educational climate. It would start out small. He would begin by assembling first-rate researchers specifically in mathematics and classics—two critical areas, yet two areas that required little infrastructure beyond books—and they would be joined by the best laboratory scientist he could secure. This initial faculty would grow as suitably strong researchers in other fields were identified and secured, but from the very beginning, the explicit mission of the faculty would be to pursue its research agenda and actively to train and engage graduate students, a number of whom would be supported with fellowships from university funds. The support of research and of the training of future researchers would allow Americans more efficiently and effectively to contribute to the store of knowledge and thus to make their mark in the intellectual arena.

[21] For the early history of the Johns Hopkins University, see Hugh Hawkins, *Pioneer: A History of the Johns Hopkins University, 1874–1889* (Ithaca, 1960).

[22] On the shaping of Gilman's ideas regarding higher education, see, in addition to Ibid, Francesco Cordasco's *Daniel Coit Gilman and the Protean Ph.D.: The Shaping of American Graduate Education* (Leiden, 1960).

In recognition, moreover, of the paucity of American publication outlets for original research in the 1870s, the university would also underwrite the publication of specialized journals in various fields. Nor was undergraduate instruction neglected. Gilman recognized that well-trained undergraduates would feed naturally into his institution's graduate programs. That lower-level work, however, was not supervised directly by the principal members of the research faculty.

For his program in mathematics, Gilman secured James Joseph Sylvester, an English mathematician with an international research reputation.[23] Given that graduate-, that is, research-level mathematics training was not yet institutionalized in Great Britain (see below), Sylvester had never had the opportunity to teach at that level, but he quickly fashioned a program that successfully drew his students into the ranks of the productive researchers. Among the topics on which he lectured were the theory of numbers, determinants and modern algebra, the theory of multiple quantity (or what would today be called matrix theory), the theory of substitutions, and partition theory.[24] Sylvester's curriculum thus focused primarily on the algebraic topics in which he was directly interested, whereas Klein's lecture courses and associated seminars treated aspects of mathematics both pure and applied. Like Klein, though, Sylvester introduced his students to active research, since he regularly challenged them to prove things that he either had not been successful in proving or that he had tossed out as open problems. Moreover, as did his colleagues at the University of Berlin, Sylvester augmented his lecture courses with an associated seminar and a Mathematics Club. Both of the latter met in the so-called Mathematical Seminary, a book- and mathematical-model-lined room dedicated to the program in mathematics in which students studied, researched, wrote, and otherwise interacted. It was, in a mathematical context, a *laboratory* for the production of new results.

From September 1876 when he arrived at Hopkins to December 1883 when he left to assume the Savilian Professorship of Geometry at Oxford, Sylvester oversaw the graduate work of some fifteen mathematics fellows, eight of whom earned the Ph.D. under him. Two of these, Thomas Craig and Fabian Franklin, remained at Hopkins, joining the mathematics

[23] Much has been written about the history of this program and its importance for the history of American mathematics. See, for example, Karen Hunger Parshall, 'America's First School of Mathematical Research: James Joseph Sylvester at The Johns Hopkins University', *Archive for History of Exact Sciences* 38 (1988), 153–96 and Parshall and Rowe, *Emergence*, 53–146. On Sylvester, his life and work, see Karen Hunger Parshall, *James Joseph Sylvester: Life and Work in Letters* (Oxford, 1998) and *James Joseph Sylvester: Jewish Mathematician in a Victorian World* (Baltimore, 2006).

[24] For a complete list of the mathematics courses taught at the Johns Hopkins University between 1876 and 1883, see Parshall and Rowe, *Emergence*, 95–6.

faculty there and trying to continue the graduate program that Sylvester had animated. Another, Irving Stringham, worked (ultimately unsuccessfully) to mount a graduate program in mathematics at the University of California, Berkeley following post-doctoral training in Germany under Felix Klein. Still another, Christine Ladd, had been allowed as an 'exception' to attend Sylvester's courses beginning in 1878 and, by 1882, had satisfied all of the requirements for the Ph.D. Owing to Hopkins's official 'males only' policy, however, she was only awarded her degree in 1926.

These and other Hopkins students and faculty, in addition to Sylvester himself, published the fruits of their mathematical labors in the *American Journal of Mathematics*. Underwritten by the University, launched in 1878, and edited by Sylvester, the *American Journal*, as it name suggested, served an emergent American mathematical research community. Fully a third of the articles appearing in it over the course of its first decade came from those associated in one way or another with Hopkins; another third came from other American contributors; and a final third came from mathematicians abroad.[25] The *American Journal* thus represented yet another novel training- and proving-ground for America's next generation of research mathematicians.

Following the Hopkins example, the trend of graduate training in mathematics gradually spread across the country.[26] Implemented initially, as the example of Sylvester's students illustrates, by a small number of home-grown and a larger number of German-trained mathematics PhDs, it ultimately took root at state-supported universities as well as at so-called land-grant universities that were partially financed by Federal funds. It also infiltrated the colonial, liberal arts colleges like Harvard, Yale, and Princeton that began their transformations into research universities in the

[25] For the percentages, see Karen Hunger Parshall, 'Eliakim Hastings Moore and the Founding of a Mathematical Community in America, 1892–1902', *Annals of Science*, 41 (1984), 313–33 on 324; reprinted in Peter L. Duren *et al* (eds.), *A Century of Mathematics in America—Part II* (Providence, 1989), 155–75.

[26] For more on this trend, see Parshall and Rowe, *Emergence,* 261–94. A substantial literature of case studies on the development of particular research-level programs in mathematics has also developed. See, for example, Parshall, 'E. H. Moore and the Founding of a Mathematical Community in America, 1892–1902'; William Aspray, 'The Emergence of Princeton as a World Center for Mathematical Research, 1896–1930', in William Aspray and Philip Kitcher (eds.), *History and Philosophy of Modern Mathematics* (Minneapolis, 1988), 346–66; Halsey Royden, 'A History of Mathematics at Stanford', in *A Century of Mathematics in America—Part II*, 237–77; Robin Rider, 'An Opportune Time: Griffith C. Evans and Mathematics at Berkeley', in *A Century of Mathematics in America—Part II*, 283–302; Gary Cochell, 'The Early History of the Cornell Mathematics Department: A Case Study in the Emergence of the American Mathematical Research Community', *Historia Mathematica* 25 (1998), 133–53; and Karen Hunger Parshall, 'Training Women in Mathematical Research: The First Fifty Years of Bryn Mawr College (1885–1935)', *The Mathematical Intelligencer*, 37 (2015), 71–83.

final quarter of the nineteenth century. And, it shaped new universities like Clark University and the University of Chicago which were created, like Hopkins, through private benefaction.

The primacy of graduate training was further reinforced by the mostly—but not exclusively—pure research orientation of the American Mathematical Society, the first specialized professional organization for mathematicians in the United States.[27] As the members of that society very quickly came to understand the notion, a *professional* mathematician was one who had earned a *doctoral* degree for an original piece of work and had then continued, in so far as circumstances allowed, both to add to the store of mathematical knowledge and to train—as his, or in rare cases, her[28] institutional circumstances permitted—succeeding generations in the field. By the close of the nineteenth century, then, higher education in the United States had at least two distinct steps: undergraduate training that led to a bachelor's degree and graduate training that led to a doctorate based on original research. In mathematics, as in other academic areas, this second step had thus been instrumental in creating a new category of academic professional.

Influences on France in the Aftermath of the Franco-Prussian War

An analogous notion of the professional mathematician also emerged in France, also in the closing quarter of the nineteenth century, also in the aftermath of war, also influenced by the Prussian example, but ultimately, and perhaps not surprisingly, in the context of very different local circumstances. France's loss in 1871 of the Franco-Prussian War had served as a kind of wake-up call to French intellectuals of all stripes, among them, French mathematicians. Indeed, at least some among the mathematical ranks had already sensed the need for change before the war. Writing to a fellow mathematician, Jules Houël, sometime between 1869 and 1871, Gaston Darboux had opined that 'we need to mend our [system of] higher education. The Germans get the better of us there as elsewhere. I think if that continues, the Italians will surpass us before too long'.[29]

[27] The New York, and later, American Mathematical Society had been preceded by specialized professional societies for research-level mathematics in a number of countries. The earliest, the Moscow Mathematical Society and the London Mathematical Society, were founded in 1864 and 1865, respectively; the Société mathématique de France and the Circolo matematico di Palermo followed in 1872 and 1884, respectively.

[28] See, in particular, Parshall, 'Training Women in Mathematical Research'.

[29] Gaston Darboux to Jules Houël, undated, in Hélène Gispert, 'La correspondence de G. Darboux avec J.Houël : Chronique d'un rédacteur (déc. 1869-nov. 1871)', *Cahiers du séminaire d'histoire des mathématiques* 8 (1987), 67–202 on 161. Also quoted in Hélène

At issue was the pervasive sense that French mathematics had entered a period of stagnation. While France had enjoyed what historian of mathematics Ivor Grattan-Guinness characterized as 'a remarkable dominance in mathematics from the 1780s until the 1820s, with Paris by far the leading center for the subject in the world'[30] in both pure and applied mathematics, it had entered into an era of perceived decline thereafter. At least as early as the 1850s, that is, from the earliest days of the Second Empire (1852–1870), France's strong, top-down control of higher education and its sense that 'to live the life of a *savant* was to engage in a public act as an obedient servant of the Empire'[31] had squelched scientific creativity in general and mathematical creativity in particular.[32] Before 1870, research, if it was supported at all within French higher education, was only fostered in the Collège de France and in the so-called *grandes écoles*, that is, the École polytechnique, the École normale supérieure, and the *écoles d'applications* such as the École des Ponts et Chaussées. Even in these institutions, however, it was expected neither that the faculty necessarily engage actively in research nor that it train future researchers. Within the Université de France with its various *facultés* such as the Sorbonne in Paris, research was even farther removed from the institutional mission.[33] Faculty members in the latter were charged with minimal lecturing—and then at the lower level of basic *cours* as opposed to at a higher, research

Gispert, *La France mathématique: La Société mathématique de France (1872–1914)* (Paris, 1991), 19 (my translation).

[30] Ivor Grattan-Guinness, 'The End of French Dominance: The Diffusion of French Mathematics Elsewhere, 1820–1870', in Karen Hunger Parshall and Adrian C. Rice (eds.), *Mathematics Unbound: The Evolution of an International Mathematical Research Community, 1800–1945*, HMATH, xxiii (Providence and London, 2002), 17–44 on 17. For a sense of the French mathematical scene—both pure and applied—in the first half of the nineteenth century, see Ivor Grattan-Guinness, *Convolutions in French Mathematics, 1800–1840: From the Calculus and Mechanics to Mathematical Analysis and Mathematical Physics*, 2 vols., Science Networks Historical Studies (Basel, 1990).

[31] Robert Fox, 'Science, the University and the State in Nineteenth-Century France', in Gerald L. Geison (ed.), *Professions and the French State, 1700–1900,* (Philadelphia, 1984), 66–145 on 90.

[32] As Hélène Gispert has convincingly argued, French mathematicians in the 1860s, instead of engaging in the latest developments in their field, were still pursuing research agendas reflective of the state of the discipline in the first half of the century. See Hélène Gispert, 'L'Enseignement scientifique supérieure et ses enseignants, 1860–1900: Les mathématiques', *Histoire de l'éducation*, 41 (1989), 44–78 on 50–2.

[33] George Weisz, 'Le corps professoral de l'enseignement supérieur et l'idéologie de la réforme universitaire en France, 1860–1885', *Revue française de sociologie* 18 (1977), 201–32 on 227. Relative to mathematics, in particular, see Ivor Grattan-Guinness, 'Grandes Écoles, Petite Université: Some Puzzled Remarks on Higher Education in Mathematics in France, 1795–1840', in *History of Universities*, 7 (Oxford, 1988), 197–225.

level—as well as with training, examining, and officially certifying secondary school teachers.[34]

Beginning in the mid-1860s, however, calls for the reform of this entrenched system, in which the Université served as a kind of learned bureaucracy, began to be heard not only in the French press but also from the Ministry of Public Instruction (compare Chapters 1 and 6 in the present volume). The latter thus initiated a number of reports on systems of higher education outside of France in order to provide a means of comparison.[35] In particular, as Darboux's statement to Houël attests, a strong sense emerged that, in order to be competitive in mathematics as well as in other fields, France needed to follow the German example, which not only coupled teaching and research but also adopted research as an explicit criterion for professional success.[36]

With the establishment of the Third Republic (1870–1940) and in the aftermath of the Franco-Prussian War, educational reforms were gradually implemented over the closing quarter of the nineteenth century that aimed to address these concerns albeit in a much larger political context. The new leaders of the Third Republic sought to neutralize the old political élite that had been associated with the *grandes écoles* and to create a new one. They did this both by strengthening the *facultés* and by embracing the idea 'that the growth of knowledge was crucial to social improvement and material progress'.[37] In particular, they provided funding to increase the size of the *facultés*, and they severed the administrative ties between the *facultés* and secondary education.[38] As a result, by the end of the nineteenth century, the Faculté des sciences at the Sorbonne in Paris had become a principal training ground for post-baccalaureate students desirous of earning a doctorate. Moreover, original research—as opposed to the demonstration through set examinations of encyclopedic knowledge of one's chosen field—had become the principal evaluative standard.[39]

The explicitly graduate training that post-baccalaureate students received was made possible, to some extent, by the doubling in the sizes of

[34] Terry Shinn, 'The French Science Faculty System 1808–1914: Institutional Change and Research Potential in Mathematics and the Physical Sciences', *Historical Studies in the Physical Sciences*, 10 (1979), 271–332 on 291.

[35] Fox, 'Science, the University and the State in Nineteenth-Century France', 92.

[36] Weisz, 'Le corps professoral de l'enseignement supérieur', 227–9 and Fox, 'Science, the University and the State in Nineteenth-Century France', 94.

[37] Shinn, 'The French Science Faculty System', 302.

[38] Ibid, 303.

[39] Craig Zwerling, 'The Emergence of the École Normale Supérieure as a Centre of Scientific Education in the Nineteenth Century', in Robert Fox and George Weisz (eds.), *The Organization of Science and Technology in France 1808–1914* (Cambridge and Paris, 1980), 31–60 on 35–7.

the science faculties to some 220 instructors and the concomitant increase in numbers of courses during the final four decades of the century.[40] Of especial importance, the augmentation of the faculties with newly minted doctoral degree holders in the position of *maître de conférences* not only opened the curriculum to the possibility of courses in individual research specialties but also made it possible for the professors to spend more of their time directing doctoral students and running actual research seminars on the German model.[41]

Relative to mathematics, these changes took place, just as in the United States, in conjunction with the formation of a specialized professional society for mathematics—the Société mathématique de France founded in 1872—as well as of new specialized journals such as its *Bulletin* founded in 1873.[42] Whereas before 1870, most of those who went into mathematics received their training at the engineering-oriented École polytechnique, in the century's final decades, such students were increasingly likely to have gotten their initial mathematical training at the ostensibly more pedagogically-oriented École normale supérieure.[43] And, whereas before 1870, if a student proceeded to a doctoral degree, it was for a relatively perfunctory piece of exposition, beginning in the decade of the 1880s, they pursued, in a *faculté* of the *Université*, actual doctoral studies aimed at the ultimate production of an original piece of research.[44] The latter level of instruction involved lecture courses and seminars—which were given by the chaired professors—as well as (sometimes) more specialized courses—which were given by the *maîtres de conférences*.[45] It was made possible, in part, by the fact that, with the doubling of the science faculties in general, the number of mathematics instructors also doubled nationwide from

[40] For the numbers, see Gispert, *La France mathématique*, table 1.2, 165.

[41] Shinn, 'The French Science Faculty System', 306–7. See also Gispert, 'L'Enseignement scientifique supérieure et ses enseignants', 59.

[42] On the professionalization of French mathematics and its symbiotic relationship with educational reforms, see Gispert, *La France mathématique,* and Hélène Gispert (ed.), *La France mathématique de la Troisième République avant la Grande Guerre* (Paris, 2015).

[43] For more on the place of the École normale in the development of mathematics in France, see David Aubin, *L'Élite sous la mitralle: Les normaliens, les mathématiques et la grande Guerre 1900–1925* (Paris, 2018).

[44] Hélène Gispert, 'The Effects of War on France's International Role in Mathematics, 1870–1914', in *Mathematics Unbound*, 105–21 on 109. On the École normale supérieure in particular, see Zwerling, 'The Emergence of the École Normale Supérieure'. The Sorbonne in Paris, but increasingly the *facultés* outside the capital city, attracted would-be mathematicians for their doctoral training.

[45] Shinn, 'The French Science Faculty System', 306–7. According to American mathematician, James Pierpont, however, at the Sorbonne, the *maîtres de conférences* were limited to conducting what were tantamount to recitation sections associated with the lecture courses given by the professors. See James Pierpont, 'Mathematical Instruction in France', *Bulletin of the American Mathematical Society*, 6 (1900), 225–49 on 235–6.

thirty-two in 1860 to sixty-four in 1900.[46] For example, as a student in the 1890s, Élie Cartan, one of France's leading mathematicians of the first half of the twentieth century, took courses at the Sorbonne on analysis from Paul Appell, the Chair of Mechanics, on elliptic functions under Charles Hermite, the Chair of Analysis, and on group theory from Gaston Darboux, the Chair of Higher Geometry and Dean of the Faculté des Sciences, while at the École normale supérieure, he studied function theory under Émile Picard, the Chair of Differential Calculus.[47] The thesis that Cartan presented to the Faculté des Sciences for his doctoral degree in 1894, 'Sur la structure des groupes de transformations finis et continus', represented a major breakthrough, namely, a classification of the simple complex Lie algebras.[48] By 1904, mathematician and then Dean of the Paris Faculty of Sciences, Paul Appell, could legitimately state that 'beyond their mission of making the sciences known and understood, the institutions of higher education . . . have another [mission], nobler than all the others, that of advancing science and of continually initiating new generations of researchers into the methods of invention and discovery'.[49] Graduate training in mathematics had been institutionalized; cutting edge courses in the field had been introduced into the curriculum; first-rate research had been produced.[50]

Writing on 'Mathematical Instruction in France' in the *Bulletin of the American Mathematical Society* in 1900, Yale mathematician James Pierpont recognized this evolution in French higher mathematics education. In his article, he sought to counterbalance what he deemed the 'excessive German influence' on American mathematics not only by describing the French system in detail to his American audience but also by encouraging American students to opt for post-baccalaureate or, in fact, post-doctoral study in France and not just in Germany.[51] Still, between 1891 and 1906 only fourteen Americans—or some 4.4% of those members of the American mathematical community who studied abroad—had pursued advanced studies in France, whereas almost

[46] Gispert, *La France mathématique*, table 1.2, 165.

[47] Cartan's course notebooks are held in the Fond Élie Cartan 38J, Archives de l'Académie des Sciences de Paris. See Carton 1: Cahiers 1.01, 1.02, 1.04, 1.08, and 1.09.

[48] See Élie Cartan, *Première Thèse: Sur la structure des groupes de transformations finis et continus* (Paris, 1894). On Cartan's early work, see Karen Hunger Parshall, 'Joseph H. M. Wedderburn and the Structure Theory of Algebras', *Archive for History of Exact Sciences* 32 (1985), 223–349 on 291–2 and Thomas Hawkins, 'Wilhelm Killing and the Structure of Lie Algebras', *Archive for History of Exact Sciences*, 23 (1977), 119–63.

[49] Quoted in Gispert, *La France mathématique*, 60 (my translation). In the papers cited in note 6 above, I inadvertently attributed this quote to Émile Picard.

[50] Gispert, *La France mathématique*, 62–3.

[51] Pierpont, 'Mathematical Instruction in France', 225.

100—or 30.6%—had done so in Germany.[52] Despite France's mathematical gains in the quarter-century after the Franco-Prussian War, Germany remained the top foreign destination for would-be American mathematicians until the 1920s.

Great Britain as a Late-Comer to Graduate Education in Mathematics

Behind even France, Great Britain had attracted a mere eleven American students of mathematics—just 3.4%—in the fifteen years from 1891 to 1906.[53] Given the common language and the fact that the colonial American colleges had largely been fashioned on the Oxbridge college model, it might have been expected that, at the very least, England would have represented more of a draw for American mathematical aspirants. The United States, however, had embraced its interpretation of the German system both in forming new institutions of higher education like the Johns Hopkins University and the University of Chicago as well as in eventually grafting research-oriented, graduate education onto some of the traditional liberal arts colleges like Harvard. Oxbridge, for its part, had been slow to react to calls for educational reform geared toward research and the production of future researchers (compare Chapter 5 in this volume). Instead, it had persisted in a college-oriented, examination- and cramming-dominated system that emphasized a traditional liberal education.[54]

Cambridge, long the more mathematically oriented of the two ancient universities,[55] was dominated by the Mathematical Tripos, the notorious examination that all 'reading men', regardless of their interests, had to take in order to obtain a bachelor's degree with honors. Training for the Tripos was done largely outside of the colleges and in the context of intensive

[52] Della Dumbaugh Fenster and Karen Hunger Parshall, 'A Profile of the American Mathematical Research Community: 1891–1906', in Eberhard Knobloch and David E. Rowe (eds.), *The History of Modern Mathematics*, 3 (San Diego, 1994), 179–227 on 205. The numbers given here represent a sort of greatest lower bound. According to Hélène Gispert, in 1901, only six Americans were studying mathematics in France, and that number had increased to only seven by 1914 and the outbreak of World War I. See Gispert, *La France mathématique*, 140.

[53] Fenster and Parshall, 'A Profile of the American Mathematical Research Community', 205. Again, this number represents a greatest lower bound.

[54] Renate Simpson, *How the Ph.D. Came to Britain: A Century of Struggle for Postgraduate Education* (Guildford, 1983), 52.

[55] On Cambridge and its strong tradition in the physics-oriented mathematical sciences, see Andrew Warwick, *Masters of Theory: Cambridge and the Rise of Mathematical Physics* (Chicago, 2003).

drilling and problem-solving under the supervision of private tutors.[56] Problem-solving and memorization, these were the main skills honed as a result of mathematical training at Cambridge throughout the nineteenth century.[57] The curriculum tested, moreover, was an increasingly antiquated one dominated by analytic geometry, conic sections, the differential and integral calculus, and Newtonian mechanics.[58] Physics thus largely defined what mathematics was deemed 'of interest'. Writing of Trinity College, Cambridge during his own student days there in the late 1890s, the noted early twentieth-century mathematician, G. H. Hardy confessed that it was only when he read Camille Jordan's 'remarkable' *Cours d'analyse de l'École polytechnique* (1909) that he 'learnt for the first time…what mathematics really meant'.[59] In his view, the official mathematical curriculum of his Cambridge education had done nothing truly to enlighten him.

Still, even in Hardy's student days at Cambridge, change had been and continued to be afoot in the context of higher education in England via a series of royal commissions. As early as 1850, the Oxford Commission had recommended that fellowships in (and funded by) the various Oxford colleges be converted into professorships in targeted, more specialized areas associated with the university. University professors would then be in a position to provide training outside the liberal arts confines of the college curriculum.[60]

From 1870 to 1875, the Devonshire Commission—with commissioners including such Victorian scientific worthies as the biologist Thomas Huxley, and the Cambridge mathematical physicist George Gabriel Stokes—cast an even wider net, examining scientific instruction nationwide. Among its many recommendations was the call for the institution of degrees awarded for the production of original research. This reflected the concurrent professionalization of science in Great Britain as exemplified in mathematics by the founding in 1865 of the London Mathematical Society. In 1885, the modern D.Sc., that is, a doctoral degree of just the sort advocated by the Devonshire commissioners, was adopted at the

[56] On perhaps the most famous of the nineteenth-century Cambridge mathematics tutors, see Alex D. D.Craik, *Mr Hopkins' Men: Cambridge Reform and British Mathematics in the 19th Century* (London, 2007).

[57] A. G. Howson, *A History of Mathematics Education in England* (Cambridge, 1982), 139–43.

[58] Ibid, 143 and Parshall, *James Joseph Sylvester: Jewish Mathematician in a Victorian World*, 44–8.

[59] G. H. Hardy, *A Mathematician's Apology*, with a foreword by C. P. Snow (Cambridge, 1967), 147. Hardy was a student at Trinity from 1896 to 1898, finishing Fourth Wrangler on the Mathematical Tripos in 1898.

[60] Simpson, *How the Ph.D. Came to Britain*, 24.

University of London, and schools like Newcastle, Manchester, and Leeds among the so-called 'red bricks' had begun actively to train students for the advanced London degree.[61] Although Oxford would only follow suit in 1900, Cambridge actually preceded London by three years in instituting a doctoral degree.

As far as actual graduate *instruction* was concerned, however, 'there was nothing' in Great Britain at the turn of the twentieth century that, in the words of historian of British education Renate Simpson, 'could as yet be even remotely described as systematic instruction for graduate students'.[62] Thomas Muir explicitly articulated this point relative to mathematics in a speech before the Mathematical Society of Edinburgh in 1884. Acknowledging that '[w]e recognize two of the functions of a University—instruction and research', he ruefully admitted that 'we ignore, so far as mathematics is concerned, a third equally important function—*instruction in research*'.[63]

Indeed, James Joseph Sylvester, who had so successfully animated the graduate program at Hopkins, tried to perform precisely that third function from his new position as Oxford's Savilian Professor of Geometry. During the course of a public lecture delivered in December 1885, he proposed to give, as he had done at Hopkins, 'lessons in the difficult art of mathematical thinking and reasoning—how to follow out familiar suggestions of analogy till they broaden and deepen into a fertilizing stream of thought—how to discover errors and to repair them'.[64] He sought, in short, to make Oxford a Hopkins on the Cherwell, and, at least initially, he attracted a 'class of 14 or 15 comprising several (5 or 6) of our college tutors to whom [he] lecture[d] twice a week on Reciprocants', the subject of his own then developing algebraic research.[65] By March 1887, however, ever-decreasing numbers in his classes had left him dejected. As he wrote to Gilman at Hopkins, 'I am out of heart in regard to my Professorial work

[61] Ibid, 48–50. The D.Sc. could be earned—for an original piece of research—after a minimum of two years following the bachelor's degree.

[62] Ibid, 66.

[63] Thomas Muir, *The Promotion of Research: with Special Reference to the Present State of the Scottish Universities and Secondary Schools: An Address Delivered before the Mathematical Society of Edinburgh, 8th February 1884* (London, 1884), 11 (his emphasis), as quoted in Simpson, *How the Ph.D. Came to Britain*, 43.

[64] James Joseph Sylvester, 'Inaugural Lecture at Oxford, on the Method of Reciprocants', in *The Collected Mathematical Papers of James Joseph Sylvester*, Henry F. Baker (ed.), 4 vols. (Cambridge, 1904–1912; reprint ed. New York, 1973), iv. 278–302 on 298. Quoted in Parshall, *James Joseph Sylvester: Jewish Mathematician in a Victorian World*, 299. See this same book (278–303, especially 296–303) for more on Sylvester's efforts at Oxford.

[65] James Joseph Sylvester to Arthur Cayley, 18 February, 1886, James Joseph Sylvester Papers, St. John's College, Cambridge, Box 12, as quoted in Parshall, *James Joseph Sylvester: Jewish Mathematician in a Victorian World*, 300.

in this University in which the real power of influencing the studies of the place lies in the hands of the College Tutors and in which I can see no prospect of doing any real good.'[66] In his view, 'this University except as a school of taste and elegant light literature is a magnificent sham. It seems to me that Mathematical science here is doomed and must eventually fall off like a withered branch from a Tree which derives no nutriment from its roots.'

Little wonder, then, that, according to Harvard President Charles Eliot in 1903, '[n]one of the higher degrees offered by Oxford University . . . could, I think, compare in attractiveness for American students with the German degree of Doctor of Philosophy'.[67] For mathematicians, the latter, as noted above, was earned in a rich and intense environment characterized by lecture courses, the seminar, and the *Mathematischer Verein*, while, at Oxford, as Sylvester's experience attested, that kind of mathematical atmosphere was simply not yet fostered. Oxford would only introduce in 1917 a doctoral degree, the D. Phil., comparable to the German or American doctoral degree. Cambridge and the University of London would follow two years later in 1919.[68]

A Comparative Assessment and a Broader Conclusion

Turn-of-the-twentieth-century American mathematicians found themselves at an interesting crossroad. Over the course of the final quarter of the nineteenth century, a community of research mathematicians had been emerging in the United States in the intertwined contexts of the professionalization of the field and the evolution of higher, graduate education in the nation. For them, teaching, research, and the training of future researchers came to define the *professional* mathematician. They were thus hard at work not only pursuing their mostly, although not exclusively, pure personal research agendas but also—when their institutional settings allowed—developing graduate programs in their field that would, one day they hoped, rival the German programs they were emulating. They fashioned high-level lecture courses; they instituted seminars; they founded mathematical clubs; and they did all of this in the context of a *university* as opposed to a *college* ethos that had evolved as their educational leaders shaped universities according to what they understood to be the

[66] James Joseph Sylvester to Daniel Coit Gilman, 11 March, 1887, Daniel Coit Gilman Papers, Coll #1 Corresp., Johns Hopkins University, in Parshall, *James Joseph Sylvester: Life and Work in Letters*, 263. The quote that follows is also from this letter.

[67] Charles Eliot to David B. Munro, Vice Chancellor of the University of Oxford, 28 July, 1903, as quoted in Simpson, *How the Ph.D. Came to Britain*, 77.

[68] Ibid, 147–59.

German model. Still, by 1900, they recognized that they had not yet reached their goal. What better way to train themselves at the research level, then, than actually to travel to Germany, to experience directly the instruction of those acknowledged masters, and then to import their newly gained knowledge to their programs at home? It was in this way that German, and especially Prussian, ideals of research-oriented training in mathematics were transplanted to the United States.

If Germany was widely perceived as enjoying mathematical hegemony around the turn of the twentieth century, the Americans were well aware that France and Great Britain were countries with long mathematical histories that continued to produce important mathematical work. As places for research-level study and training, however, they were decidedly less attractive than Germany. Indeed, first France and then especially England in Great Britain—in the context of very different national circumstances—reformed their systems of higher education to bring them more in line with standards and practices in place in Germany.[69] This comparative study reveals how, by the interwar period, all four of these countries had come to support advanced programs comparable in effectiveness relative to training future researchers. Members of all four—and others as well—were engaged in a mathematical dialogue in person in the context of the quadrennial International Congresses of Mathematicians that had begun in Zürich in 1897 as well as via publication in research-level periodicals that transcended national boundaries. Indeed, in coming to share the same notion of what it meant to be a professional mathematician—key aspects of which were graduate-level training, the attainment of the Ph.D., and the production of original research—all four had begun to transcend the merely national and were taking part in what was increasingly becoming an international mathematical research community.[70]

University of Virginia

[69] For a sense of the programs in place in all four countries in 1900, see the course offerings listed in the *Bulletin of the American Mathematical Society*, 6 (1900), 355–8 (for Columbia, Cornell, and Harvard); 6 (1900), 409–10 (for the University of Chicago and Yale); 6 (1900), 464–5 (for the University of California, Berkeley and the Johns Hopkins University); 7 (1900), 40–4 (for Berlin, Göttingen, and other German universities); 7 (1900), 103–6 (for Cambridge University); and 7 (1900), 150–1 (for the University of Paris and Oxford University).

[70] For more on this process of internationalization, see Parshall and Rice, *Mathematics Unbound* and Karen Hunger Parshall, 'The Internationalization of Mathematics in a World of Nations: 1800–1960', in Eleanor Robson and Jackie Stedall (eds.), *The Oxford Handbook of the History of Mathematics* (Oxford, 2009), 85–104.

5

Research Training in the Humanities in British Universities, *c.*1870–1939: Classical Studies, History, Philosophy

Janet Howarth

Introduction

'Post-graduate study, except in some branches of science, has not grown to any great dimensions in British Universities.' As a British Council pamphlet of 1946 admitted, this was an acknowledged area of weakness.[1] In 1938–9 only just over 2% (1, 175) of Britain's 50, 000 full-time university students were humanities post-graduates.[2] Resources available to them were meagre by comparison with their peers in the sciences. It was not until 1957 that State Studentships were introduced for graduate study in the humanities. Often post-graduates worked in isolation, without the companionship provided by the scientists' laboratories. The one exception was archaeology, which attracted support from the public as well as classical scholars. The British Schools at Athens (1886) and Rome (1901) were funded largely by public subscription; later benefactions made possible the creation of the Oxford University Ashmolean Museum of Art and Archaeology (1908) and, in London, Mortimer Wheeler's Institute of Archaeology (1937).[3] London's Institute of Historical Research became however in 1921 the first purpose-built centre for research in the humanities in Britain, opening in temporary premises, the 'Tudor Cottage' in Malet

[1] Sir Ernest Barker, *British Universities* (London, 1946), 20.

[2] A. H. Halsey (ed.), *British Social Trends since 1900* (Basingstoke, 1988), Table 7.1, 270; Renate Simpson, *How the PhD Came to Britain. A Century of Struggle for Postgraduate Education* (Guildford, 1983), Table iii, 166.a.

[3] H. Waterhouse, *The British School at Athens: The First Hundred Years* (London, 1986); A. Wallace-Hadrill, *The British School at Rome. One Hundred Years* (London, 2001); D. B. Harden, *Sir Arthur Evans, 1851–1941. A Memoir* (Oxford, 1983), 11–14; Negley Harte, *The University of London, 1836–1986* (London, 1986), 230–3.

Janet Howarth, *Research Training in the Humanities in British Universities,* c.*1870–1939: Classical Studies, History, Philosophy* In: *A Global History of Research Education: Disciplines, Institutions, and Nations, 1840–1950*. Edited by: Ku-ming (Kevin) Chang and Alan Rocke. *History of Universities* XXXIV/1, Oxford University Press (2021). © Oxford University Press. DOI: 10.1093/oso/9780192844774.003.0006

Street, and moving to the newly-built Senate House in 1938.[4] The ancient collegiate universities of Oxford and Cambridge were rich in resources—endowments, libraries, archives, museum collections—but these were not devolved to departments. There were as yet no graduate colleges.[5] Oxford's History faculty, the largest in the country, had no faculty building until 1957.[6]

The introduction of research degrees was also a late development in Britain. It was complicated by Oxford and Cambridge traditions. Since the Middle Ages they had awarded senior doctorates in Divinity, Law, Medicine and (occasionally) Music. To these were added at Cambridge in 1883 and Oxford in 1900 research doctorates in modern subjects, the Doctor of Letters (Litt.D or D.Litt.) and Doctor of Science (Sc.D or D.Sc.). These were degrees awarded by each university to its own graduates for published work: the Oxford statute stipulated that this must include 'an original contribution to the advancement of learning or science' and be 'of sufficient merit', and the candidate must be at least 39 terms from matriculation.[7] The doctor in this tradition was a mature scholar, his expertise acquired over many years. Late-Victorian university reform brought pressure for degrees, which, like the continental PhD, were awarded to junior scholars for a piece of supervised research. These took various forms. In 1895 Oxford created the B.Litt. (Bachelor of Letters) and B.Sc. (Bachelor of Science)—two-year degrees open to graduates of any university. Cambridge resisted this model until the 1920s, creating instead a path to the BA by research. The newer universities, including London, tended to award MAs by dissertation. Some universities—including London and the Scottish universities—also awarded senior doctorates. The introduction of a (more or less) uniform two-year PhD or DPhil came about in 1917–20, primarily to enable graduates from American and colonial universities to get the professional qualifications they needed in Britain rather than Germany. But as late as 1961–2 a majority of Britain's university teachers in Arts subjects (53%, compared with 21% in the physical and biological sciences) had no higher degree.[8]

The slow and patchy development of research training in the humanities reflects well-known features of British university history: the delay of over half a century before the Humboldtian ideal of the research university

[4] D. J. Birch & J. M. Horn (eds.), *History Laboratory: The Institute of Historical Research, 1921–96* (London, 1996).

[5] K. V. Thomas, 'College Life, 1945–70', in B. H. Harrison (ed.), *The History of the University of Oxford,* Vol 8, *The Twentieth Century* (Oxford, 1994), 210–11.

[6] Bodleian Library, OUA FA 5/3/2, f.33; Sir Maurice Powicke, 'The Maitland Library'.

[7] *Oxford University Gazette*, 22 Feb., 1900, 321.

[8] A. H. Halsey and M. A. Trow, *The British Academics* (London, 1971), 209.

found support, late secularisation of Oxford and Cambridge, slow progress in developing universities in London and elsewhere, low take-up of higher education (under 3% of the age-group in 1939), and—above all—the absence of state control of universities.[9] In the words of the Asquith Commission on Oxford and Cambridge (1922), that was regarded as 'a precious part of our intellectual and moral heritage. ... The ways of thought and feeling of the modern British community are hostile to any development in the direction of State control of the academic spirit.'[10]

Martin Daunton has argued that we should see the organization of knowledge in Britain as a distinctive model with its own rationale, 'a "mixed economy" of provision and funding, with a preference for voluntarism and the market over the state.'[11] The state did give financial support to institutions that facilitated and engaged in research activities—museums, galleries, the Public Record Office, the Royal Commissions on Historical Manuscripts and Monuments—and there was a vigorous tradition of amateur scholarship and research outside universities, promoted by learned societies.[12] Universities, operating within this mixed economy, had considerable latitude to develop their own norms. Public enquiries of the period record the prevailing state of academic opinion. From the 1870s the university's role in advancing learning and research was accepted; and Robert Anderson concludes that 'Oxbridge Reformed' had 'striking achievements in research, even if this was not always integrated with teaching in the approved German way.'[13] It became good practice (if not always followed) to appoint research-active university teachers. The Asquith Commission stressed the

> extreme importance that provision should be made to secure, between the graduation of a student and his being called upon ... to undertake full teaching work, an interval, during which he would have an opportunity of carrying out a programme of advanced study or research.[14]

Yet resistance to a mandatory research qualification remained strong for nearly half a century. The Robbins Report on Higher Education (1963)

[9] See R. D. Anderson, *European Universities from the Enlightenment to 1914* (Oxford, 2004), and *British Universities Past and Present* (London, 2006).

[10] *Report of the Royal Commission on Oxford and Cambridge Universities* (Cmd 1588: London, 1922), 14.

[11] M. Daunton (ed.), *The Organization of Knowledge in Victorian Britain* (Oxford, 2005), 18.

[12] P. Levine, *The Amateur and the Professional: Antiquarians, Historians and Archaeologists in Victorian England, 1838–1886* (Cambridge, 1986).

[13] Anderson, *British Universities*, 49.

[14] Asquith *Report*, 105. *Cf* the British Academy's Rockefeller Report, *Research in the Humanities and the Social Sciences* (London, 1961), 13.

maintained that 'in the humanities, in particular, insistence on a higher degree or substantial publication as a *sine qua non* of appointment to a junior lectureship would be disastrous.' In the British idea of a university, its educational and social functions, transmitting a common culture and forming 'cultivated men and women' still ranked alongside its contribution to research.[15]

In such a decentralised and unprescriptive system, one way of exploring what research training was actually available in the humanities is to look at the experience of a sample of British scholars of recognised distinction: Fellows of the British Academy (FBAs). The Academy was set up in 1902 to represent historical, philosophical and philological studies, and its *Proceedings* publish memoirs of deceased Fellows, written by their peers. Its claims to include the preeminent scholars in each field can be contested—the first woman FBA, Beatrice Webb, was elected in 1932—but these memoirs can tell us something about how researchers in a range of Arts disciplines might acquire their expertise.

The British Academy Sample

The sample analysed here consists of 138 FBAs who died between 1930 and 1970—mostly second and third generation academicians, though they include five of the original Fellows. They represent three fields, classical studies (including archaeology), history and philosophy. At a time when boundaries between disciplines were inconsistently drawn and scholars often worked in more than one field these categories are however inevitably inexact. I have followed the Oxford practice of classifying ancient historians with classicists and—perhaps more questionably—included archaeology with classical studies, despite the fact that some archaeologists worked on prehistory and not all were classically trained. In these years it was not unusual for university teaching to take individuals into fields not touched on in their undergraduate degrees. Over a third (19) of the historians in the sample had not taken a BA degree in History (or Modern History, as it was termed at Oxford), most coming to it from a classical background. In 1914 73% of Oxford college scholarships were reserved for classicists: the ablest students were normally expected to read the four-year classical BA course, Literae Humaniores.[16] In our FBA sample, no less than 63 (46%) had read Lit. Hum., though some came to

[15] *Higher Education: Report of the Committee Appointed by the Prime Minister under the Chairmanship of Lord Robbins 1961–63* (Cmd 2154, London, 1963), 6–7, 101.

[16] R. Currie, 'The Arts and Social Studies, 1914–1939', in Harrison (ed.), *The Twentieth Century*, 110.

Table 5.1 Universities attended by FBAs: first and second BAs

	Oxford	Cambridge	London	English civic univs	Scottish univs	Wales	Irish univs	Other	No univ. education
Historians	29	10	3	6	-	1	1	-	1
Second BA	4	1							
Classicists/ archaeologists	23	20	1	-	6	-	1	4	3
Second BA	8	3							
Philosophers	13	5	-	1	7	-	-	3	-
Second BA	4	7							

Table 5.2 Universities at which FBAs in the sample held professorial chairs

	Oxford	Cambridge	London	English civic univs	Scottish univs	Wales	Irish univs	Cwlthh Univs	US Univs	Other
Historians	5	8	9	8	4	3			2	
Classicists/ archaeologists	11	9	4	6	6	3	1			2
Philosophers	6	2	2	5	7	3	1	2	4	1

it as graduates of other universities, while others went on to take a second BA in History or Theology at Oxford.

All but four were university-educated but by no means all had academic careers in universities. The sample includes museum directors, officials at the Public Record Office, and independent scholars with private means or employed in various professions – the civil and armed services, the church, the law, architecture. Most had BA degrees from Oxford or Cambridge (Table 5.1). These include second BA students: there was a well-trodden path to Oxbridge for ambitious graduates from the Scottish universities and (especially for historians) from the new English civic universities. Professors who became FBAs (Table 5.2) were more widely distributed, reflecting the expansion of the civic universities and the federal universities of London and Wales, and the increased openness of professorial appointments in Scottish universities. Their careers mostly fell within the decades between the 1890s and 1950s.

The Scholar's Life Cycle and Credentials

Table 3 summarises the types of further academic study undertaken by scholars in the sample after graduating, and academic distinctions earned in the course of a lifetime. In brief, it shows that the post-graduate phase of their career, insofar as it was used to acquire research skills, was more likely to be spent studying abroad or for a second BA degree at Oxford or Cambridge, or writing an essay or dissertation that might win a university prize or college fellowship, than in acquiring a research degree or post-graduate diploma. Historians and classical scholars were more than twice as likely to have a higher doctorate (usually D.Litt/Litt. D) than a post-graduate research qualification. But the accolade that most FBAs could expect towards the end of a distinguished career was the honorary doctorate—valued especially because it was bestowed unasked, and often by more than one university (the historian G. M. Trevelyan acquired no less than 13, F. G. Kenyon, Greek scholar and Director of the British Museum had 12).[17] Like the British Academy Fellowship itself, or—for the minority whose work bridged the arts/science boundary—a Fellowship of the Royal Society, an honorary degree signified recognition by one's peers at a national and even international level.

The memoirs that record the achievements of FBAs are not indifferent to credentials, but they treat the formation of a scholar as the product of a lifetime, in which the post-graduate years might or might not have special

[17] G. Clark, 'George Macaulay Trevelyan, 1876–1962', *PBA,* 49 (1963), 375–86; H. I. Bell, 'Sir Frederic George Kenyon, 1863–1952', *PBA,* 38 (1952), 269–94.

Table 5.3 Postgraduate study or training, higher doctorates, honorary degrees, FRSs: Classicists/archaeologists, historians, philosophers in the FBA sample

	Study abroad	2nd BA	Post-graduate research degree or diploma	Prize essay or dissertation	Higher doctorates	Honorary doctorates	FRSs
Historians (51)	24 (47%)	13 (25%)	7 (14%)	19 (37%)	16 (31%)	36 (71%)	2
Classicists/ Archaeologists (58)	34 (59%)	12 (21%)	6 (11%)	15 (26%)	13 (22%)	42 (72%)	4
Philosophers (28)	10 (36%)	11 (39%)	8 (29%)	11 (38%)	8 (28%)	16 (55%)	1
Total 138	68 (49%)	37 (27%)	21 (15%)	45 (33%)	37 (27%)	94 (68%)	6

significance. Often the emphasis is on family and schooling. Many had a family background in the learned professions or learned societies. The archaeologist Arthur Evans, for example, belonged to the fourth generation of his family to include a Fellow of the Royal Society: his father, a wealthy paper manufacturer, was an amateur geologist, archaeologist and numismatist who became President of the Society of Antiquaries.[18] Schools of various types – public, grammar, even the private school 'run by a brilliant classic' that educated the shipbroker's son and future philosopher G. F. Stout—might provide classical training to an exceptional standard of scholarship.[19] It was common for high-flying graduates to support themselves by teaching while waiting for the chance of a university post. At Winchester, the City of London School and Dulwich College boys studied comparative philology before they went to university.[20] M. R. James found inspiration for his life's work as a schoolboy at Eton, working on manuscripts and incunabula in the College library.[21] It was at Ruthin School in North Wales that I. A. Richmond became interested in

[18] J. L. Myres, 'Sir Arthur Evans, 1851–1941', *PBA,* 27 (1941), 323–57.

[19] C. A. Mace, 'George Frederick Stout, 1860–1944', *PBA,* 31 (1945), 307–16. On 'the high standard of work in the classics at many schools in England and Scotland' see Gordon Williams, 'Eduard Fraenkel, 1888–1970', *PBA,* 56 (1970), 438 note 1.

[20] G. C. Richards, 'Alfred Chilton Pearson, 1861–1935', *PBA, 21* (1935), 449–63; C. Bailey, 'Robert Seymour Conway, 1864–1933', *PBA,* 22 (1936), 434–44; 'Sir F. G. Kenyon'.

[21] S. Gaselee, 'Montague Rhodes James, 1862–1936', *PBA,* 22 (1936), 418–33: See also C. Webster, 'Benedict Humphrey Sumner, 1893–1951', *PBA,* 37 (1951), 359–72; C. R. Boxer, 'Edgar Prestage, 1869–1951', *PBA,* 44 (1958), 199–206.

Roman Britain; and at Westminster that C. C. J. Webb developed 'the habit of reflection which was to turn him at last into a professional philosopher.'[22]

On the other hand, aspiring academics might gain expertise in various ways after graduating. Percy Gardner made the reputation and scholarly contacts that won him professorial chairs at Cambridge and Oxford in his sixteen years as an employee in the British Museum's coins and medals room.[23] Others learned their trade by archival, cataloguing or editing work, participation in archaeological digs and what Arthur Evans called the 'school of rough travel', or by contributing to collective publications. The historians Charles Firth, T. F. Tout and A. E. Pollard wrote hundreds of biographies for the *Dictionary of National Biography* (which began in the 1880s as a commercial venture with the publishers Smith, Elder & Co.).[24] Frank Stenton and James Tait developed their wide-ranging knowledge of medieval sources while researching for the *Victoria Histories of the Counties of England*, which also started as a commercial undertaking.[25] Local record and historical societies provided medievalists especially with opportunities for self-training in research.[26] Contributors to the new learned journals in the 1880s and after found their articles scrutinised by interventionist editors, such as R. L. Poole and C. W. Previté Orton at the *English Historical Review*.[27] G. E. Moore, in his 26 years as editor of *Mind*, 'took enormous trouble in corresponding, in his own hand, with contributors and in suggesting improvements in exposition'.[28] Some kinds of expertise could only be acquired outside universities. R. H. Tawney's approach to economic history was shaped by his early years as a tutor in working-class adult education.[29] The diplomatic historian Harold Temperley's advice to the modern historian was that he 'should train himself for research by travel and by study of men, as much as by study of books'.[30] Temperley was one of half a dozen historians in the sample whose experience of wartime service and/or at the Paris Peace Conference was

[22] Eric Birley, 'Sir Ian Archibald Richmond, 1902–1965', *PBA,* 52 (1966), 293–302; W. D. Ross, 'Clement Charles Julian Webb, 1865–1954', *PBA,* 41 (1955), 339–47.

[23] G. Hill, 'Percy Gardner, 1846–1937', *PBA, 23* (1937), 459–69.

[24] G. Davies, 'Charles Harding Firth, 1857–1936', *PBA,* 22 (1936), 380–400; V. H. Galbraith, 'Albert Frederick Pollard, 1869–1948', *PBA,* 35 (1949), 258–74; F. M. Powicke, 'Thomas Frederick Tout, 1859–1929', *PBA,* 15 (1929), 491–518.

[25] Doris M. Stenton, 'Frank Merry Stenton, 1880–1967', *PBA,* 54 (1968), 315–423; F. M. Powicke, 'James Tait, 1863–1944', *PBA,* 30 (1944), 379–400.

[26] W. A. Pantin, 'Herbert Edward Salter, 1863–1951', *PBA,* 40 (1954), 219–39.

[27] C. C. J. Webb, 'Reginald Lane Poole, 1857–1939', *PBA,* 25 (1939), 311–20; M. D. Knowles, 'Charles William Previté-Orton, 1877–1947', *PBA,* 33 (1947), 351–60.

[28] R. B. Braithwaite, 'George Edward Moore, 1873–1958', *PBA,* 47 (1961), 298–310.

[29] T. S. Ashton, 'Richard Henry Tawney, 1880–1962', *PBA,* 48 (1962), 461–82.

[30] Harold Temperley, *Research and Modern History* (London, 1930).

formative.[31] Others, such as the medieval ecclesiologist A. H. Thompson and the pioneers of (respectively) Portuguese and Slavonic Studies, Edgar Prestage and R. W. Seton-Watson, took up university posts only after developing new fields of study by freelance work.[32]

The philosopher A. N. Whitehead, who held appointments at Cambridge, Imperial College London and Harvard, took the view that 'the valuable intellectual development is self-development, and…it mostly takes places between the ages of sixteen and thirty. As to training, the most important part is given by mothers before the age of twelve'.[33] Whitehead's own education at the public school Sherborne had prioritised classics, religion, and 'a good deal of mathematics'; he commended its 'combination of imaginative appeal and precise knowledge'.[34] In writing of his undergraduate life at Trinity College Cambridge, where he read Mathematics, Whitehead dwells—as do many authors of British Academy memoirs—on the intellectual influence of friends, both contemporaries and dons, as well as 'formal teaching':

> Incessant conversation…started with dinner at about six or seven, and went on till about ten o'clock in the evening…Groups of friends were not created by identity of subjects for study. We all came from the same sort of school, with the same sort of previous training. We discussed everything – politics, religion, philosophy, literature…This experience led to a large amount of miscellaneous reading…Looking backwards across more than half a century, the conversations have the appearance of a daily Platonic dialogue.

The select Apostles' Society meetings on Saturdays from 10 pm into the small hours were 'the concentration of this experience'.[35] 'Absolute candour was the only duty that the tradition of the Society enforced', according to Henry Sidgwick. W. C. Lubenow has suggested that 'modern Cambridge philosophy was shaped' by its discussions.[36]

Whitehead recalled his time at Trinity without nostalgia:

> As times changed, Cambridge University has reformed its methods. Its success in the nineteenth century was a happy accident dependent on social circumstances which have passed away – fortunately.[37]

[31] G. P. Gooch, 'Harold Temperley, 1879–1939', *PBA,* 25 (1939), 355–93. The others were G. P. Gooch, Lewis Namier, R. W. Seton-Watson, B. H. Sumner and C. K. Webster.

[32] D. Douglas, 'Alexander Hamilton Thompson, 1873–1952', *PBA,* 38 (1952), 317–32; G. H. Bolsover, 'Robert William Seton-Watson, 1879–1951', *PBA,* 37 (1951), 345–58.; 'Edgar Prestage'.

[33] A. N. Whitehead, *The Aims of Education and Other Essays* (London, 1932), 1.

[34] Dorothy Emmet, 'Alfred North Whitehead, 1861–1947', *PBA,* 33 (1947), 293–306.

[35] A. N. Whitehead, 'Autobiographical Note' in *Essays in Science and Philosophy* (New York, 1947), 7–8.

[36] W. C. Lubenow, *The Cambridge Apostles, 1820–1914: Liberalism, Imagination and Friendship in British Intellectual and Professional Life* (Cambridge, 1998), 33, 57.

[37] 'Autobiographical Note', 8.

Yet he exemplifies the importance for his generation of school and undergraduate experience, and the fact that originality and impeccable scholarship could be achieved without standardized forms of professional training.

Research Training in Universities: Adapting the BA Degree

Early moves towards formal research training in the humanities at Oxford and Cambridge took the form of changes in the BA curriculum, providing opportunities for specialized study as well as a liberal education.[38] In History this involved the introduction of Special Subjects based on primary sources. In Lit. Hum. at Oxford periods of Greek and Roman history were designated for study 'as far as possible in the original authors', and there were optional Special Subjects for the ablest candidates.[39] Cambridge classicists gained an advantage by dividing the Tripos into two Parts. Part I (in itself a qualification for the BA degree) provided a general course mainly on language and literature; the minority of students who also took Part II could choose to specialize in literature, history, philosophy, archaeology or philology. The four-year Oxford Lit. Hum. degree, on the other hand, gave students in their first five terms a literary curriculum with an emphasis on translation and composition (Honour Moderations, or 'Mods'), followed by seven terms of ancient history and philosophy ('Greats'). Classical literature was not promoted to a place in Greats until 1968. But space was made, under the influence of T. H. Green, for the inclusion of modern alongside classical philosophy, while the study of Roman history became more professional, with new ventures into Romano-British archaeology. Research interests not adequately represented in Greats were catered for, from the early twentieth century, by Diploma courses in Classical Art and Archaeology, Anthropology, and Geography. Lectures and advice from post-holders who taught these courses were not confined to diploma students. As Professor of Classical Archaeology, Percy

[38] Christopher Stray (ed.), *Classics in 19th and 20th Century Cambridge: Curriculum, Work and Professional Life* (Cambridge, 1999), and *Oxford Classics: Teaching and Learning, 1800–2000* (London, 2007); Peter Slee, *Learning and a Liberal Education. The Study of Modern History in the Universities of Oxford, Cambridge and Manchester, 1800–1914* (Manchester, 1986); D. S. Goldstein, 'History at Oxford and Cambridge: Professionalization and the Influence of Ranke', in G. G. Iggers and J. M. Powell (ed.), *Leopold von Ranke and the Shaping of the Historical Discipline*, (New York, 1990), 141–53.

[39] Oswyn Murray, 'Ancient History', in *The History of the University of Oxford*, vii, M. G. Brock and M. C. Curthoys (eds.), *Nineteenth-Century Oxford* (Oxford, 1997), Part 1, 536–7, Part 2, 335.

Gardner 'gave personal instruction to 757 men and 129 women, not to mention those who merely attended his lectures'.[40]

At both universities controversy over syllabus reform lasted well into the twentieth century. Cambridge historians, for example, were divided between advocates of a course that was 'a school for statesmanship' and those who wanted more specialized historical options and less social science.[41] Conflict over the place of research training in the Modern History School, and of research qualifications in college teaching appointments, resonates through British Academy memoirs of Oxford historians.[42] This was an important issue: a First Class degree was often treated not merely as a necessary condition, but as a sufficient qualification, for appointment to a tenured college Fellowship.

By the turn of the century a case could in fact be made that an Oxford or Cambridge Honours degree did prepare the ablest undergraduates for research. The aim of the Modern History School was 'in the case of those who aim at a high class, to teach the principles upon which the study and criticism of original authorities should be pursued'.[43] The ecclesiastical historian H. M. Gwatkin maintained that

> In Cambridge either the Theological or the Historical Tripos will now give an excellent training in historical method. A man who goes through either, and takes a good place in his Second Part, has laid a broad foundation for future work, and made a good start with the critical study and comparison of original writers... though he may still want special help from the philosopher, the antiquarian, the palaeographer, the economist or the teacher of languages.[44]

Still more confident and circumstantial were claims made for Greats in a later symposium on examinations edited by the educationist Philip Hartog. Candidates brought to Lit. Hum. 'the precision of thought' that came with a thorough command of Latin and Greek. In philosophy they were

> generally expected to make themselves particularly intimate with Plato's *Republic* and the *Nicomachean Ethics* of Aristotle, to follow the development

[40] 'Percy Gardner', 464.

[41] G. Kitson Clark, 'A Hundred Years of the Teaching of History at Cambridge, 1873–1973', *Historical Journal*, 16/3 (1973), 535–53.

[42] For example, 'C. H. Firth'; C. G. Robertson, 'Sir Charles Oman, 1861–1946', *PBA,* 32 (1946), 299–306; R. W. Southern, 'Sir Maurice Powicke, 1879–1963', *PBA,* 50 (1964), 275–304. For a survey of this dispute, see J. P. Kenyon, 'Sir Charles Firth and the Oxford School of Modern History', in A. C. Duke and C. A. Tamse (eds.), *Clio's Mirror: Historiography in Britain and the Netherlands* (Zutphen, 1985), 163–83.

[43] A. H. Johnson, *Faculty of Arts. Honour School of Modern History* (Oxford, 1900), quoted in Slee, *Learning and a Liberal Education*, 128.

[44] In W. A. J. Archbold, *Essays on the Teaching of History, by F. W. Maitland and Others* (Cambridge, 1901), 9.

> of thought from Descartes to Kant or later, and to think out for themselves a position which will enable them to give reasoned and consistent answers to at least the more central questions with which philosophy is concerned.[45]

In ancient history they were 'required by statute to use the original authorities', and that meant that 'superficiality [could] be treated [by the examiners] as unpardonable'. The expectation was that students would 'apply their minds to the whole of the evidence for their particular problem', guided by the weekly tutorial with their philosophy and history tutors. The one technical qualification provided by this intellectual training was 'an ability to study, and if necessary teach, philosophy and ancient history'.[46] The Cambridge classicist F. E. Adcock, known for the 'poise and style' of his own writing, noted that Tripos examiners were required to 'have regard to the style and method of the candidates' answers and . . . give credit for excellence in these respects'; and that 'the growth of stereotyped standards' was avoided by the discretion and autonomy given to examiners.[47] At both universities it was claimed that examiners valued evidence of independent thought and did not seek standard answers from Honours candidates.[48] Charles Oman, who did a lot of tutorial teaching in both ancient and modern history before he became a professor, warned pupils that for a high class 'some originality' was needed. His own technique was to 'set essays that involved some problem of deduction or comparison, and that could not be answered by paraphrasing . . . a textbook or manual'. As an examiner he saw how easy it was to detect a 'particular clever turn of words that came from a common tutor' in answers from candidates from the same college.[49]

Moves to interest undergraduates in research are recorded from the late 1870s.[50] Examples of research-focused teaching figure in several FBA

[45] Sir Philip Hartog (ed.), *The Purposes of Examinations. A Symposium* (London, 1938), 30–5. The article on Greats was written by the Camden Professor of Roman History Hugh Last in consultation with the philosopher R. G. Collingwood.

[46] Ibid, 38, 40.

[47] N. G. L. Hammond, 'Frank Ezra Adcock, 1886–1968', *PBA,* 54 (1968), 425–34.

[48] For a contrary view, that teachers and students 'relied on mindless cramming as a route to a high class of honours', see Reba N. Soffer, *Discipline and Power. The University, History and the Making of an English Elite, 1870–1930* (Stanford, 1994), 137–8. The examiners' reports cited are however open to a different interpretation. Boards of examiners were dominated by tutors: these were internal reports, circulated for the private information of colleagues. Comments on the shortcomings of candidates were intended as constructive criticism. The most frequent complaint is of the poor quality of candidates in the lowest classes.

[49] Sir Charles Oman, *Memories of Victorian Oxford* (London, 1941), 149. On tutorial teaching practices at Oxford see also Robert Currie, 'The Arts and Social Studies', in Harrison (ed.), *The Twentieth Century*, 130–1.

[50] For an 1879 Oxford class 'for the discussion of and the illustration of the principles of textual criticism' see S. Harrison, 'Henry Nettleship and the Beginning of Modern Latin

memoirs in our sample. William Ridgeway's Part II archaeology students at Cambridge were taught

> not to be satisfied with superficial conclusions, but to probe deeply into the matter in hand and strip off the layers to reveal the kernel of truth within. They learnt . . . to go back as far as possible to the first authority. They were told that method, attention to detail, thoroughness, and accuracy are the hallmarks of the true scholar. . . They learnt further the use of anthropological parallels, the value of self-criticism, detestation of humbug, caution against plausible theories, and the necessity of first collecting the evidence and then determining what conclusions can logically be drawn from it.[51]

A. C. Clark, Corpus Professor of Latin at Oxford (1913–34) is described by a pupil as taking a class

> through his own text of Cicero's *Philippics* in a way which opened up the vast possibilities of Textual Criticism. We saw the possibilities of his own special methods and it is still second nature, when faced with a textual dislocation, to count the letters (with or without the help of a pin).[52]

John Laird, an Edinburgh graduate who came South to read Moral Sciences at Cambridge, felt that as a pupil of McTaggart, Moore and Russell he 'began all over again':

> I came to prefer dialectic to history, more special to broader inquiries, a grain of proof to a bushel of sweeping suggestion, and I did my best to be as candid as I could. . . In Cambridge. . . we followed an argument in the spirit of adventure. . . In our view nothing was final but the rules of sound navigation, and everyone seemed ready to be argued out of his fundamental conception of the term before.[53]

At Oxford, too, studying philosophy could be a strenuous experience. The Socratic method, wrote the author of R. R. Marett's memoir, was the 'true Oxonian method of teaching':

> The apt student – I paraphrase the master's [Plato's] words – gives himself and his teacher no rest until he finds perfection or at least progresses so far that he can be his own guide, with none to lead him.[54]

For serious students, the Balliol historian A. L. Smith set an equally demanding standard. According to one pupil, the Edinburgh graduate

Studies at Oxford' in Stray, *Oxford Classics*, 112. On the origins of the Stubbs Society and the King's College Politics Society, see Soffer, *Discipline and Power*, 169–72.

[51] F. H. Stubbings, 'Alan John Bayard Wace, 1879–1957', *PBA,* 44 (1958), 263–80.
[52] C. Bailey, 'Albert Curtis Clark, 1859–1937', *PBA,* 23 (1937), 513–25.
[53] W. S. Urquhart, 'John Laird, 1887–1946', *PBA,* 32 (1946), 415–32.
[54] H. J. Rose, 'Robert Randolph Marett, 1866–1943', *PBA,* 29 (1943), 357–70.

James Eadie Todd – not an FBA, but a future professor at Queen's University, Belfast – Smith treated lectures as 'a subsidiary method of teaching, primarily adapted to the needs of the low-brows', but his own tutorials were on a quite different level:

> You read your essay to him; if it was a good one the effect was to stimulate him…He rose from his chair…pouring out…a torrent of criticism, of leading questions, of points missed…On a good day, the whole thing reminded you of a superbly able counsel tearing to pieces the speech of his opposite number…Smith gave you illuminating points, and criticisms and references, but on principle he never elaborated them. He expected you to go away and work them out or look them up and then write a revised precis of your original essay. If you did this, you got all that he had to give you; if you did less, you got next to nothing from him.[55]

The Modern History School was however the main target for critics of the system of tutorial teaching for examinations: 'The historical teaching of history has been practically left out, in favour of the class-getting system of training'.[56] That charge, made by William Stubbs in the 1870s, was quoted by his pupil and early-twentieth century successor as Regius Professor, Charles Firth, in a provocative inaugural lecture. Firth's attack on the examination system was taken seriously and he won minor concessions: from 1908 candidates could offer an optional thesis, and essays entered for university prizes could be submitted for assessment. But the fundamental issue—how to combine preparation for unseen examinations with training for research—remained unresolved. An alternative approach, giving undergraduates hands-on research experience, was developed in the Manchester History Department by two Oxford-trained medievalists, T. F. Tout and James Tait. Tout taught third-year Special Subject classes in the Freeman Library (a History room in the University Library) in German seminar style, setting each student a topic to research in printed primary sources. He also introduced a compulsory undergraduate thesis, an example that was followed in some other civic universities.[57] Manchester History graduates who went to Balliol for a second BA were not always happy there. 'The confident way in which [A. L. Smith] made generalizations, and weighed moral influences, made any pupil of Tout's hair stand on end', according to V. H. Galbraith.[58] Both he and F. M. Powicke went back to Manchester as research fellows; both were, as critics of the Oxford

[55] H. A. Cronne, T. W. Moody and D. B. Quinn (eds.), *Essays in British and Irish History in Honour of James Eadie Todd* (London, 1949), 126–7.

[56] C. H. Firth, *A Plea for the Historical Teaching of History* (Oxford, 1904), 30.

[57] Slee, *Learning and a Liberal Education*, 153–61.

[58] H. W. C. Davis, R. H. C. Davis and R. W. Hunt, *A History of Balliol College* (Oxford, 1963), 241.

system, to return there as Regius professors. It fell to Powicke to give an account of the Modern History School for Hartog's 1936 symposium. To the question, 'how far does the examination fulfil its purpose?', he gave a hesitant response.

> The man who wishes to pursue his studies farther is sufficiently equipped on taking his degree to be able to do so, provided that he is willing to learn and to go slowly.

The need was however, 'to do something to drive home to undergraduate students the truth that they are only on the fringe of a vast and unfathomable study'.[59]

Pupils claimed that Powicke himself achieved this in a Special Subject class on 'Church and State in the Time of Edward I' that 'gave… undergraduates a new idea of historical research'; but his plan to divide the Oxford BA course, so that Part II students could be taught alongside postgraduates, came to nothing.[60]

Fellowships, Essay Prizes, Study Abroad

At the ancient universities an initiation in research often came through the fellowship and prize systems, the main routes to advancement for the academically ambitious. In the late nineteenth century colleges offered short-term 'prize fellowships' without teaching obligations to support young graduates while they established a professional career: these were awarded at Oxford normally by examination and at Cambridge by dissertation.[61] These fellowships and essay prizes were a mark of distinction that might even in exceptional cases compensate for missing a First Class degree.[62] Before the First World War almost all Oxford-trained historians who won an essay prize 'went on to conspicuously successful academic careers.'[63] So did a graduate of University College London, T. F. T. Plucknett, who won the Royal Historical Society's Alexander Prize and made his career as a legal historian at Harvard and the London School

[59] Hartog, *Purposes of Examinations*, 43–4.
[60] 'Sir Maurice Powicke', 288.
[61] A. J. Engel, *From Clergyman to Don. The Rise of the Academic Profession in Nineteenth-Century Oxford* (New York, 1983), 257–66. Lord Curzon, *Principles and Methods of University Reform* (Oxford, 1909), 182 records that by then there were 'nearly twenty' fellowships 'assigned to Research or… to some object of special or advanced study'.
[62] See, for example, H. L. Bell, 'Arthur Surridge Hunt, 1871–1934', *PBA,* 20 (1934), 323–36; C. M. Bowra, 'John Dewar Denniston, 1887–1949', *PBA,* 35 (1949), 219–32; J. M. Hussey, 'Norman Hepburn Baynes, 1877–1961', *PBA,* 49 (1963), 364–73.
[63] Soffer, *Discipline and Power*, 176, 263–4 note 60.

of Economics.[64] Even an unsuccessful entry for an essay prize might awaken interest in what became a life's work, as in the case of P. S. Allen, editor of the *Opus Epistolarum* of Erasmus (recently described as 'one of the great monuments of English learning').[65] In the FBA sample, the priority for Oxford classicists seems to have been competing by examination for a Craven Fellowship: this gave £200 a year for two years of 'advanced study', two-thirds of which had to be spent abroad. But when classicists and philosophers did win essay prizes, the work submitted could be substantial and research based, marking out the author's future field of work and destined for publication.[66] The same can be said of the fellowship dissertations submitted by Cambridge candidates. Some FBAs who did not write prize essays or dissertations had instead published substantial books by the age of 30.[67] These first exercises in research, though produced without formal supervision, fulfilled the same function in the formation of a scholar as a thesis submitted for a research degree.

Many FBAs had studied abroad, though it is not always clear what that entailed. Only two in our sample went so far as to take continental PhDs, both at the University of Leipzig. The philosopher G. D. Hicks studied there for four years; but R. L. Poole—whose work in the British Museum's manuscripts department had equipped him with technical training—was actually in Leipzig for only four months.[68] Many went abroad primarily to learn languages. Charles Firth, for example, 'spent some months in Hanover improving his German; [but] he never studied at a continental university.'[69] Although a keen advocate of the German professorial seminar, he had probably never attended one. Of the historians who did attend continental universities, A. G. Little—for many years Reader in Palaeography at Manchester—was introduced at Dresden and Göttingen

[64] S. F. C. Milsom, 'Theodore Thomas Frank Plucknett, 1897–1965', *PBA,* 51 (1965), 505–19.

[65] H. W. Garrod, 'Percy Stafford Allen, 1869–1933', *PBA,* 19 (1933), 381–407; J. B. Trapp, 'Percy Stafford Allen (1869–1933), Erasmian scholar', *Oxford Dictionary of National Biography [ODNB].*

[66] Examples are: 'The Ethics of Savage Races', R. R. Marett's first venture into anthropology, which won the Green Moral Philosophy Prize in 1893; F. G. Kenyon, *The Palaeography of Greek Papyri* (Oxford, 1891), the first monograph on the subject published in any language; A. E. Taylor, 'Reciprocal Relations between Ethics and Metaphysics', published as *The Problem of Conduct* (London, 1891).

[67] Examples are: F. C. S. Schiller, *The Riddle of the Sphinx: A Study in the Philosophy of Evolution* (London, 1911); Harold Mattingly, *The Imperial Civil Service of Rome* (Cambridge, 1911); John Laird, *Problems of the Self* (London, 1917); I. A. Richmond, *The City Wall of Imperial Rome: An Account of its Architectural Development from Aurelian to Narses* (Oxford, 1930).

[68] W, G, de Burgh, 'George Dawes Hicks, 1862–1941', *PBA,* 27 (1941), 405–31: 'Reginald Lane Poole'.

[69] G. N. Clark, 'Sir Charles Firth', *English Historical Review,* 51, no. 202, April 1936.

to 'the principles and practice of the critical examination of original historical documents.'[70] R. L. Poole's son Austin 'learned in German seminars the groundwork of German history and method': his reputation was made by his chapters on German history in the *Cambridge Medieval History.*[71] H. A. L. Fisher, a Lit Hum. graduate, made the transition to Modern History by studying in Göttingen and Paris: he was remembered for combining 'the scholarship of the Sorbonne' with the 'literary power traditional in his English and Oxford surroundings'.[72] Fisher's pupil R. W. Seton Watson studied at Berlin, Paris and Vienna, earning an Oxford D. Litt. for his book *Racial Problems in Hungary* (London: Constable, 1908). G. P. Gooch attended lecture courses in Berlin and Paris that bore fruit in his classic survey of *History and Historians in the Nineteenth Century* (London: Macmillan & Co., 1913).[73] Other historians went abroad not to study at universities but in search of primary sources: Z. N. Brooke to the Vatican Library, the diplomatic historian C. K. Webster on a tour of continental archives before the outbreak of war in 1914, Richard Pares in the 1920s to archives in the United States and West Indies.[74]

British philosophers of an earlier generation had gained much from their visits to German universities: for philosophers in our sample the benefits were less obvious.[75] The moral philosopher W. R. Sorley studied theology at Tübingen and Berlin, but his early Idealist phase was influenced chiefly by T. H. Green, while Henry Sidgwick at Cambridge had provided training in 'the philosophical temper of candour, self-criticism, and regard for the truth.'[76] The Idealism of Green, Edward Caird and F. H. Bradley, though always controversial among professional philosophers, had widespread influence, but was not seen by its British adherents as derivative from Hegel.[77] A. S. Pringle-Pattison, who did work on Kant and Hegel, gained little from his time (1878–82) at a series of German universities, where Idealism was out of fashion.[78] Some philosophers

[70] F. M. Powicke, 'Andrew George Little, 1863–1945', *PBA,* 31 (1945), 335–56.

[71] V. H. Galbraith, 'Austin Lane Poole, 1889–1963', *PBA,* 49 (1963), 431–46.

[72] Gilbert Murray, 'Herbert Albert Laurens Fisher, 1865–1940', *PBA,* 26 (1940), 464.

[73] Herbert Butterfield, 'George Peabody Gooch, 1877–1968', *PBA,* 55 (1969), 311–38.

[74] H. M. Cam, 'Zachary Nugent Brooke, 1883–1946', *PBA,* 32 (1946), 381–93; S. Bindoff and G. N. Clark, 'Charles Kingsley Webster, 1886–1961', *PBA,* 48 (1946), 427–48; A. L. Rowse, 'Richard Pares, 1902–58', *PBA,* 48 (1962), 345–56.

[75] C. C. J. Webb's Academy memoir recalls the importance of German contacts for Ingram Bywater's Aristotle scholarship, and the influence of Hermann Lotze's Göttingen lectures on J. Cook Wilson.

[76] F. R. Tennant, 'William Ritchie Sorley, 1855–1935', *PBA,* 21 (1935), 393–405.

[77] C. G. Robertson and W. D. Ross, 'John Henry Muirhead, 1855–1940', *PBA,* 26 (1940), 381–8; R. G. Collingwood, *An Autobiography* (Oxford, 1939), 15–19.

[78] J. B. Capper and J. B. Baillie, 'Andrew Seth Pringle-Pattison, 1856–1931', *PBA,* 17 (1931), 447–89.

developed an interest in psychology while studying abroad: F. C. S. Schiller in the United States, where he became a friend of William James; Samuel Alexander and G. D. Hicks in Germany.[79] But A. N. Whitehead was among those of his generation who did not study abroad, despite the importance for his early work on mathematical logic of the ideas of Hermann Grassmann, and the influence of Giuseppe Peano and Gottlob Frege on the collaboration with Bertrand Russell that produced *Principia Mathematica* (1910–13).[80] G. E. Moore did not take Sidgwick's advice to spend a year or two at a German university:

> I had reasons for wishing . . . to reside in Cambridge and I still feel very doubtful whether I should have got as much benefit by studying in Germany as I did by staying at home.[81]

This was a golden age for Cambridge philosophy and its analytical style owed little to foreign influences.

In classical studies, however, there was not only a need to visit sites and museums but also a lasting sense of the superiority of German scholarship.[82] This was to be confirmed in the 1930s with the arrival of eminent refugees from Nazism, notably Eduard Fraenkel, Corpus Professor of Latin at Oxford (1935–53).[83] Well over half our classicists and archaeologists had studied abroad (Table 5.3). In most cases this did entail attendance at lectures and seminars at German universities, or residence at the British School in Athens or Rome. Arthur Evans spent a year at Göttingen. Lewis Farnell, inspired by German research culture while studying archaeology at Berlin and Munich, became a leader of the chief pressure group in Oxford for research and university reform ('The Club').[84] W. M. Lindsay was among the philologists who went to Germany as a graduate, returning to give Oxford's first palaeography lectures in the 1880s and publish his standard work, *The Latin Language* (Oxford: Clarendon, 1894).[85] German universities trained students in the latest developments in comparative philology, rigorous standards in textual scholarship and the contextual and interdisciplinary 'science of antiquity' (*Altertumswissenschaft*). 'As was then

[79] R. R. Marett, 'Ferdinand Canning Scott Schiller, 1864–1937', *PBA,* 23 (1937), 538–50; J. Laird, 'Samuel Alexander, 1859–1938', *PBA,* 24 (1938), 378–95; 'G. D. Hicks'.

[80] A. N. Whitehead, 'Autobiographical Notes', 10; Bertrand Russell, *The Autobiography of Bertrand Russell* (London, 1971 edition), i. 144–5.

[81] 'An Autobiography', in P. A. Schilpp (ed.), *The Philosophy of G. E. Moore* (New York, 1952), 6.

[82] Gilbert Murray, 'German Scholarship', in *Quarterly Review*, 443 (April 1915), 330–2.

[83] 'Eduard Fraenkel', 421–4, 435–42.

[84] R. R. Marett, 'Lewis Richard Farnell, 1856–1934', *PBA,* 20 (1934), 285–96.

[85] H. J. Ross, 'Wallace Martin Lindsay, 1858–1937', *PBA,* 23 (1937), 487–512. See also R. M. Dawkins, 'Peter Giles, 1860–1935', *PBA,* 21 (1935), 406–32; 'Robert Seymour Conway'.

the custom at the beginning of a professional career in classical studies', notes a biographer of F. E. Adcock, 'he attended the seminars of Wilamowitz in Berlin and Eduard Meyer in Munich from 1910 to 1911.'[86] There are critical comments on the scholarship of some academicians who lacked post-graduate training in Germany.[87] Gilbert Murray, professor of Greek at Glasgow and Oxford, is among them, although he began in 1894 a correspondence with the great Hellenist Ulrich von Wilamowitz-Moellendorf—'Dear Friend and Teacher'—that lasted for many years.[88]

That said, there were classicists who achieved distinction without studying abroad. The Cicero scholar A. C. Clark travelled in search of manuscripts rather than training but his editions were nevertheless well regarded.[89] J. D. Denniston's definitive work *The Greek Particles* (1934) was a product of the English tradition of composition and translation: his mastery of idiom owed something to Oxford's Composition Club, seven classics dons who met to translate works of English literature into classical Greek.[90] Areas of recognised achievement in British classical scholarship included by 1914 numismatics, the study of Greek vase painting, papyrology and archaeology (above all, the excavations of B. P. Grenfell and A, S. Hunt at Oxyrhynchus and Arthur Evans at Knossos).[91] After the First World War German universities lost their hegemony—classics post-graduates might go instead to Vienna or Princeton.[92] Among the younger archaeologists in the sample, Dorothy Garrod took the Oxford Diploma in Anthropology before training at the Institut de Paléontologie in Paris, while the Australian Gordon Childe and the Leiden graduate Henri Frankfort trained as post-graduates in (respectively) Oxford and London.[93]

Post-graduate Research Training in Britain Before 1939

Opinion among academics remained divided as to how far research training for the ablest Honours students should become part of the BA course and how far it belonged instead to the post-graduate years. This lack of

[86] 'Sir Frank Ezra Adcock', in *Oxford Dictionary of National Biography*.

[87] 'F. G. Kenyon'; 'Cyril Bailey, 1871–1951', *PBA,* 1951; 'Gilbert Murray, 1866–1957', *PBA,* 1957.

[88] Gilbert Murray, 'Memories of Wilamowitz', *Antike und Abendland*, 4 (1954), 13.

[89] 'A. C. Clark'.

[90] C. M. Bowra, 'John Dewar Denniston, 1887–1949', *PBA,* 35 (1949), 219–32.

[91] 'A. S. Hunt'; 'Harold Mattingly, 1894–1964', *PBA,* 1964; Bernard Ashmole, 'Sir John Davidson Beazley, 1885–1970', *PBA,* 56 (1970), 443–61.

[92] F. E. Adcock, 'Martin Percival Charlesworth, 1895–1950', *PBA,* 36 (1950), 277–90; R. P. Winnington-Ingram, 'Amy Marjorie Dale, 1902–1967', *PBA,* 53 (1967), 423–46.

[93] Gertrude Caton-Thompson, 'Dorothy Annie Elizabeth Garrod, 1892–1968', *PBA,* 55 (1969), 339–61; S. Piggott, 'Vere Gordon Childe, 1892–1957', *PBA,* 44 (1958), 305–12: V. G. Childe, 'Henri Frankfort, 1897–1954', *PBA,* 41 (1955), 367–72.

clarity was one factor that complicated the task of introducing in British universities the types of training found in the German seminar, the École des Chartes and *École Pratique des Hautes Études* in Paris or the American graduate school. At Oxford, for instance, lectures in palaeography and diplomatic for classicists and medieval historians began in the 1890s, and were supplemented in 1908 by lectures on 'Sources of English History' and a seminar conducted by the eminent jurist and historian of English feudal institutions Paul Vinogradoff.[94] But the lectures were poorly attended: graduates studying for the B. Litt. were few and their research interests scattered, while few undergraduates found time for lectures that were outside the syllabus examined in the Schools. Vinogradoff's seminar, modelled on German practice, had a budget from the university and a room in All Souls' College, which also housed the 'Maitland Memorial Library.' Its members worked together on primary sources and published the results in a British Academy publication, *Survey of the Honour of Denbigh* (London, 1914), and nine volumes of *Oxford Studies in Social and Legal History* (Oxford, 1909–27). Most of them were, however, not students but young dons. Among those published in the *Oxford Studies* (though it is not known whether she attended the seminar) was the only woman historian in the sample, Helen Cam, then a Fellow of Girton College, Cambridge and later Professor of History at Harvard (1948–54).[95] 'It is no exaggeration to say that Vinogradoff's seminar provided the best course of training in the methods of historical research which at that time could have been obtained in the University of Oxford', claimed a former colleague: yet it attracted very few undergraduates or graduate students.[96] No more than four or five students attended Charles Firth's B.Litt. class on seventeenth-century British history. Low attendance at graduate lectures remained a perennial problem.[97] In classics, where post-graduate students were even scarcer, the most celebrated examples of the professorial seminar—Gilbert Murray's class on the art of translation and Eduard Fraenkel's seminar—were attended mainly by first and second-year undergraduates.[98] Philosophers were to develop seminar teaching

[94] C. H. Firth, *Modern History at Oxford, 1841–1918* (Oxford, 1920), 37, 46–9.

[95] C. R. Cheney, 'Helen Maud Cam, 1885–1969', *PBA,* 55 (1969), 293–310. Two Oxford women tutors who did attend the seminar were Ada Elizabeth Levett, a future Professor of History at Westfield College, London, and Eleanor Lodge, Oxford's first woman D. Litt. See Frances Lannon, 'Eleanor Constance Lodge, 1869–1936', *ODNB.*

[96] H. A. L. Fisher, 'Memoir', in *Collected Papers of Paul Vinogradoff* (Oxford, 1928), i. 32–9.

[97] Committee for Advanced Studies 1919–31, OUA FA 5/3/1.

[98] 'Gilbert Murray'; Stephanie West, 'Eduard Fraenkel Recalled', in Stray, *Oxford Classics*, 214–15.

after the Second World War in a new and successful post-graduate course, the B. Phil., but it was in lectures and informal discussions among colleagues in the 1930s that the foundations of post-war Oxford analytic philosophy were laid.[99]

Manchester, with humanities departments that were relatively small and controlled by their professors, and London, re-founded as a teaching university in 1900, offered more favourable conditions for post-graduate education. Manchester's Professor of Latin (1903–29) R. S. Conway was an inspiring supervisor who

> would often set candidates for the MA degree to write theses on some subordinate part of the questions on which he was working – in Virgil or Livy or Cicero – and so gathered round him something like a school of research, the members of which afterwards went out as missionaries, to spread the enthusiasms which they had learnt.[100]

Tout's History Department gained a national reputation for medieval research and by 1920 had 25 postgraduate students, including five PhD candidates, two of them from Oxford. The Institute of Historical Research became a focus for research training on a larger scale, catering for graduate students from colleges of the University of London and open to visitors from other universities. By 1923 it accommodated six preliminary courses on historical sources and palaeography and seventeen graduate seminars.[101] It became the venue of the Anglo-American Historical Conference, first held in July 1921: and the first issue of the Institute's *Bulletin* included guidance from a committee of British and American scholars on how to edit a historical text.[102] The IHR could be seen as an English version of the research institute, the creation of its Director (1921–39) A. F. Pollard, who had his own vision of a postgraduate seminar as 'a group of scholars, young and old, meeting in a library, as scientists in a laboratory', an occasion when 'students and teachers discussed common problems arising from their work.'[103] Pollard's years as assistant editor of the *Dictionary of National Biography* shaped this vision. The book-lined rooms shown in early photographs of the Institute, without a fixed seminar table, may reflect memories of the Dictionary Office.

[99] G. J. Warnock, 'John Langshaw Austin, 1911–1960', *PBA,* 49 (1963), 345–63.
[100] 'R. S. Conway'.
[101] Birch and Horn, *History Laboratory*, 130.
[102] *Bulletin of the Institute of Historical Research*, 1 (1923), 6–25.
[103] Sir John Neale, 'Professor A. E. Pollard', in *Essays in Elizabethan History* (London, 1958), 238–9; Birch and Horn, *History Laboratory*, 10. See also 'Training in Historical Research', *BIHR*, 31.

The IHR was not, however, the only focus for research education for historians in London.[104] The London School of Economics had provided a base for London's first lectures in palaeography and diplomatic.[105] Its Professor of International Relations C. K. Webster held a weekly seminar at his home, his wife dispensing tea. Sometimes 'conducted in the language of a continental member', it was remembered as 'a "cell" of that world-wide fellowship of international historians which Webster was to do more than any Englishman of his time to foster and sustain.'[106] London did not follow Manchester's example by introducing a BA dissertation, but it too featured source-focused Special Subject classes, designed to prepare Honours students for post-graduate work. R. H. Tawney's British Academy memoir prints the syllabus of his LSE class on 'Economic and Social England, 1558–1640', outlining his conception of History as concerned 'not with a series of past events, but with [understanding] the life of society, and with the records of the past as a means to that end.'[107] The medieval economic history seminar run by his pupil M. M. Postan with Eileen Power produced a collaborative volume, *Studies in English Trade in the Fifteenth Century* (London, 1933). It resembled a more collegial version of Vinogradoff's Oxford seminar.[108]

'Germanizing' tendencies had always had their critics, and British Academy memoirs suggest a predictable growth in anti-German sentiment. M. R. James 'disliked most things German, except their scholarship.'[109] At Cambridge there was a backlash against the notion of history as 'a science, a technique', associated with the German-educated *fin-de-siècle* Regius professor Lord Acton.[110] The stereotype of the dominant professor, with his 'school of disciples' or mission to '"organize" the studies of the younger dons', is sometimes repudiated.[111] G. E. Moore's phrase 'do your philosophy for yourself' expressed the individualist ethos of English scholarship.[112] The graduate seminar itself could be seen as problematic.[113] T. F. Tout was said to be 'incapable of thinking of his work with his pupils in the academic terms of "graduate instruction" or "seminars."'[114] At Oxford F. M. Powicke's 'informal meeting of tutors and research students

[104] On the Institute of Archaeology see Jacquetta Hawkes, 'Robert Eric Mortimer Wheeler, 1890–1976', *PBA,* 63 (1977), 483–507.

[105] G. W. Prothero, Presidential Address in *Transactions of the Royal Historical Society*, 16 (1902), xxii.

[106] 'C. K. Webster', 438. [107] 'R. H. Tawney', 471.

[108] Maxine Berg, *A Woman in History. Eileen Power, 1889–1840* (Cambridge, 1996), 209–10.

[109] 'M. R. James', 428. [110] 'C. W. Previté-Orton', 358–9.

[111] For example, 'G. F. Stout', 315; 'A. C. Clark', 524.

[112] 'G. E. Moore'. [113] 'Sir Charles Oman', 301–3; 'N. H. Baynes', 369.

[114] 'T. F. Tout', 505.

to read papers and discuss problems' was known as the 'Medieval Group' rather than 'seminar'; but even so, Richard Southern recalls, 'some did not like it.'[115] In G. M. Trevelyan's inaugural lecture, as in many memoirs, stress is laid on the help given instead 'in an unofficial way' by senior scholars to beginning researchers:

> If the Seminar be held as alien to the genius of this University, the friendship of older with younger scholars is not alien to our traditions. … The Cambridge University Historical Society exists in large part to foster such personal relations between the more experienced and the younger hands.[116]

In the 1920s and 30s pressure to adapt to American norms could be equally unwelcome. In the humanities the PhD was relatively slow to acquire status as a qualification. Renate Simpson has documented an attempt in 1930, with support from the Cambridge English, Classics and Moral Sciences Faculties, to abolish it in 'non-scientific subjects.'[117] Criticism of the PhD degree cannot be dismissed as just complacent chauvinism: it came from some scholars with a serious commitment to research training. V. H. Galbraith used his inaugural lecture in Edinburgh in 1937 to air discontents with the 'system of higher degrees granted for theses embodying an "original contribution to knowledge."' There was 'much to be said for it, and it [had] in any case come to stay.'

> Nevertheless I cannot think it altogether congenial to our native outlook… These 'original' theses are compiled in a very short time…[and] they are done by young people who have scarcely attained the equipment of a scholar by the time the thesis is completed… [T]he result, at its best, is apt to be the publication of an immature monograph, much less readable than it would have been if more slowly evolved. … [T]he student works in an atmosphere of anxiety and haste, at the very time in his career when leisure and time to think are most essential. He passes from the superficial study of wide periods to a specialisation that is too narrow, too intense and too hurried.[118]

In conclusion, then, it did not look in the 1930s as if further adaptation of British practice was likely to come about in the near future. Research training in the humanities clearly did have its limitations: it produced fewer scholars and a much lower output of scholarly work than European or American universities, and it relied on the presence in universities

115 'Sir Maurice Powicke', 288.

116 G. M. Trevelyan, *The Present Position of History* (London, 1927), 24.

117 Renate Simpson, *The Development of the PhD in Britain, 1917–59 and Since* (2009), 280–4.

118 V. H. Galbraith, 'Historical Research and the Preservation of the Past', *History*, 22/8 (March 1938), 305–6.

(Oxbridge especially) of an elite of undergraduates from cultivated homes, often expensively educated, often with private means with which to buy 'leisure and time to think.' But the British tradition also had virtues that were prized, in a culture that valued quality over quantity of scholarship, literary merit and readability over mere originality, collegiality and individual insights over hierarchy and the 'research school.' Only with the expansion of British universities after the Second World War – and all that entailed, in terms of new sources of funding, more academic jobs and pressures for professionalization – were the conditions created in which attitudes would change.

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6

The *Année Sociologique* as Training Ground for Sociology: Durkheim, Mauss, and the Art of Book Reviewing in *Fin de Siècle* France

Daniela S. Barberis

Introduction

The efforts of Émile Durkheim and his colleagues to institutionalize sociology as a scientific research discipline in France in the late nineteenth century encountered several roadblocks. One of them was the difficulty of providing professional training for the emerging sociologists given the lack of a formal program of education and of dedicated faculty or facilities. Durkheim and his associates worked around their relative lack of institutional resources through the foundation of the journal *Année sociologique*, a collaborative project of considerable scope. While this journal has been extensively studied, the role that book reviews played in the formation of the Durkheimian group and its common identity has not been explored before. The reviews were conceived as a means to an end by Durkheim and his collaborators; they were not simply reporting on the work of a particular author, but highlighting what they themselves saw as valuable to the construction of sociology in his work, thus presenting their point of view and their work methods to the public *through* the critique of the work of others. Reviewing was conceived as a creative task, albeit one done using an impersonal and scientific method—a method spelled out by Durkheim in the *Rules*. It is also significant that the group was very much aware of the role of the book review, i.e., this is their own description of their practice.

I will furthermore argue that in the process of creating this collective work, the Durkheimian group also produced a moral community, with

Daniela S. Barberis, *The* Année Sociologique *as Training Ground for Sociology: Durkheim, Mauss, and the Art of Book Reviewing in* Fin de Siècle *France* In: *A Global History of Research Education: Disciplines, Institutions, and Nations, 1840–1950*. Edited by: Ku-ming (Kevin) Chang and Alan Rocke. *History of Universities* XXXIV/1, Oxford University Press (2021). © Oxford University Press. DOI: 10.1093/oso/9780192844774.003.0007

specific moral-epistemic virtues and that they were aware of the importance of these epistemic values to their enterprise. They write of the collective character of the true scientific enterprise and of the solidarity needed to achieve it.

The issue of training younger researchers was particularly salient among the Durkheimians[1] and justifies focus on their project to the exclusion of other contemporary competing sociologies.[2] In order to discuss the efforts of Durkheim and his colleagues to make sociology into an academic discipline, I will first sketch the challenges posed by the status quo in the French university at this time.

French University System

During the liberal phase of the Second Empire (1864–70), French academics became increasingly aware of the deficiencies of their higher education system. A decade of political repression during the 1850s had made them intensely conscious of their vulnerability and relatively low status within French society. The growing prestige of German science and universities also generated concern that France's intellectual status within the international academic community was on the wane; these fears were intensified

[1] Durkheim's competitors took very different approaches to the creation of the new discipline. Gabriel Tarde (1843–1904), a provincial examining magistrate for most of his life, was an intellectual isolate. His provincial location and lack of institutional affiliation to the University system played a role in his lack of intellectual following, but it was also a matter of temperament. Tarde achieved international fame with the publication of his *Lois de l'imitation* in 1890 and from then on accumulated marks of institutional recognition, including an appointment to the Collège de France in 1900 (chair of modern philosophy), where, despite the chair's title, he was left free to teach as he pleased. Tarde did not start teaching until late in his life and did not cultivate followers. See Terry N. Clark, *Prophets and Patrons: The French University System and the Emergence of the Social Sciences* (Cambridge, 1973), 68.

René Worms (1869–1926) created his multiple institutions — *Revue internationale de sociologie*, Institut International de Sociologie, Bibliothèque sociologique international (1893) and Société de sociologie de Paris (1895)—by recruiting already established figures of international standing. This approach also avoided the problem of training new recruits and providing them with academic positions. On Worms' institutions and theories, see Daniela S. Barberis, 'In Search of an Object: Organicist Sociology and the Reality of Society in Fin-de-Siècle France', *History of the Human Sciences,* 16 (2003), 5.

Finally, the institutions created by Fréderic Le Play (1806–82) were focused on social reform, privately funded and independent of the University system. Following the monographic method pioneered by Le Play, they did train those who collected family data, but Le Playiste social economy remained focused on influencing government policy rather than on training researchers. On Le Play see Janet R. Horne, *A Social Laboratory for Modern France: The Musée Social and the Rise of the Welfare State* (Durham and London, 2002).

[2] For an overview of the field of French sociology and a brief history of its emergence, see Daniela S. Barberis, 'Sociology' in Michael Moriarty and Jeremy Jennings (ed.), *The Cambridge History of French Thought* (Cambridge, 2019), 477–87.

by the German victory in the Franco-Prussian war of 1870.[3] From this point on, the French state began attempting to equal or surpass Germany academically, and sponsored fellowships to allow its academics to study the rival German university system.[4] Reports on the state of German disciplines were frequently published in the *Revue internationale de l'enseignement* and in journals with a broader public. France had not been keeping up with the innovations introduced by the emergence of the modern research university, which included the development of new spaces and new ways of training students. In response, a reform movement developed, aimed at academic professionalization. One of the highest priorities for the small group of reformers was that research and intellectual production be a central task of professional life. Other closely linked demands were for academic freedom and institutional autonomy, increased resources and salaries, and the creation of universities to unify the separate professional faculties—of law, medicine and pharmacy, theology, and letters and sciences.[5]

A serious hindrance to reform, however, was built into the existing system. Faculties were geared primarily for training in the professions or for preparation of secondary school teachers rather than research. The university was dominated by three national examinations (or four, if one includes the *baccalauréat*, the final examination for secondary education): the *licence*, the *agrégation*, and the doctorate. For the letters and science faculties, the *licence* and *agrégation* were certification degrees for *lycée* (French secondary school) teachers, while the doctorate later in the century became a test of research ability demanded of faculty personnel. The difficulty, however, was that the *agrégation* was in fact required for most university positions. Consequently, the training and early careers of university teachers revolved around the needs of the *lycées*: emphasis was placed on the development of rhetorical skills and mastery of knowledge appropriate to teachers of secondary students.

[3] George Weisz, *The Emergence of Modern Universities in France, 1863–1914* (Princeton, 1983), 6.

[4] Both Durkheim and Célestin Bouglé held such fellowships. Durkheim studied with Wilhelm Wundt and Bouglé with Georg Simmel. The minister for education sent the most promising *agrégés* to study the German system and the scientific work that was being done.

[5] In the nineteenth century, the French term 'Université' embraced secondary as well as higher education. Both *lycées* and *facultés* were part of a single centralized system, controlled by the Ministère de l'Instruction Publique. In 1896, Louis Liard unified the *facultés*—which had been largely unconnected and dispersed—into institutions called *universités*. As the century progressed, the administration of the Université increasingly extended its jurisdiction to include the Collège de France, Institute de France and other institutions of research and erudition. On the development of the complex French University system in this period, see Weisz, *The Emergence of Modern Universities*.

Besides taking time away from research, national examinations rigidly defined university programs. Certain courses had to be taught because the subject matter would be tested; other offerings generally failed to attract students because they were not included in examination programs. National examinations tied the professor, in principle at least, to a rigid syllabus. They often forced academics to teach subjects far removed from their area of research specialization. Courses geared to national examinations left little time for research seminars. Consequently, professors could not train research-oriented students who might pursue problems relevant to the formation of new disciplines such as sociology. All this was exacerbated by the growth of enrollment in university programs under the Third Republic.

An obvious solution to this hindrance to research training would have been to shift the burden of national examinations. This, however, proved impossible. Professional credentials needed to be protected by objective guarantees, and university academics thought they were better placed than others to grant such credentials. Although they were a burden, national examinations were also a source of power due to guaranteed student enrollment that brought leverage when requesting larger budgets. The *baccalauréat*, for instance, was especially resented, and during the 1880s there was widespread sentiment among academics in favor of abandoning it to *lycée* teachers. Ultimately, however, university professors were unwilling to give up a responsibility that, burdensome though it might be, concentrated enormous power in their hands.

Given that the basic systemic problem could not be easily resolved, reformers searched for other ways of increasing research time. One strategy was the establishment of special research institutions, such as the École Pratique des Hautes Études (EPHE, founded in 1868), linked administratively to universities but free of all teaching responsibilities except for the training of advanced research students through small seminars and laboratory work. However, as Weisz has argued, 'the dilemma specific to French higher education was the structural inability to separate *training* for the research role from training for the liberal and teaching professions. To put it another way, except at the EPHE, French higher education was incapable of making room for a formal system of graduate studies capable of producing teacher-researchers.'[6]

University reform, unlike primary and secondary education reform, never attained widespread political support during the Third Republic. But it did have the backing of a small group of strategically placed politicians, like Jules Ferry and Léon Bourgeois, who recognized its

[6] Ibid, 212.

ideological significance. Believing that the conflicts that had afflicted France during the 19th century were the result of intellectual and religious divisions, these men looked to universities to help promote intellectual and social consensus. According to their plan, academics should be called upon to develop a system of political and moral principles based on scientific procedures to which all men of good faith could adhere—principles they would then use to train teachers, administrators, and loyal citizens, immune to all forms of political extremism. In order to pursue this vision, republican leaders appointed a new generation of administrators and gave them considerable freedom to renovate the system.[7] The period of most intense reform began in 1884 with the nomination of Louis Liard as director of higher education in the Ministry of Public Instruction.

The first post in the social sciences in France was established by Liard at the University of Bordeaux and was given to Émile Durkheim. The aim was to challenge the German monopoly on these new disciplines and, at the same time, to use higher education to foster social integration. Given the decline of religion as a unifying ideology, science was now appealed to as the basis for unifying moral and political values. Durkheim's appointment as *chargé de cours* in 'Science Sociale et Pédagogie' by a ministerial decree of July 29, 1887 was part of this attempt to pursue the 'social mission' of the University. Durkheim had impressed Liard with his republican idealism and his desire to establish a secular morality based on science.[8] Yet, while Liard was sincere in his desire to utilize universities for the purpose of social integration, it was not easy for politically motivated teaching to penetrate the system. Although it was possible to establish a new course or a chair, unless the subject found a place on the severely overloaded examination programs it would have little impact.

Strategies Going Forward

A great deal was expected of the social sciences by both the general public and the university administration, as they would, it was believed, help to restore social peace. Durkheim designed a lecture series aimed at introducing social science for students from various disciplines (philosophy, history and law) and for the public at large. He believed sociology had a fundamental role to play in forming the moral unity of the French Third Republic.

[7] Ibid, 10.

[8] Steven Lukes, *Émile Durkheim: His Life and Work. A Historical and Critical Study* (Stanford, 1985), 103.

The efficacy of his series of public lectures on this mixed audience, however, is hard to assess. According to Inspector Zeller, the audience for his lectures on social science was at first 'quite large', but then 'thinned out a lot'. The situation changed in his second year, when Durkheim enjoyed 'great success'. There were several philosophy students from the faculty of letters, as well as 'jurists, law students, [and] a few colleagues; this was quite a demanding audience', noted his nephew and student, Marcel Mauss.[9] There were also 'the stray members of the public who pack into the lecture theaters of our big provincial universities'.[10] But even degree seekers were not required to attend lectures. As Durkheim wrote of Mauss, 'He chose what seemed to him to be the most useful courses, and attended lectures only when he wished to. This was in keeping with the university's principle of academic freedom.'[11]

In his opening lecture for his social science course, Durkheim stated that there was room in the university for a science that was in the process of being created at the same time it was being taught and that the auditors of his courses were as much collaborators as pupils, who should 'join him in searching, in feeling the way, and sometimes even in wandering astray'.[12] He called for all workers of good will to join him in this effort and repeated the call the following year: 'Let us proceed as quickly as possible…let us unite our efforts and work in common.'[13] He envisioned his classroom as research laboratory and not only as a place for transmitting knowledge. He was not there to reveal a doctrine or offer ready-made solutions but to attract students of various backgrounds to sociology—he hoped philosophy, law and history students would be interested—and to educate public opinion as a whole.

Some of Durkheim's students did take a more active interest in sociology. Marcel Mauss is the obvious example, but Charles Lalo, Paul Hourticq, Marcel Foucault and Abel Aubin all displayed interest and eventually obtained their *agrégation* at Bordeaux. But all of them were still philosophy *agrégés* since the discipline of sociology did not exist independently. Although they all collaborated in the first *Année sociologique*, especially in

[9] Marcel Fournier, *Émile Durkheim: A Biography* (Cambridge, UK/Malden, MA, 2013), 110; Marcel Mauss, 'In memoriam: L'oeuvre inédite de Durkheim et de ses collaborateurs', in *Oeuvres*, iii (Paris, 1969 [1925]), 484.

[10] In 1887–8, the faculty of letters had some 120 students, including twenty or so philosophy students (thirteen degree seeking candidates and six candidates for the *agrégation*). Ibid, 91.

[11] Ibid, 131.

[12] Émile Durkheim, 'Course in sociology: opening lecture', in Mark Traugott (ed. and trans.), *Émile Durkheim on Institutional Analysis* (Chicago, 1978 [1888a]), 43.

[13] Émile Durkheim, 'Introduction to the sociology of the family', in Mark Traugott (ed. and trans.), *Émile Durkheim on Institutional Analysis* (Chicago, 1978 [1888b]), 228.

its earlier period (volumes 2–6, 1899–1903), yet, with the exception of Mauss, none of these young men remained attached to the Durkheimian enterprise for long because the pursuit of a career in the social sciences remained constrained by the absence of positions and the domination of the traditional disciplines.

A New Strategy: Create a Journal

Durkheim's great strength was his ability to draw together a team of collaborators who produced the *Année sociologique* and formed what is now known as the French school of sociology. The strong academic credentials of the *Année* team (who possessed credentials from the École normale supérieure as well as *agrégation* and doctoral degrees) set it apart from other groups with which they were in competition to found an independent sociology. It was also particularly successful in attaining posts in higher education and prestigious teaching institutions (the Faculté de lettres de Bordeaux, the Sorbonne in Paris, as well as the École pratique des hautes études). While the group was not homogeneous in its views, a case can be made that the most heterogeneous members of the initial group left as the group stabilized, and that it presented a united front to outside critiques.

The first issue of the *Année* (1898) included as collaborators, besides Durkheim himself, his nephew Marcel Mauss, Célestin Bouglé, Paul Lapie, Dominique Parodi, Henri Hubert, Paul Fauconnet, François Simiand, Emmanuel Lévy, Gaston Richard, Albert Milhaud and Henri Muffang. Durkheim had by then been promoted to *professeur de sciences sociales* at Bordeaux (June 1896)—a double promotion because he was both given tenure and the name of his chair was changed to 'social science' without further qualification (the designation 'pedagogy' was dropped, though Durkheim continued to teach those courses).[14] Lévy (doctor of law), was *chargé de cours* at the law faculty of Toulouse, Bouglé *maître de conferences* at Montpellier, Richard and Lévy were the only doctors besides Durkheim, but Richard was still waiting for an appointment, and the rest were just *agrégés*, most of them with *lycée* positions. The main common trait among the founders of the *Année* was thus the *agrégation*: this initial group contained 12 agrégés: 8 in philosophy, 2 in history (Hubert and Milhaud), one in grammar (Muffang) and one in law (E. Lévy).[15]

[14] The title of his chair would revert to 'Science of Education' when he was called to the Sorbonne in 1902.

[15] Philippe Besnard, 'La formation de l'équipe de l'*Année sociologique*', *Revue française de sociologie*, 20 (1979), 17.

The *Année sociologique* was a discipline building enterprise: it was a collective undertaking, it discussed a wide variety of material, and it organized the intellectual division of labor around a number of fields, effectively defining the discipline of sociology by its choices of authors and books. As Terry N. Clark has argued, the *Année* was far more than a journal: 'It shared many goals and performed many functions of a modern social research institute.'[16] In his preface to the first volume, Durkheim stressed that the journal was not a personal venture: 'Science, since it is objective, is essentially an impersonal matter and can develop only from collective effort.'[17] He hoped the new undertaking would help sociology move beyond its philosophical phase and take its rightful place among the sciences. Sociology had started as a form of philosophical speculation that tried to embrace all of social life in a synthetic formula. It must now turn to special research—research that demanded precision, objectivity and specialization.

Durkheim appreciated the fundamental importance of teamwork in developing sociology as a true science and moving it away from amateurism.[18] As far back as 1886, in one of his first reviews for the *Revue philosophique*, he wrote: 'sociology, like other sciences, and perhaps even more than other sciences, cannot progress without team work and a collective effort.'[19] And in 1893, in *De la division du travail social*, he explained the backwardness of social sciences as due to the fact that scholars following their 'natural [and individual] inclinations,… have remained too distant from one another to be aware of all the bonds that unite them'.[20] The 'unity of science' was indispensable to achieve true scientific progress; progress presupposed a clear realization of the collective character of all scientific enterprise, and the solidarity necessary to achieve it. Therefore, it is very likely that Durkheim started to think about ways of creating the collective dynamic necessary to truly found a scientific sociology many years before the foundation of the *Année sociologique*, and even before Durkheim met his future collaborators. Given Durkheim's ideal for sociology, much was at stake in achieving a groundwork of common ideas among the group that would produce the journal.

[16] Clark, *Prophets and Patrons*, 183.

[17] Émile Durkheim, 'Préfaces to *L'Année sociologique*', in Yash Nandan (ed.), *Émile Durkheim: Contributions to* L'Année sociologique (New York, 1980 [1898–1899]) 51.

[18] Besnard, 'La formation de l'équipe', 16.

[19] Émile Durkheim, 'Les études de sciences sociales', in J.-C. Filloux (ed.), *La Science sociale et l'action* (Paris, 1970 [1886]), 214.

[20] Émile Durkheim, *Division of Labour in Society*, trans. W.D. Halls (Basingstoke, 1984 [1893]), 306.

The general movement in European academia towards large, impersonal collaborative research exemplified by the *Année* group started in the humanities rather than in the natural sciences.[21] Examples are the large research projects of the Prussian Academy of Sciences at the end of the nineteenth century, such as the *Thesarus Linguae Latinae* or the great German historical and philological editorial projects of the nineteenth century, such as *Monumenta Germaniae Historica* and *Corpus Inscriptionum Latinarum*, founded in 1819 and 1863. These projects demanded large-scale organization, the collaboration of many specialized contributors, and needed substantial financial support.[22] They required scholarly teamwork and demonstrated the effectiveness of the division of academic labor. Big 'humanities' like 'big science' put the importance of the individual scientist or scholar into question. Enterprises like Lord Acton's *Cambridge Modern History*, with its ambition that the contributions of its different specialists should be so uniform 'that nobody can tell, without examining the list of authors, where the Bishop of Oxford laid down his pen, and whether Fairbarn or Gasquet, […], took it up',[23] sought to make its authors invisible. Acton wished for what Lorraine Daston has called 'aperspectival objectivity'.[24] The contributors should avoid 'the needless utterance of opinion, and the service of a cause'. As we will see, the *Année* group—despite their emphasis on objectivity, the division of labor, and the need of collaborative work for the advancement of science—were at work in the service of a cause.

When recruiting members for the journal, Durkheim emphasized the need for them to believe in the project of establishing an independent,

[21] As was also the case of that other innovation: the research seminar. See, on the seminar, Bernhard vom Brocke, 'Wege aus der Krise: Universitätsseminar, Akademiekommission oder Forschungsinstitut; Formen der Institutionalisierung in den Geistes und Naturwissenschaften 1810–1900–1995', in Christoph König und Eberhard Lammert (eds.), *Konkurrenten in der Fakultät: Kultur, Wissen und Universität um 1900* (Frankfurt am Main, 1999), 191–218; and Gert Schubring, 'Kabinett-Seminar-Institut: Raum und Rahmen des forschenden Lernens', *Berichte zur Wissenschaftsgeschichte*, 23 (2000), 269–85.

[22] Kasper R. Eskildsen, 'Commentary: Scholarship as a Way of Life: Character and Virtue in the Age of Big Humanities', *History of Humanities*, 1 (2016), 390. See also Rudiger vom Bruch, 'Mommsen und Harnack: Die Geburt von Big Science aus den Geisteswissenschaften', in Alexander Demandt, Andreas Goltz, and Heinrich Schlange-Schoningen (eds.), *Theodor Mommsen: Wissenschaft und Politik im 19. Jahrhundert* (Berlin, 2004), 121–41. Also, Carlos Spoerhase, 'Big Humanities: "Große" und "Großforschung" als Kategorien geisteswissenschaftlicher Selbstbeobachtung', *Geschichte der Germanistik*, 37/38 (2010), 9–27; and Torsten Kahlert, 'Große Projekte: Mommsens Traum und der Diskurs um Big Science und Großforschung', in Harald Müller and Florian Eßer (eds.), *Wissenskulturen: Bedingungen wissenschaftlicher Innovation* (Kassel, 2012), 67–86.

[23] Cited by Eskildsen, 'Commentary', 391.

[24] Lorraine Daston, 'Objectivity and the escape from perspective', *Social Studies of Science*, 22 (1992), 597–618.

scientific sociology. As he wrote to the young philosophy *agrégé* Paul Lapie, they must all agree on the need to do 'sociology sociologically', meaning 'without referring that science to something other than itself'.[25] Lapie was doubtful but responded that he granted sociology as much independence from psychology as he did to biology from physics or chemistry, and yet he believed that sociology's ties to psychology had to be affirmed. Similar exchanges would take place between Durkheim, Bouglé and Lapie all through 1897. Durkheim did his best to be conciliatory, writing Lapie that he saw 'in sociology nothing more than a *psychology, but a sui generis psychology*'.[26] Lapie was quite satisfied with this formula. A minimum consensus was eventually reached around the possibility and the need of making sociology an independent science in its object, method and theoretical conceptualization.

Interviewing a potential collaborator, a friend of Henri Hubert, Durkheim emphasized that the young man should only join the *Année* if he believed in the project and wanted to help: 'If he does not believe, it is better if he abstains; when I saw him, he did not have faith.'[27] Durkheim was willing to put work into persuading recruits to share his particular sociological views, but a broad consensus on the aims of the enterprise was a requirement, as was intellectual seriousness. As he wrote Hubert about his friend, 'I am not looking for collaborators at all costs [*quand même*]. Our common work presupposes a common faith and great mutual trust.'[28]

Durkheim thus seems quite comfortable with the seemingly 'perverse' claim that people and their virtues matter to the making and authority of 'late modern' science.[29] Despite expressing the credo of the 'impersonality' of science—the notion that science has 'nothing to do with personal characteristics and patterns of familiarity' and that it enjoys its 'special authority through *being understood* to have no such dependencies'[30]—he also clearly valued specific personal virtues such as intellectual seriousness or trustworthiness without recognizing a tension between these two statements. Durkheim repeatedly wrote that he was impressed by the

[25] Émile Durkheim, 'Documents: Lettres de Durkheim. Durkheim candidat et patron. Lettres à Parodi, Fournière, Lapie et Havet', *Revue française de sociologie,* 20 (1979), 37.

[26] Ibid.

[27] Letter of Durkheim to Hubert, April 28, 1898, in Émile Durkheim, 'Lettres d'Émile Durkheim à Henri Hubert, présentées par Philippe Besnard', *Revue française de sociologie,* 28 (1987), 495.

[28] Ibid, 494.

[29] For Steven Shapin, late modern is 'from roughly 1900 to the present'. Steven Shapin, *The Scientific Life: A Moral History of a Late Modern Vocation* (Chicago and London, 2008), xv.

[30] Shapin, *The Scientific Life*, 1.

dedication of his collaborators, which 'also puts me under an obligation.'[31] Bouglé and Lapie were 'full of ardor', 'full of devotion and very zealous'; Hubert was the most 'selfless' member of the team.[32] He writes Bouglé of the *Année* group that 'you have all shown such dedication that it would be very surprising if we cannot do something good'.[33] As Daston and others have highlighted, epistemic virtues were important to the pursuit of collaborative research both in the sciences and in the humanities. Projects that relied on the work of others required that they be knowledgeable, credible and reliable, not only internally to the group members, but also externally to the world.

Creating Sociology Through Book Reviewing

When instructing his young colleagues, Durkheim argued that there was no point in reviewing a book for the *Année Sociologique* only to itemize or describe the contents. The review had to be a theoretical contribution as well. The commentary, he said, should reflect and advance the wider agendas of the sociological discipline that they were pioneering. 'Playing the role of the sort of judge who passes sentence and rates talent', was not good enough. 'Our role'—Durkheim wrote in a preface to the *Année*—'must be to extract the objective materials from the works we are studying, namely suggestive phenomena and promising views…[F]or however slight a book's substantive value, it is a corresponding gain for science'.[34]

Durkheim gave his nephew specific, detailed instructions on how to write his reviews:

> As for the reviews, it will be necessary not only to analyze each work individually, but to develop a general plan of review [*plan d'ensemble*] in order to avoid repeating points and to present things in the most interesting form. Extricate and place all the residue in the light, everything that can be utilized, facts or ideas; in order to do that, keep to the important works. Above all do not forget that the readers are, for the most part, not aware of anything and try, without being unnecessarily lengthy and monotonous [*sans longueurs inutiles*], to dot the i's. It will be an excellent exercise for you.[35]

[31] Letter of Durkheim to Mauss, June 1897, in Émile Durkheim, *Lettres à Marcel Mauss*, presented by Philippe Besnard and Marcel Fournier, with the collaboration of C. Delangle, M.-F. Essyad and A. Morelle (Paris, 1998), 67.

[32] Letter of Durkheim to Hubert, March 1898, in Durkheim, 'Lettres à Hubert', 490.

[33] Letter of Durkheim to Bouglé, July 6, 1897, in Victor Karady (ed.), Émile Durkheim, *Textes 2: Religion, morale, anomie* (Paris, 1975), 402.

[34] Durkheim, 'Préfaces to *L'Année sociologique*', 51.

[35] Letter of Durkheim to Mauss, Bordeaux, July 3, 1897. Durkheim, *Lettres à Marcel Mauss*, 75.

The reading of the works reviewed should be constructive, positive, but at the same time critical.[36] The fact that this work was a form of training for the younger participants was made explicit, as in the letter above ('an exercise') and Durkheim saw it as preparatory to more independent and original work such as articles and theses.

Many years later, Davy explained the general effect of the reviews of the *Année*: 'Those reviews were in fact systematic: they aimed to report, not on all books, but [...] on books whose subject was of sociological interest; they aimed to bring out, often unbeknownst to the author, this interest, *thus affirming a point of view and teaching a method.*'[37] Through this work, the *Année* group was demonstrating a method of sound analysis and progressively increasing the treasury of facts and ideas available for the construction of sociology.

Durkheim and his collaborators treated reviewing and classifying their material for the *Année* as a creative task. The Durkheimians used their journal to present an overall view of the science of society as they envisaged it. One of the main purposes of the *Année* was to gradually work out the natural divisions of sociology. The classifications underwent considerable changes during the first five years of the journal. Thus, to trace the changes in the organization of the various sections of the *Année* is at the same time to trace the development in the theoretical grasp of the various areas in question. Various sections grew and others disappeared, together, in some cases, with the collaborators who supplied them.

This organizing work started from the moment of selection of books for review. Durkheim wrote Hubert about the principles that should guide their choices of books and journals in some detail: 'We are a Sociological Review not a Review of erudition. We should only highlight those works that appear to us liable to be used by sociologists.'[38] This meant eliminating all critical and exegetical literature from the reviews—such works could be mentioned in the bibliography, which should be as complete as possible. Durkheim argued that the line of demarcation between what was useful

[36] Durkheim gave Bouglé the same advice: 'Basically, it is the residue of either things or ideas—and its extent may vary—that should determine the length of the analysis...We must, don't you think, abandon the current critical practice of concentrating on the author at the expense of the book and of rating talents rather than noting the findings and their importance. When it comes to science, shouldn't rating authors be less important than rating the things (opinions or documents) we owe them?' Letter of Durkheim to Bouglé, Bordeaux, June 20, 1897, in Durkheim, *Textes* 2, 398.

[37] Georges Davy, 'Émile Durkheim: l'homme', *Revue de métaphysique et de morale*, 26 (1919), 195. My emphasis.

[38] Letter of Durkheim to Hubert, March 30, 1898, in Durkheim, 'Lettres à Hubert', 493.

for sociology and the rest would be difficult to establish at first (would 'fluctuate') but would become progressively clear over time:

> In sum, keep all the books that may be of interest for the sociologist. Among those, make a second triage and devote to those that seem sufficiently important a study of a certain length. As for the others, short notices. What is not analyzed should receive a bibliographic mention. Here are, I believe, the rules that should guide us.[39]

Unlike his contributors, who specialized in one or another domain of sociology or the social sciences, Durkheim acted as both a general coordinator and as a specialist.[40] Given that the contributors to the *Année* were dispersed throughout France in various universities and lycées, Durkheim formed the necessary link between them. The group seldom met in person as a group and some of the contributors never exchanged correspondence except through the mediation of Durkheim or, in some cases, Durkheim's nephew and 'alter ego', Mauss.

Durkheim encouraged his collaborators to specialize across a wide range, though within the framework and the methodological principles laid down in *The Rules of Sociological Method* and in various methodological notes in the volumes of the *Année*.[41] He regarded these principles as specifying the conditions for scientific and impersonal achievement. Durkheim kept firm control over the editorship of the journal, revised almost all the copy and even supervised the setting up of proofs. Davy has recorded that Durkheim would send back even the smallest reviews to their authors, with suggestions for revision and that he 'insisted on examining everything in the smallest detail'.[42] Durkheim's suggestions were often specific: shorten the article, cut the repetitions, and so on. 'I'm getting involved in the smallest details', he told Bouglé. He made certain cuts himself. He was generous with his encouragement and congratulations: 'Very lively, very interesting analysis.' 'Clear and interesting exposition.'[43]

Besnard has pointed out that Durkheim's strong editorial hand produced some tensions among the collaborators[44] and that, despite the fact that he delegated the ordering of the books for review to Hubert, he still had the books come to him [Durkheim] before passing them on to his helper, thus retaining control of the book ordering. This, however, was not due to a desire for control for its own sake, but, as Durkheim explained to

[39] Ibid. [40] Fournier, *Émile Durkheim*, 457.
[41] Lukes, *Émile Durkheim*, 293.
[42] Davy, 'Émile Durkheim: l'homme', 188. This is supported by letters to Bouglé, Simiand and Mauss.
[43] Fournier, *Émile Durkheim*, 267.
[44] Philippe Besnard, *L'Anomie, ses usages et fonctions dans la discipline sociologique depuis Durkheim* (Paris, 1987), 484.

Hubert, was due to the particular nature of the work done through the ordering of the books. As he reviewed the book orders, Durkheim would organize them into the existing sociological sub-sections of the journal and try to evaluate whether they formed a coherent enough whole or whether he needed to look for more books for that particular part of the journal. He could not do this simply by looking at the list of titles, he needed to see the books themselves. In time, he told Hubert, this task could be delegated but, for the moment, Durkheim felt the coherence of the journal depended on it too much for him to give it up: an entire process of organization and conceptualization was at stake in this task.[45] As he wrote his nephew: 'The *Année* is a whole, and that is its great merit. So someone has to look after everything.'[46] Durkheim did not yet trust his young recruit to single out books in the way he would; he had not yet acquired the particular patterns of attention Durkheim had cultivated in himself. Mauss later wrote of the *Année* that:

> In that kind of atelier, great abnegation of self is necessary. A laboratory is only good if it has a leader [*chef*], but also if it is filled with good people, that is to say, young and old people, who have work hypotheses, numerous ideas, extended knowledge, but who are above all ready to share all those in common, to participate in the work of the old [*anciens*] and to launch the work of the new [*nouveaux*], in the same way that all participate in theirs. . . . [Durkheim's] work would have been impossible, if we hadn't devoted ourselves . . . and if I did not devote myself still.[47]

The sense of participating in a meaningful collective enterprise was widely shared among the members of the group and helped them overcome various crises over the years. This ideal of common work is illustrated by the frequency of joint or unstated authorships of review articles and by the pattern of exchange of scientific principles among the Durkheimians that constituted the basis of their intellectual communion.[48] In this way, the *Année* group produced among themselves the moral solidarity they wished to see arise on a larger scale in French society. As Durkheim had argued in his doctoral thesis, the real social function of the division of labor was not economic but moral: it was to create solidarity among individuals. By making each member of the group dependent upon the others, the *Année*

[45] Letter from Durkheim to Hubert, March 15, 1900, in Durkheim, 'Lettres à Hubert', 505.

[46] Letter of Durkheim to Mauss, Friday, February 1900, in Durkheim, *Lettres à Marcel Mauss*, 253.

[47] Marcel Mauss, 'L'oeuvre de Mauss par lui-même', *Revue française de sociologie,* 20 (1979[1930]), 210.

[48] Victor Karady, 'Stratégies de réussite et modes de faire-valoir de la sociologie chez les durkheimiens', *Revue française de sociologie*, 20 (1979), 49–82.

had made them 'an integral part of the whole…'[49] In *Suicide*, Durkheim had advocated for the creation of professional groups that would be intermediaries between the individual and the state and produce meaningful connections among their members. The *Année* generated—on a small scale—the kind of community united by significant (and attainable) goals that Durkheim envisaged. Durkheim hoped it would have an impact upon a broader public as well: 'The sight of a group of workers with a common purpose and working towards the same goal will be a spectacle of considerable interest.'[50] 'It could have a considerable moral effect.'

Initially, Durkheim's extensive work of editing gave form to the style of professional review writing of his collaborators. Just as aspiring scientists first honed their skills by repeating exercises that were part of the repertoire of their discipline, the young members of the *Année* developed certain habits of mind by working at book reviews before taking on original articles for the *Année*. Durkheim encouraged and directed the research work of his younger teammates, providing them with guidance in creating original articles in the field of sociology, offering models of scientific research in the field, and helping them obtain academic appointments, as we shall see below. Much of this guidance was offered via correspondence due to the physical dispersal of the *Année* group but there were periodic meetings among members of the inner circle, when Durkheim visited Paris, for example, or when he invited members of the group to stay at his home in Épinal during the summer academic vacations. Later, the 'inner' members of the team, such as Mauss, increasingly took on training and professionalizing roles themselves.

Another Aspect of the Strategy: Original Papers

The *Année* was fundamental in establishing the research and publication credentials of its participants—a central aspect of the project to reform higher education and professionalize its faculty. Durkheim's letters to his younger *Année* collaborators reveal his great concern that their personal work would suffer due to the weight of the collective work of reviewing material for the journal. Durkheim was acutely aware of the increasing importance of the doctorate and of publications for a successful academic career, and advised his collaborators accordingly.[51] As he wrote Mauss, 'I reckon that we must produce, that we will only count to the extent that

[49] Émile Durkheim, *De la division du travail social,* 6th ed. (Paris, 1932[1893]), 394.

[50] Letter of Durkheim to Mauss, April 10, 1897, in Durkheim, *Lettres à Marcel Mauss,* 54.

[51] Karady, 'Stratégies de réussite', 81, used the growing size and later age of defense of dissertations as an indicator of this greater importance of research.

we produce, and that we must head in that direction.'[52] The *Année* contained not only an annual survey of all works that could be seen as pertinent to the construction of sociology, but also original papers (*Mémoires originaux*) that contributed directly to this construction—and to the publication record of the contributors.

Durkheim worked in collaborative manner not only on the *Année* reviews, but on his own books and articles and those of his team members. The most intense example of this collaboration was his relationship with his nephew. As Mauss wrote later, 'I have perhaps worked too much in collaboration with others…I contributed to Durkheim's *Suicide* (quantitative method, classifying 26,000 suicides individually arranged on cards and distributed in 75 cases). I worked on everything he wrote as he also did with me; often he even rewrote entire pages of my work. I published two monographs with him, including *Primitive Classification* in which I provided all the data.'[53] Mauss also had an intense collaborative relationship with Hubert, of which Durkheim was also sometimes a part. In Mauss's words: 'With Hubert, I published a monograph on *Sacrifice* and another on *Magic*, and the preface to our *Mélanges*. Generally, I took part in everything which he did which was not strictly criticism or archaeology. He always read over everything I wrote.'[54]

Mauss, Hubert and Durkheim were all involved in writing the essay on *Sacrifice*, whose creation can be followed through their correspondence. Hubert and Mauss worked on the plan, exchanged index cards, discussed various points, added information and corrected drafts. They were learning to work together. Durkheim inserted himself in their collaboration, writing his nephew: 'Once done with the research, you will quickly write a draft which you will send me […]. In a short time, I will see what corrections or remarks are necessary, *desiderata* of all sorts. I think I have an aptitude for this job of patching, which is at bottom my old job as a professor.'[55] Mauss completed the very last version; he and Durkheim only had time to send Hubert 'those passages in which we are afraid we might have disfigured your thought'.[56] Durkheim made some last minute changes: 'I have tried to get inside your minds. If I've distorted your argument, I have done so quite unintentionally. But it's only a matter of detail.'[57]

Similar working arrangements between Mauss and Hubert continued over time. Sometimes they resented Durkheim's editorial intervention.

[52] Letter of Durkheim to Mauss [1899], cited by Fournier, *Marcel Mauss* (Paris, 1994), 138.
[53] Mauss, 'L'oeuvre de Mauss par lui-même', 140–1. [54] Ibid, 141.
[55] Letter of Durkheim to Mauss, n.d. [1898], cited by Fournier, *Marcel Mauss,* 156.
[56] Letter of Mauss to Hubert, Épinal, n.d., [1898], Ibid, 157.
[57] Letter of Durkheim to Hubert, 8 February 1899, in Durkheim, 'Lettres à Hubert', 500.

Writing to Mauss about their 'General theory of magic' article, Hubert wished he and Mauss had been able to collaborate more closely and criticized Durkheim's interference with their work: 'I believe that our collaborative work would have been better without Durkheim's revisions, as they seem to me to exaggerate the flaws in our own work.'[58] But, over all, they felt they gained from each other's expertise and interventions. Hubert, the historian, countered Mauss's philosophical tendencies towards abstraction and warned him against formulas and clichés. Durkheim kept Mauss, who tended to be overly ambitious and late in completing all projects, on task. Durkheim claimed to be 'charmed' to 'collaborate with you two'.[59] In fact, Durkheim was pleased with his interactions with all *Année* collaborators: 'My relationships with my collaborators have been very pleasant for me and I have found in them all a very touching devotion to the communal project [*chose commune*].'[60]

The Durkheim-Hubert-Mauss 'trinity'[61] was not the only active collaboration in the *Année*. Mauss also wrote, for instance, a defense of sociology in *La Grande Encyclopédie* with Fauconnet, 'aided by Durkheim.' The fruit of their collaboration was ultimately subdivided into three articles; the original encyclopedia article comprised less than a third of all they wrote. A second part was published under Fauconnet and Durkheim's name in the *Revue philosophique* (1910) as 'La sociologie et les sciences sociales.' The third part, 'Les divisions de la sociologie', was to have been published under their three names, but was lent out for a while, misplaced, and later rediscovered by Mauss (1938).[62]

The homogeneity of the group has been a subject of debate among historians of sociology. From the perspective of insiders to the group, the 'Durkheimians' were loosely integrated. As Durkheim wrote to Bouglé, 'it is neither necessary nor desirable that everyone should adopt exactly the same formula'.[63] Davy wrote of the 'clan of the *Année sociologique*', whose unifying spirit Durkheim 'created and maintained…without the least tyranny, leaving each to his entire liberty. He exerted influence only through the immense superiority of his mind and his method. Everyone liked to go and see him and, while receiving his advice, experience the affectionate interest he had for all. But there were no committee meetings, no gatherings, no watchword'.[64]

[58] Letter from Hubert to Mauss, 1905, cited by Fournier, *Émile Durkheim*, 454.

[59] Letter Durkheim to Mauss, beginning of January 1898, in Durkheim, *Lettres à Marcel Mauss*, 100.

[60] Letter Durkheim to Mauss, Bordeaux, December 22, 1897, in Ibid, 97.

[61] Letter of Durkheim to Hubert, January 9, 1901, in Durkheim, 'Lettres à Hubert', 512.

[62] Fournier, *Marcel Mauss*, 243.

[63] Lukes, *Émile Durkheim*, 294.

[64] Davy, 'Émile Durkheim: l'homme', 195.

The original *Année* group included several distinct factions: a sizeable sub-group headed by Bouglé (Bouglé-Lapie-Parodi) that had significant intellectual differences with Durkheim (having criticized him in print in the 'Année' rubric of the *Revue de métaphysique et de morale*, and, in the case of Bouglé, in his *Les sciences sociales en Allemagne*); an important but isolated contributor in Richard, who was also critical of Durkheim at times; and a significant subgroup of young men connected to Durkheim through Mauss, who would eventually become the core animators of the journal.

Outsiders, however, viewed the group as having a unified doctrine and were critical of it.[65] Alfred Espinas, for example, saw the group as a 'militia' and a 'secret society' which 'used its mysteries to conceal its ambitions' and operated with 'its police, its reports, its admissions, its white and black lists'.[66] But insiders, such as Bouglé, who had not been trained by Durkheim, as was the case of younger members of the group such as Davy, also saw the group as united around an ideology he did not share. In letters to his friend Halévy, Bouglé called the group formed by Mauss-Durkheim-Hubert the 'tabu-totem clan' and the 'United Sociological Party.' Bouglé and his friend Halévy were critical of what they saw as the excessive importance given to primitive religion (and religion in general as 'playing a capital role in social life'[67]) in the *Année*.

Bouglé had particular trouble with his book on castes, which he had sent to Durkheim, who passed it on to Mauss for review. Durkheim had a lot of criticisms of Bouglé's manuscript, generally around what he saw as Bouglé's insufficient expertise on India and its caste system and the lack of attention given to the religious aspects of the institution of castes. Mauss added a series of detailed comments of his own, intercalating a page of comment to every page of Bouglé's text.[68] Durkheim noted that Mauss's letter to Bouglé 'at my insistence, made a lot of demands'. Durkheim refused to publish the book in the new 'Travaux sociologiques' collection of the *Année*: 'I am not prepared to give it my seal of approval.'[69] At first Bouglé resisted the demands, but he eventually gave in and corrected his

[65] For example, Henri Berr, 'Le progrès de la sociologie religieuse', *Revue de synthèse historique*, 12 (1904), 43; *Revue de métaphysique et de morale*, 1904.

[66] Quoted in Hubert Bourgin, *L'École normale et la politique. De Jaurès à Léon Blum* (Paris, 1938), 91

[67] Émile Durkheim, 'Letter to the director of the *Revue néo-scolastique*', in Durkheim, *The Rules of Sociological Method and Selected Texts on Sociology and its Method*, ed. Steven Lukes and trans. W. D. Halls, (New York, 1982 [1907]), 259–60.

[68] Fournier, *Émile Durkheim*, 526–7.

[69] Letter of Durkheim to Mauss, October 1, 1907, in Durkheim, *Lettres à Marcel Mauss,* 387.

manuscript sufficiently to make it acceptable to Durkheim. It was then published as the first volume of the new collection.

Bouglé never left the group but became more peripheral over time, as was the case of all those who could not fully embrace the research program and views of the 'inner circle'. The *Année* team moved toward greater intellectual unity from its inception until the end of the period considered here, 1914. While they may not have adhered to a single 'formula', the collaborators became less eclectic as time went on and a stronger, more cohesive team formed mostly by former students of either Durkheim or Mauss emerged. Durkheim's own views can be gleaned from this letter to Simiand, to whom he writes that the original articles of the *Année sociologique* should be

> . . . our work or the work of people still entirely in agreement with us. . . . This last principle seems to be altogether excellent. I have no need to tell you how much it has cost me to publish certain things. I did it in the first place because at the beginning I did not dare to hope for the friendly [intellectual] homogeneity that has been established amongst us, and because I only thought of making the *Année* a collection, into which the only qualification for entry would be scientific honesty. I acted in this way because there was no means of acting otherwise. But it is clear that this eclecticism, however limited it may have been, harms the impression of the whole. I might add that in what has been published, *it is only what comes from us that is of value.*[70]

Placing Group Members in Faculty Positions

Part of the *Année* group's success was due to its capacity to bring people into the group and to eventually place them in prestigious academic or research positions.

Marcel Mauss arrived in Paris in 1895 and remained an important resource, obtaining information, borrowing books, visiting other academics on his uncle's behalf and acting as a 'recruitment agent' for the *Année*, until Durkheim's arrival in Paris in 1902. Having completed his philosophy *agrégation* under his uncle's direction, Mauss turned to the study of religions on his advice. Rather than going directly into secondary level teaching, Mauss decided to enroll at the EPHE, where he signed up for the fourth and fifth sections (historical sciences and philology, and religious sciences, respectively). Mauss's choice was decisive for both nephew and uncle, as Durkheim was to find supporters and collaborators amongst Mauss's teachers and friends. The EPHE had a decisive influence

[70] Letter to Simiand, 15 February 1902. Quoted by Lukes, *Émile Durkheim,* 295. My emphasis.

on the birth of sociology in two ways. In intellectual terms, it made possible the study of religions of 'primitive' peoples, and in social terms, it led to the creation of a multidisciplinary research environment that welcomed the new discipline. Many important members of the *Année* team were part of the EPHE, including Hubert, Antoine Meillet and Robert Hertz.

In 1901, the deaths of two professors at the EPHE opened positions for both Mauss and Hubert. With the support of Sylvain Lévi and Durkheim, who provided references and advice, they were both successful in their candidacies. Durkheim interceded with various faculty members and even with the director of higher education. This set a pattern that was often repeated on behalf of other members of the *Année* group, who mobilized their contacts to place their own in academic positions. When Durkheim was promoted to the Sorbonne from Bordeaux, the team immediately strategized on how to fill his vacant position, which went to Gaston Richard, nominated *chargé de cours*. He was promoted to the rank of professor of social sciences in 1906, releasing the position of *chargé de cours*—the chair originally created for Durkheim—to Paul Lapie. In the same way, when Bouglé was promoted from a chair in social philosophy in Toulouse to the Sorbonne,[71] Durkheim, Bouglé and Lévy-Bruhl orchestrated a strong campaign to have Paul Fauconnet appointed—which succeeded, despite his not having completed his doctorate.[72] Durkheim and his associates were consolidating their position in academic circles and the intellectual field. Their journal dominated the social sciences and a new generation seemed poised to continue and take over from the founders.

Sociology, however, remained a subspecialty of philosophy. The academic legitimacy of Durkheimian sociology was heavily dependent on the approval of the philosophical establishment—a situation that resulted in sociology's failure to fully institutionalize itself. Durkheim's efforts to advance sociology were both furthered and crippled by his membership in the philosophical profession. He recruited his collaborators, to a large extent, from the ranks of philosophy *agrégés*. The academic credentials of the *Année* team opened to them prestigious journals and societies where they could propound their sociological views. Durkheim's choice of centering sociology upon themes that were traditionally part of the self-definition of philosophy (such as social morality or the categories of thought) was both a result of his (and his collaborators') philosophical background and a factor in maintaining sociology inside the field of

[71] To a chair of history of social economics, which had been Espinas's, created by an endowment of the Comte de Chambrun.

[72] Fournier, *Émile Durkheim*, 516.

philosophy. The privileged position of Durkheimian sociology as the accepted interlocutor of philosophy produced the exclusion of other competing sociologies from academia, such as that of René Worms and the *Revue internationale de sociologie*; but Durkheimian sociology remained locked in a dialectic of definition by opposition with philosophy—and thus dependent upon it.[73]

As I outlined in my introduction on the university system in France, there were not many possibilities open to the Durkheimians in creating a new discipline. Individual chairs could be created or renamed given sufficient administrative support, but the institutionalization of training for research remained difficult in a system geared towards the preparation of secondary school teachers and the perpetuation of a series of national examinations. The would-be sociologists were forced to go through a double training, becoming *agrégés* in philosophy or another discipline (history, law) and pursuing their sociological training as a sideline under the guidance of one of the few mentors available. Hubert and Mauss eventually developed courses that trained students in the study of ethnography and religion at the EPHE, but the future of all these graduates could not be guaranteed by sociology itself, which remained without a clear career path. The only clear career path open to them was that offered by their previous training in the traditional disciplines, which allowed them to obtain *lycée* positions. Most of the successful members of the group worked their way from jobs in secondary education to more specialized positions later in their careers.

In 1907 there was a crisis in the *Année* that was symptomatic of the contradictory pull between traditional faculty positions and a shared research agenda, in which the members of the group were almost unable to meet the deadline for the current issue of the journal. Durkheim himself had already been periodically overwhelmed trying to fulfill his teaching and other duties and directing the *Année*. As the other members of the group in turn attained teaching positions, they experienced the same stresses. Bouglé called the journal 'the Sociological Olympiad' and Fauconnet complained about how much of their time was taken up by the work of reviewing. This crisis highlights the structural problem of a university system that required—for the acquisition of academic legitimacy

[73] The dependence was mutual, although sociology was certainly the weaker member of the partnership. See Pierre Bourdieu, 'Le champ scientifique', *Actes de la recherche en sciences sociales*, 2–3 (1976), 88–104, on the complicity of antagonists inside a scientific field. For the interdependence of Durkheimian sociology and academic philosophy, see Daniela S. Barberis, 'Moral Education for the Elite of Democracy: The *classe de philosophie* Between Sociology and Philosophy', *Journal of the History of the Behavioral Sciences*, 38 (2002), 367.

and power—the attainment of faculty positions whose teaching and other requirements made it impossible for the newly minted faculty to pursue their research agenda at their former pace. This crisis was resolved by the separation of the reviews and the original articles into two separate publications and by publishing the reviews only every three years (1910 and 1913). The pace of the *Année* was slowed, but the work went on. A younger set of contributors—Bourgin, Halbwachs, Bianconi and Hertz—who worked on volume ten, gave the journal a new impetus. The 'old hands' were very pleased, as Fauconnet wrote to Mauss.[74] Sociology seemed well on its way toward the achievement of academic institutionalization: important positions in Paris and in provincial universities (Bordeaux, Toulouse) were occupied by members of the group; it had a significant presence in the most prestigious research institutions (EPHE) and a new generation was in training. The future seemed bright.

Although the Durkheimians had gained the upper hand over other competitors who did not reach academic 'canonization', the fragility of their approach was revealed by the carnage of the Great War. Many of the best and brightest died,[75] including Durkheim's son, André, soon followed by his heartbroken father, Hertz, David, Bianconi, Reynier and others. Mauss remained, an ambivalent heir to the enterprise.

With the death of the *Année* participants, chairs reverted to other disciplines and it was difficult to maintain the sheer amount of work required to continue the *Année* in its previous form. The tension between faculty positions and research work noted above meant that research work inside this system required abnegation—large amounts of work received little formal academic reward—but there were no alternatives to this approach. In the interwar years, the leading members of the *Année* branched out beyond sociology and exerted widely recognized and significant influence over many fields: the French ethnological school of Marcel Mauss; the historians of the *Annales d'histoire économique et sociale* led by Marc Bloch and Lucien Febvre; the comparative studies of Indo-European mythology of Georges Dumézil; the structural anthropology of Claude Lévi-Strauss, and others.[76] But despite the considerable and continuing intellectual prestige of Durkheimian sociology, by the middle of the twentieth century, French sociology had almost disappeared as a discipline.

North Central College

[74] Quoted by Fournier, *Émile Durkheim*, 530.

[75] Over half of the students in the class that entered the École Normale in 1913 were killed, as were eighteen of the class of 1911. See Clark, *Prophets and Patrons*, 209.

[76] See Alice L. Conklin, *In the Museum of Man: Race, Anthropology, and Empire in France, 1850–1950* (Ithaca and London, 2013); Simonetta Falasca-Zamponi, *Rethinking the Political: The Sacred, Aesthetic Politics, and the Collège de Sociologie* (Montreal and London, 2011).

7

Shaping the Unruly Statistician

Theodore M. Porter

In his *Grammar of Science*, first published in 1892, Karl Pearson emphasized that accurate classification of facts was the first step of scientific method.[1] He was just beginning at this point to think of himself as a statistician, and of scientific method as closely linked to statistics. A case could be made for Pearson as the first modern statistician, yet his field has always been heterogeneous, even ill-defined, resisting any neat definition. What Pearson may have founded was a mathematical field. *Statistics* had already been around under other definitions for more than a century. He could be quite critical of these predecessor forms of statistics, yet he did not want to sacrifice any of their breadth.

Even if we ignore the etymology of this *state-istics* and insist on a definition in terms of quantified knowledge, the *statistician* remains an elusive quarry. Only since the 1930s has it been reasonably possible to take an advanced degree in this kind of statistics. Meanwhile, many practitioners have focused their study on one or more substantive disciplines including social science, astronomy, economy, demography, natural history, psychology, evolutionary biology, and eugenics, where much statistical teaching also has taken place. The work of official statistics, most notably the census, cannot be neatly excised from this field, since it draws heavily on mathematical tools of data preparation. Much of the work of statistics consists of service to other disciplines such as medicine, engineering, and business. There can be no neat history of the professional training of statisticians except one that is oversimplified to the point of falsehood. This essay addresses statistics as the foundation for a broad ecology of enumeration, inference, and measurement.

This paper departs in several respects from the classic story of the nineteenth-century German university, which first made science and scholarship into the basis for a career. Pearson in 1892 remained a

[1] Karl Pearson, *The Grammar of Science* (London, 1892), 8.

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fervent advocate of this German ideal, which treated the inculcation of research ideals through close study of a particular subject as a form of self-cultivation. In practice, it ordinarily led to disciplinary specialization. While the Germans were not alone in sharpening their focus on discipline-based knowledge, the new research university provided an environment for a more systematic specialist training. Yet the university ideal could never have survived if it had been simply inward-looking. Quite apart from their general role as a marker of class and culture, advanced degrees were linked to a variety of careers. Studies involving ancient languages or mathematics, for example, were integral to the preparation of *Gymnasium* (secondary school) teachers. In the natural sciences, and especially in technological fields, training at universities led also to research positions in private industry. Later in the century, university research institutes in fields like chemistry were often devoted to industry and technology more than to education. The higher faculties of law, medicine, and theology trained students for professional roles and generally shunned the focus or narrowing required by a research specialty. Research and training in practical fields, including engineering, mining, and agriculture, resembled the professions in being organized to serve clients or businesses of various sorts, and only secondarily to cultivate new knowledge in a discipline.[2]

Statistics, whether as a substantive or as a methodological study, is especially difficult to pin down. It was originally understood as an empirical science of the state, and in that form it was practiced by scholars and state officials beginning in the eighteenth century. In the 1830s and 1840s, as its object shifted from the state to society and economy, it was more and more limited to social numbers. By the 1850s, however, a few were saying that it was properly defined by its reliance on numerical methods, which happened to apply especially well to the science of society. This emerging sense of statistics as a form of quantitative reasoning points to the continuity between the mathematical field of statistics and its political and administrative forms. In practice, nineteenth-century statisticians were overwhelmingly associated with bureaucratic agencies for recording population, trade, education, crime, poverty, migration, mortality, and madness. To the end of the century, most statisticians (*statists* in English) were still reluctant to let their enterprise be redefined as an auxiliary science—in German *Hilfswissenschaft*—or aid to other sciences. This tension was never resolved. Since about 1900 there has been a scientific field of statistics, defined mainly in mathematical and methodological terms, overlapping with, but mostly distinct from public or official statistics,

[2] R. Steven Turner, 'The Growth of Professional Research in Prussia, 1818–1848: Causes and Context', *Historical Studies in the Physical Sciences*, 3 (1971), 137–82.

which continues to be carried out principally in state agencies or by scholars concerned with state and economy.[3]

Even this wide formulation ignores some of the most interesting aspects of the statistical sciences. Whole industries have grown up around certain statistical tools. These include insurance, various forms of probabilistic modeling, randomized experiments, industrial quality control, regressions (much favored in econometrics), estimations, and the whole world of social surveys from social-science research to political polling and marketing surveys. And still we barely scratch the surface. Currently there is a move afoot to rebrand statistics as data science, which would be more inclusive and less focused on classically scientific endeavors.

Statistics, as an area of mathematics, has been extraordinarily fruitful for the sciences. It was, however, never an unmoved mover. The concepts and techniques of statistics, from error theory and correlation to stratified sampling and analysis of variance, grew up in interaction with natural and social sciences. In practice, the mathematics has never been cleanly separable from its uses. While researchers certainly do sometimes apply statistical methods in ways that are detached from their own disciplinary affiliations, the usual practice is for graduate students to learn their basic statistical methods from courses and textbooks devoted to their own academic field. Perhaps every important statistical tool or problem has a history reaching back to a time before there was any such thing as mathematical statistics. That is, the history of the creation and transmission of research methods in statistics is a highly variegated one. Only in a very loose sense has it been the story of a discipline.

Learning on the Job

Many of the formal tools of statistics can be linked to techniques of aggregating, correlating, handling residuals, and planning experiments. A wide range of problems like these had arisen already in the early modern period, and if they were not marked off as a specific category of problems, the researchers at least were learning from one another's examples. The method of least squares, developed in astronomy and geodesy to calculate a best value from a swarm of measurements and to estimate the bounds of error, was formally articulated in the first decade of the nineteenth century.

[3] Historical studies of these two sorts of statistics were mostly oblivious to one another for a long time, but are brought together in different ways in Theodore M. Porter, *The Rise of Statistical Thinking, 1820–1900* (Princeton, 1986); Ian Hacking, *The Taming of Chance* (Cambridge, 1990), and Alain Desrosières, *The Politics of Large Numbers* (1993), trans. Camille Naish (Cambridge, 1998). There is by now an extensive scholarship on these questions.

Before long there were textbooks, and least squares became as fundamental as telescopes and thermometers to the work of observatories.[4] The practices of social statistics were less precisely articulated and were communicated mostly in a less formal way. Government bureaus concerned with population, trade, health, crime, and the like typically put out numbers without revealing much about their methods. The work, however, was labor-intensive, and special forms of expertise inevitably developed within the offices. For example, medical statistics on the results of smallpox inoculation and vaccination were recorded and shared within networks of doctors, who also discussed and debated their methods. Life insurance actuaries, some of whom made astronomical observations in their spare time, shared data techniques with one another and eventually organized actuarial societies. The Statistical Society of London, founded in 1834, provided a meeting place and a journal for a variety of statistical compilations. It also was a model, perhaps unneeded, for related organizations at home and abroad, some bearing the name *statistics*, others not. An American Statistical Association was organized in Boston in 1839 and, like the English society, has a continuous history up to the present. Until at least 1870, such organizations were much more interested in getting data to guide social reform than they were in working out methodologies of statistical reasoning. But often enough they did not agree, and dissent provided an excellent stimulus to rouse these social quantifiers from their empiricist slumbers.[5]

As early as 1785, M. J. A. N. Condorcet and Pierre-Simon Laplace deployed serious mathematics to calculate probabilities of correct judicial decisions in relation to the size of the jury, on the assumption of a fixed probability that each juror would decide correctly. Siméon Denis Poisson continued the work in the 1830s using official data from French courts. The Belgian observatory director Adolphe Quetelet was almost unique among state statisticians in seeking to understand tabulated numbers of births, crimes, and marriages in relation to mathematical probability. His 1835 book *On Man*, subtitled *Essay on Social Physics*, achieved a considerable reputation, especially for its insistence on natural laws of social behavior and in relation to questions about human free will. He also took a lead role

[4] Stephen M. Stigler, *The Seven Pillars of Statistical Wisdom* (Cambridge, 2016); Stigler, *The History of Statistics: The Measurement of Uncertainty to 1900* (Cambridge, 1986). See also James Franklin, *The Science of Conjecture: Evidence and Probability before Pascal* (Baltimore, 2001).

[5] Andrea Rusnock, *Vital Accounts: Quantifying Health and Population in Eighteenth-Century England and France* (Cambridge, 2002); Michael J. Cullen, *The Statistical Movement in Early Victorian Britain* (Hassocks, 1975).

in the organization of Belgian statistics, both as savant and administrator. He construed the statistical bureau as a social observatory.[6]

Quetelet had in mind the enlightenment of the public as well as effective state management. The statistical office and the observatory were for him, nodes in an apparatus of quantitative research. He wanted to make the academy into a site of collective research, focusing on periodic phenomena. His topics ranged from motions of the planets, seasons, and blooming times of plants to cycles of human activity as revealed by statistics of birth, death, crime, and suicide. It was definitely statistical, at least in the anachronistic sense of being based on abundant data collection. Quetelet's effort to make his academy into an instrument of the research he favored required that it function also as a training ground for quantitative science. This point emerges clearly in his *éloges* for deceased Belgian academicians, summed up in the history he wrote of 'mathematical sciences' at the Belgian Academy.[7]

These efforts, however, were less about statistics as a distinct field of knowledge than about a style of research that extended well beyond it. Medical statistics was more amenable to systematic application as expert knowledge. Jules Gavarret in 1840 had applied Poisson's basic formula to determine whether the difference in outcomes associated with a treatment under investigation could with sufficient assurance be attributed to its genuine efficacy rather than to random fluctuation. A considerable number of German doctors, most of them practicing in insane asylums, subsequently used this formula of Poisson's. While this seems to attest to the openness of these doctors to basic probability theory, I am aware of no evidence that it was ever taught as part of a medical curriculum.[8]

There were professors of *Statistik* in Germany going back to the eighteenth century. While it stretches things somewhat to call this study a discipline, it was taught in universities, sometimes under its own name and sometimes as an aspect of cameralism—the study of economic affairs in relation to the management of state budgets. A related study, political economy, appeared there in the early nineteenth century as a field of study, typically as an alternative and rival to law as the study best fitted to the formation of state officials. Economic study typically included some

[6] Charles Gillispie, 'Probability and Politics: Laplace, Condorcet, and Turgot', *Proceedings of the American Philosophical Society*, 116 (1972), 1–20; Loraine Daston, *Classical Probability in the Enlightenment* (Princeton, 1988); L. A. J. Quetelet, *Sur l'homme et le développement de ses facultés, ou Essai de physique sociale* (Paris, 1935). Joseph Fourier had earlier written in a census volume on the mathematics of population; see Porter, *Rise of Statistical Thinking*, 97–8.

[7] Quetelet, *Histoire des sciences mathématiques et physiques chez les Belges* (Brussels, 1864); Porter, *Rise of Statistical Thinking*, 40–55.

[8] J. Rosser Matthews, *Quantification and the Quest for Medical Certainty* (Princeton, 1995); Theodore M. Porter, *Genetics in the Madhouse: The Unknown History of Human Heredity* (Princeton, 2018), 185, 302.

statistics, and both fields were sometimes included as topics within *Staatswissenschaft*, state science, which appeared on the scene under that name in the 1820s. These complex and rather fussy details are of secondary importance here, apart from the general point that statistics was being taught at universities, mostly for pragmatic reasons and without depending on a clear disciplinary status. The institutional and historical form of political economy that achieved dominance in Germany by 1870, mainly under the name *Nationalökonomie*, was as devoted to statistics as to history, and dismissed the individualism of English political economy as merciless *Manchestertum*. By then, economy had a clear disciplinary status, including many university chairs, yet its orientation in Germany was pragmatic and applied rather than scientific.[9]

The first systematic program of statistical education arose in a similar milieu, yet one still more bound up with official, administrative statistics. Ernst Engel, who came to Berlin from Saxony, had been trained in chemistry and mining. One of his first actions as head of Prussian statistics was to negotiate the creation of a Statistical Seminar. It began in 1862 with just eight students, but by 1872, in the aftermath of German unification, it had grown to 32 students. The course was designed for statisticians within the Prussian state, and subsequently in other German ones, and was part of a strategy to upgrade and harmonize statistical procedures. His own revision of techniques for taking a census and sorting and tallying the results was much admired in Prussia and beyond. His reform effort began with a shift from registering families in books, one line per family, to recording each individual separately on a data card. The new system greatly facilitated the process of sorting individuals and converting the results into diverse forms of tables, sometimes with several variables along the rows and columns of a single table. One very practical aim of his seminar was to bring statistical practices in different ministries into line with the census office. He tolerated, to a degree, visitors from outside of Germany, but the seminar was not mainly for them. While it was connected to university teaching in the state sciences, the seminar was for civil servants, not university students—at least not until they crossed over the line from university to state administration.[10]

[9] Andre Wakefield, *The Disordered Police State: German Cameralism as Science and Practice* (Chicago, 2009) presents a cynical view of the eighteenth-century cameralists; David F. Lindenfeld, *The Practical Imagination: The German Sciences of State in the Nineteenth Century* (Chicago, 1997) give a much more appreciative view of the nineteenth.

[10] Michael C. Schneider, *Wissensproduktion im Staat: Das königlich preußische statistische Bureau, 1860–1914* (Frankfurt, 2013), 131–56; Morgane Labbé, 'Institutionalizing the Statistics of Nationality in Prussia in the 19th Century', *Centaurus*, 49 (2007), 289–306; Christine von Oertzen, 'Machineries of Data Power: Manual versus Mechanical Census Compilation in Nineteenth-Century Europe', in Elena Aronova, Christine von Oertzen, and David Sepkoski (eds.), *Data Histories*, *Osiris*, 32 (Chicago, 2017).

Engel liked to compare his statistical seminar with a chemistry laboratory. It would be rash to dismiss his claim out of hand. The work of the census, especially under Engel, was closely tied to economic and social research on vital topics such as ethnicity, labor, poverty, health, and social insurance. The scholarship on Engel's seminar, unfortunately, includes much more about his negotiations to set up administrative and funding arrangements than on what sort of educational program he developed. Georg Knapp, nephew of the great chemist Justus Liebig, was among the rather few statisticians of his era who had mathematical training. It is possible to trace the evolution of a mathematical form of state statistics in central Europe and Russia, often involving the movement of mathematicians into this social field.[11] Engel's seminar, however, was not a site of mathematics. Reflecting back on his own experience in the seminar in 1865 and 1866, Knapp recalled approvingly the social instruction, and at the same time spoke mockingly of students for whom a simple logarithm was treated as if secured by seven seals. Yet it is evident that Engel's statistical seminar belonged to the culture of the German university, whose commitment to research and to science could assume a wide range of forms.[12]

Statistics Was a British Science? Biometry and Statistical Mathematics

The nineteenth-century predecessors of what in the following century became a mathematical field of statistics appears idiosyncratic to the point that no explanation in terms of broad disciplinary developments seems at all promising. Quetelet wanted to see the astronomical and meteorological work of the observatory integrated with census tallies and with tables of social phenomena such as crimes and suicides. Francis Galton worked on his own for decades on the presumed transmission within families of exceptional talents, and subsequently on statistical patterns of inherited size in peas and then people. Karl Pearson set out to build a discipline in a way that his predecessors had not, but he, too, depended on assembling a statistical edifice out of highly disparate elements. It appears quite different from the systematic programs of disciplinary training that were so successful in German philology, chemistry, and mathematics.

[11] Porter, *Rise of Statistical Thinking*, chap. 8; Martine Mespoulet, *Statistique et revolution en Russie: Un compromise impossible (1880–1930)* (Rennes, 2001).

[12] Schneider, *Wissensproduktion*, 131–2; Georg Friedrich Knapp, *Aus der Jugend eines deutschen Gelehrten* (Stuttgart, 1927), 154.

It could well be that the less consolidated disciplinary structures of Britain brought more advantages than liabilities for building up a new field of statistical calculation, modeling, and inference. As it happens, the most mathematical among German statisticians, such as Wilhelm Lexis and, later, Wilhelm Weinberg, also worked in a relatively independent way. At the same time, none of these statisticians-in-the-making, not even the English ones, were truly independent. Instead, they drew on the materials and formulations of diverse scientific inquirers working in such fields as medicine, agriculture, insurance, and psychology (or psychophysics), each with its own statistical practices. Researches on these topics had considerable value for the emerging biometric school. Galton already was recruiting allies and mobilizing data from experts in these fields in the 1870s. Around 1900, as Pearson rose to prominence, specialists on mental illness, learning disabilities, criminality, and the like quickly recognized the significance of his work for what they were doing. Many took the initiative to contact him, sometimes even before he had learned of their data and expertise.[13]

Still, the English biometricians played a crucial role in shaping statistics as a mathematical field. Even Ronald Aylmer Fisher, who took his undergraduate degree in 1912, faced a world with no established curriculum and no recognized career track for a statistician. It cannot be a coincidence that Galton, Pearson, and Fisher all studied at Cambridge University. All three underwent an intense training oriented around a celebrated mathematical competition, the Tripos. From the standpoint of a mathematician on the European continent, Tripos mathematics seemed more like mathematical physics or applied mathematics. It worked very well, however, as the basis for a career in statistical mathematical sciences. Its focus was not on rigorous proofs, but on solving problems. Anyone who hoped to have a chance of excelling in this competition had to sign up with an experienced 'coach', who drilled the students relentlessly on material relevant to the exam. There was some consistency of style over the seven decades separating Galton's study at Cambridge from Fisher's, even if the specific content was transformed almost completely.[14]

Their mathematical strengths were quite different. Galton suffered a breakdown at Cambridge after driving himself relentlessly in preparing for the 'Little Go' or preliminary exercise. In consequence, he never advanced very far in mathematics, and did not even sit for the Tripos. Yet

[13] See Porter, *Rise of Statistical Thinking* on Galton and Porter, *Unknown History*, chap. 10 on Pearson's biometric allies.

[14] Andrew Warwick, *Masters of Theory: Cambridge and the Rise of Mathematical Physics* (Chicago, 2001).

he was extraordinarily creative and had an excellent ability to discern the mathematical structure of a scientific problem whose solution was beyond his powers. He understood enough, however, to describe the problem so that a trained mathematician could derive a solution. Galton also worked very skillfully with visual representations, most notably a mechanical one, his 'quincunx', a diagonal matrix of pins on a board through which little balls of shot fell and rebounded. At the bottom would appear one or more bell-shaped normal curves of variable width. The quincunx served him as a model of statistical variability, shaped by processes of reproduction and selection.

Pearson, a remarkable social and historical visionary, and at times a bold if unsuccessful physical theorist, achieved an impressive technical competence in mathematics, an ability to set up complex algebraic problems and press forward to a solution. He devoted great effort to fitting curves, and he spared himself no trouble in working out the tangled effects of reciprocal correlations in heredity. He envisioned a world made impersonally efficient by means of scientific method in the form of statistics. Fisher's training in statistics began with error theory and the method of least squares, then extended to evolution and eugenics. He was better able than Pearson to cut through swarms of algebraic symbols to achieve an elegant reframing of a statistical problem.[15]

Galton, who lived from an inherited fortune, marched to his own drummer. By the 1890s, he had come to see statistics as potentially a distinct methodological field devoted to reasoning about empirical numbers and measures. By this time he was especially caught up in the study of evolution and biological inheritance, but he was also coming to realize that some of the relationships he had at first understood as biological principles were more general than that, and could be applied to data from any field. His decisive moment in this regard came at the end of 1888 when he worked out the basic geometry of correlation. About then he began working to encourage young mathematicians to devote their careers to the mathematics of statistics. Although he never really acted as a teacher, he corresponded with younger men and made suggestions. His ideas were picked up in several countries, but especially at home in Britain. His most devoted admirer, and the most important for statistics, was Pearson, who, around 1895, took up statistical mathematics as his great intellectual cause. Like Galton, he was especially impressed by its potential importance for

[15] Stephen M. Stigler, 'Darwin, Galton, and the Statistical Enlightenment', *Journal of the Royal Statistical Society, Series A*, 173 (2010), 469–82; Theodore M. Porter, *Karl Pearson: The Scientific Life in a Statistical Age* (Princeton, 2004).

evolution and eugenics, but his ambitions knew no limits, and he intervened in the work of diverse disciplines, as he later boasted, like a buccaneer.

Pearson's intellectual range and competence were dazzlingly wide. Galton confirmed and to some degree redirected his interests in quantitative reasoning, but certainly was not responsible for Pearson's initial interest in statistics. That came, interestingly enough, from his work as a college teacher of applied mathematics. After several years of uncertainty as to where his best talents lay and where he could make a difference, he accepted a position at University College, London, in applied mathematics. Immediately he set to work to redefine engineering there as a field rooted in mathematics and measurement. In contrast to the mathematical students he knew from Cambridge, the engineering students at UCL put little faith in abstract science. He complained of their preference for working with their hands over devoting themselves to the acquisition of effective intellectual skills. The 'engineering laboratory' that provided the principal focus of his teaching was not designed to turn engineers into mathematicians, but focused on 'graphical statics', for the solution of practical mathematical problems. These techniques, growing out of engineering traditions from the period of the French Revolution, had been developed for the instruction of engineers mainly in Italy and Germany. Pearson was not content to defend these techniques as within the reach of imperfectly-educated engineers, but also, and principally, as a way of making mathematical reasoning visual and intuitive, as it had not been since the triumph of algebra (and analytic geometry) more than two centuries earlier. He set about developing graphical methods of statistics as an offshoot of these engineering initiatives, for the sake of lectures he delivered at just this moment to commercial students at Gresham College in the City of London.[16]

Pearson's philosophical book on science, which acquired a cult status in certain circles during the early decades of the twentieth century, emphasized the moral and political virtues of scientific method. The first edition of this book, which began as another set of Gresham Lectures, was completed just before he turned to statistics as his life mission. Many of his claims there for scientific method seem to resonate with his emerging view of statistics as the all-purpose instrument of scientific reason. From his youth, he had spoken often of an alliance, almost an identity, of science and socialism. Scientific method, which here referred chiefly to something on the order of the scientific spirit, required a person to accept as true only what can be held

[16] Porter, *Karl Pearson*, chap. 8; and Pearson, 'Contributions to the Mathematical Theory of Evolution, II: Skew Variation', *Philosophical Transactions of the Royal Society of London* (A) 186 (1895), 343–414, Fig. 18.

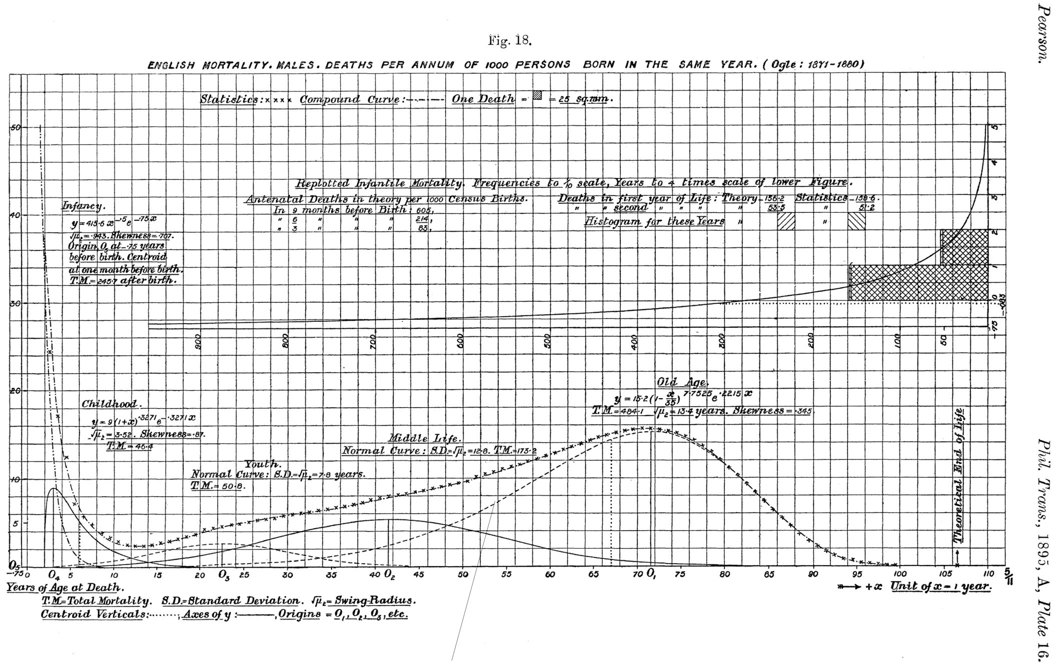

Figure 7.1 An example of Pearson's graphic method. As he turned from graphical statics in engineering to statistics, Pearson focused increasingly on curve-fitting, mainly to approximate the data but also to clarify causes. The most memorable of these efforts was the curve he drew to fit annual death rates of English males, an irregular curve with one peak near the age of birth and another at about age 70. His solution was a sum of five skew curves from a family of curves that he had just developed. In a popular lecture, he explained how the curve of mortality in relation to age was as if produced by five marksmen, shooting with widely varying degrees of accuracy at travelers of a particular age crossing the bridge of life. Pearson, 'Contributions to the Mathematical Theory of Evolution. II. Skew Variation in Homogeneous Material', *Philosophical Transactions of the Royal Society of London, A*, 186 (1895), 414.

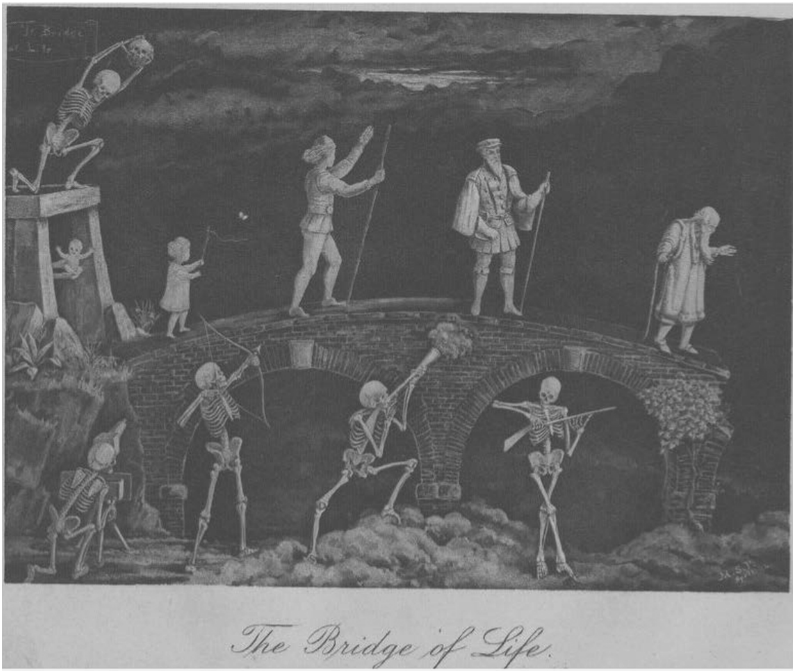

Figure 7.2 Pearson's wife Maria Sharpe created a striking image to illustrate this process. 'The Bridge of Life,' Frontispiece to Pearson, *The Chances of Death and Other Studies in Evolution* (London, 1897).

disinterestedly because it is valid for everyone. Statistics, as a form of reasoning, seems like the fulfillment of a moral commitment to take full account of the evidence, even to reduce reason to calculation. His own theory of knowledge was at stake, in a way, in his efforts to transmit this method of analysis and evaluation to the public, and in particular to his students.

Pearson, however, never supposed that statistics should make intellectual and moral decisions routine or mechanical. He insisted on the contrary view, idealizing the intimate relationship of master and apprentice in the medieval university as a living model for science, still. Although he gave lectures at the most advanced level as well as to undergraduates, he refused to write a textbook or even to teach from one. A student must not be satisfied to learn rules, but must mature into a comprehension of the craft. Students and assistants in his statistical and eugenic laboratories recall 'the professor' making his daily rounds to discuss the research of every student and colleague. They were impressed and inspired by these interactions, and at the same time were oppressed by them. Some of the women and most of the men in his statistics laboratory had a falling out with him at some point. They felt the weight of his brilliance and of his stubbornness. It was difficult to confine these disagreements to the intellectual and technical dimension. He accused them of disloyalty, of abandoning the sacred statistical cause. Some of the most able felt compelled to break with him for a time. Such deep and disturbing disagreements might be dismissed as reflecting Pearson's personal characteristics, which they did. Yet he was not necessarily always in the wrong, and statistics, over the twentieth century, was subject to a series of deep divides, sometimes boiling over into bitter controversies. Some have been impossible to resolve.[17]

Udny Yule and Major Greenwood, though relatively long-term associates of Pearson's laboratory, never held permanent positions there. A succession of young men and a few women came to Pearson's lab as paid researchers, with the expectation of moving on after a few years. They collaborated in his research projects and wrote some papers on their own, and often moved on to jobs that made use of their statistical skills or even to carry out statistical research, despite the failure thus far of statistics to achieve recognition as a job category. Another group of researchers, all women, held positions in Pearson's labs that stretched out for decades. They enjoyed less independence and, in general, received lower salaries, but Pearson encouraged them to coauthor research papers and even to publish independently. His primary eugenic project was more medical than statistical, yet his laboratory associates became expert also in statistics. It is necessary to understand that most of their time, and even of Pearson's, was devoted to the procurement of relevant data and to putting it into an appropriate shape for statistical study. Before the skulls could be analyzed and classified, they had to be measured along many dimensions with calipers, then photographed, perhaps, from multiple angles. School assessments had to be compared with bodily measurements and medical assessments. After that came days and weeks with a Brunsviga calculator to process the data. Pearson, too, kept one always at his side. The need for appropriate formulas to analyze data was unquestioned, yet mathematics here was the tip of the iceberg. Much of the rest was data work.[18]

[17] Porter, *Karl Pearson*, chap. 9; on statistical controversies see Donald MacKenzie, *Statistics in Britain, 1865–1930: The Social Construction of Scientific Knowledge* (Edinburgh, 1981).

[18] Rosaleen Love, "Alice in Eugenics-Land': Feminism and Eugenics in the Scientific Careers of Alice Lee and Ethel Elderton', *Annals of Science*, 36 (1979), 145–58; Eileen Magnello, 'The Non-Correlation of Biometrics and Eugenics: Rival Forms of Laboratory Work in Karl Pearson's Career at University College London', *History of Science*, 37 (1999), 79–106, 123–50.

For many years, Pearson brought in research students, typically for a year, to study in his lab and to collaborate in the research. They came from diverse backgrounds and from several countries, sometimes from other continents. None of them arrived as a statistician in Pearson's sense, since no such field existed. Instead, he taught economists, psychologists, biologists, anthropologists, criminologists, medical statisticians, and, in an especially well-known case, a brewer, W. S. Gossett, who in the course of his visit develop a new statistical test. Pearson took a dim view of government statisticians, the sorts of people who directed census offices, and he refused to have anything to do with their organization, the International Statistical Institute. He allowed them, however, to visit his laboratory and to learn its techniques. One of the most successful of these visitors was Prasanta Mahalanobis, who had a lead role in establishing the Indian Statistical Institute in Calcutta, and eventually became a leader of economic planning in independent India.

Experiment and Inference

Like Pearson, Fisher was deeply committed to the quantitative study of heredity. Both had important roles in the articulation and defense of Darwinian evolution, and each was outspoken on the urgency of eugenic research. While Pearson's hereditary studies dealt mainly with quantifiable traits, Fisher wanted to get beneath the traits and apply his statistics to the presumed Mendelian factors. Genetics, in alliance with eugenics, was one of the most important fields of application for statistical methods. It was, more than that, of crucial importance for the articulation of statistical mathematics, just as biological, medical, and anthropological studies provided the most important topics for much of Pearson's work. Fisher, like Pearson, took an active interest in several distinct scientific fields. His statistics, though intimately bound up with genetics, owed no less to the stimulus of agricultural research. It was above all his work that reshaped the role and identity of the statistician.

Pearson and Fisher, after some tense but respectful early interactions, became bitter antagonists. When, in 1919, Fisher had the opportunity to take up a research position in Pearson's lab, he chose to keep clear of the constraints that Pearson would impose, and accepted instead a post with the agricultural station of Rothamsted, just north of London. Agriculture was a familiar topic of statistics, most obviously in the form of crop summaries, but more profoundly as a focus of controlled experimentation in order to increase of crop yields. Fisher conceptualized the problem in a new way, based on individual plots as the unit of analysis. These plots were to be compared with control plots, always on the basis of adequate replication, and the choice of experimental and control plot would be based on a procedure of randomization, in effect, by tossing a coin. The specific purpose of the exercise was to achieve sufficient confidence that the measured difference of a new fertilizer, for example, was genuine, that is, not the result of meaningless fluctuation. Randomizing brought the experiment into comformity with basic assumptions of probability theory, permitting the calculation of what he called the likelihood that such a difference might have arisen merely by chance. If this likelihood was sufficiently low, for example, below 5%, the difference between treatment and control would, provisionally, be taken to be real.

This procedure tended to shift the focus of a statistical experiment away from a measure of the strength of a relationship between variables to a probability measure. Significance in this context is statistical, not substantive, referring not to the importance of the effect, but to the confidence that the effect is nonzero. Although Fisher allowed that different significance levels might be appropriate in different circumstances, most disciplines fixed on a particular one, 0.05, with the more strenuous 0.01 as runner up. On occasion he sharply criticized the fixation of researchers on particular significance levels, yet he declared in 1935 in his authoritative book on *The Design of Experiments* that "every experiment may be said to exist only in order to give the facts a chance of disproving the null hypothesis.' This kind of testing became the heart of inferential statistics, what many social and natural scientists construed as the essence of scientific methodology. Fisher here offered a vision of scientific inference as technically demanding, perhaps, but highly routinized, preferring a clear standard to a result that matters.[19]

Agricultural researchers, already familiar with statistics in several forms, were not slow to recognize the promise and coherence of Fisher's methods. Before long, students began coming to Rothamsted. His agricultural experiments became known internationally, leading eventually to invitations to visit US agricultural schools at Iowa State College and North Carolina State, both of which became, in turn, important centers of statistical research and the diffusion of statistical methods. *The Design of Experiments* showed that his alliance of experimentation and experiment extended far beyond agriculture. It begins with the homely example of a lady who says she can tell whether her milk has been put in before or after the tea. Ian Hacking pointed to a resemblance between the lady's claim and those of psychical research, arguing that the technique of randomization

[19] Gerd Gigerenzer, Zeno Swijtink, Theodore Porter, Lorraine Daston, John Beatty, Lorenz Krüger, *The Empire of Chance: How Probability Changed Science and Everyday Life* (Cambridge, 1989), Fisher's quote from 211.

may have originated in psychical research. Trudy Dehue then explained how randomized controls had entered and become routine in the psychology of learning still earlier. The absolute priority is perhaps not important, especially since the forms and purposes of randomization were far from uniform. If psychologists did not articulate a developed strategy of randomization in advance of Fisher's, they were in an excellent position to notice the statistical mode of experimentation and to systematize it for their own discipline. Farm plots were replaced by schoolrooms and other laboratory spaces, and fertilizer by a curricular modification or the introduction of a preliminary exercise. A rigorous and impersonal methodology, which might be important to persuade schools or militaries to take seriously the claims of school reformers, should at the same time enhance the scientific reputation of the discipline.[20]

Applied researchers and social scientists began looking to statistics for a purely objective scientific standard. This depended on closing their eyes to the bitter controversies by which the field was riven. Karl Pearson's rejection of Fisher's statistical program was perhaps losing its credibility by 1920, but the Polish immigrant Jerzy Neyman, who received some of his training in Pearson's lab, teamed up with Pearson's son Egon to frame a different program for statistics that was at odds with Fisher's significance testing. Gerd Gigerenzer showed how writers in psychology defined a new statistics, bringing together as needed pieces that both Fisher and Neyman regarded as incompatible. We see here how the usual assumption about hierarchies within science breaks down. Training in statistics altered the basic character of the psychological experiment, just as it had reshaped the agricultural one. At the same time, fields of application like agriculture and psychology reinterpreted and reshaped what was being worked out as a new mathematical field.[21]

Disciplines and Professions

To some degree in the 1930s, and then with a vengeance after the Second World War, the new tools of error management and of statistical inference provided a revised basis for the human sciences, therapeutic medicine as

[20] Gigerenzer et al., *Empire of Chance*, chap. 3; Ian Hacking, 'Telepathy: Origins of Randomization in Experimental Design', *Isis*, 79 (1988), 427–51; Trudy Dehue, 'Deception, Efficiency, and Random Groups: Psychology and the Gradual Origination of the Random Group Design', *Isis*, 88 (1997), 653–73; John Carson, *The Measure of Merit: Talents, Intelligence, and Inequality in the French and American Republics, 1750–1940* (Princeton, 2007).

[21] Gerd Gigerenzer, 'Probabilistic Thinking and the Fight against Subjectivity', in Lorenz Krüger, Gerd Gigerenzer, and Mary S. Morgan, (eds.), *The Probabilistic Revolution, ii: Ideas in the Sciences* (Cambridge, 1987), 11–33.

well as social science, and for other fields as well. Statistics was identified with objectivity and with the rigorous neutrality that science was taken to demand and now seemed to be able to supply. The social disciplines were particularly insistent on drawing a sharp line between real social science and the well-meaning efforts of soft-hearted social reformers. This rejection of moralizing language, however, did not prevent social science from offering guidance to policy initiatives, which they preferred to express using terms like adjustment or efficiency, helping the social system to function smoothly, and getting more bang for the buck. Statistics, as we have seen, had long been associated with broadly professional and administrative activities pertaining to industry, agriculture, schooling, health, housing, and poor relief. Problems of classification associated with mandatory schooling stimulated the introduction of new statistical techniques into psychology. New statistical tools, including a new economic field, econometrics, developed in response to interwar economic instability. Statistics still did not mean just one thing; the more engaged forms of social science included different sorts of statistical tools from those demanding academic rigor above all else.[22]

In psychology, too, the most basic statistical tools had been framed in contexts of application even before these fields became university disciplines. Although they were responsive to developments in the new mathematical field of statistics, the methods they taught remained in an important sense their own. Public health was like this too, the product of a long tradition that emphasized environmental causes of sickness and mortality and that carefully tracked the progress of epidemics. The economy of clinical medicine, by contrast, was anchored in individualized relationships between physicians and their paying patients, and the training of clinicians had usually emphasized this dimension. Although the therapeutic trial did not arrive out of the blue, it depended a good deal on the initiative of regulators and statisticians. Statistical medicine was as important for Karl Pearson and his students as were evolution and eugenics. The randomized trial, which had multiple sources, was eagerly taken up psychologists and more hesitantly by clinicians. Even for them, the introduction of the RCT does not come down to the passing of a baton from one great statistician to another. Instead, a range of pressures and incentives involving medical researchers, regulatory authorities, and

[22] Kurt Danziger, *Constructing the Subject: Historical Origins of Psychological Research* (Cambridge, 1990). On the problem of economic cycles and origins of econometrics, Mary S. Morgan, *The History of Econometric Ideas* (Cambridge, 1990).

pharmaceutical companies stimulated a move toward systematic evaluation of drugs.[23]

Although statisticians did not have to break down the doors of clinical medicine, neither did they draw mainly from their own traditions. This is in contrast to econometrics, which borrowed more heavily from economic traditions than from mathematical statistics, and even from experimental psychology, with its crucial sources in educational studies. Although the social sciences drew heavily from the new mathematical field of statistics, they did so by assimilating it to their own traditions. Medical statisticians, by contrast, typically recruited from outside, sometimes in defiance of the customary individualism of clinical practice. It matters, too, that modern medicine has long been rich enough to import statistical experts to preside over the design of therapeutic experiments. Some became medical specialists in their own right. Doctors participating in large-scale research had to sacrifice the expert discretion that came with medical individualism in order to participate in large-scale clinical trials. Clinical medicine had no clear precedents for this. The logic of the randomized trial came from statistics.[24]

Who is a Statistician?

Medical statistics, too, developed almost immediately into a distinctive form of statistical practice, and soon, this special form of statistics began to be taught in medical schools. In fields like psychology, economics, and ecology, some scientists achieved a level of statistical expertise approaching that of professional statisticians. The founding of the Institute of Mathematical Statistics in 1935 may be taken as a convenient marker for the emergence of mathematical statistics as a partly autonomous field, one that was beginning to train its own students. However, the perpetuation of statistical expertise is much more interesting and complicated than the model of autonomous disciplines would suggest. As statistics became a routine and necessary tool in a wide variety of disciplines and practices, their faculties learned to teach using methods and examples that were often specific to the subject disciplines. Many or most of their students lacked the preparation to take a graduate course taught by a mathematician.

[23] Martin Edwards, *Control and the Therapeutic Trial: Rhetoric and Experimentation in Britain, 1918–48* (New York, 2007), esp. 14.

[24] There is now a considerable literature on the origins of the clinical trial and its politics. The classic work is Harry Marks, *The Progress of Experiment: Science and Therapeutic Reform in the United States, 1900–1990* (Cambridge, 1997); see also Gérard Jorland, Annick Opinel, and George Weisz, (eds.), *Body Counts: Medical Quantification in Historical and Sociological Perspective* (Montreal and Kingston, 2005).

Statistics, in short, has never been easy to isolate from other forms of knowledge. Beyond that, it is increasingly regarded as an indispensable component of common knowledge. The work of census offices and other sites of official statistics remains central to this aspect of the field. Right from the start, in the early nineteenth century, reformers and politicians liked to claim that the numbers would speak for themselves. Throughout the history of public statistics, it has been common to argue that statistics can support the interests of the citizenry by revealing in simple, numerical terms if a political program was sound or misguided. By the twentieth century, it was no longer only the critics who argued that valid and informative numbers might require the involvement of experts. Statistics emerged in the 1930s and 1940s as a highly dispersed field, taught sometimes as a branch of mathematics, sometimes as a distinct discipline specializing in the management of chance and variability, and sometimes as a workbook of practical techniques for turning the data of a discipline into acceptable research papers.

The tools of probability that Pearson, Fisher, and others began using for biological, agricultural, medical, and social data eventually came back to government statistics. Census offices, commerce ministries, departments of agriculture, and bureaus of labor statistics had not been inert during the decades when it took shape as a mathematical field. Outside the Anglophone world, state statisticians remained the most visible experts in statistical work.[25] They continued to dominate the International Statistical Institute, and they have had a key role in negotiating such unity as the European Union has been able to establish. They already were moving toward a more mathematical and method-conscious form of statistics by the late nineteenth century. They were not slow to take up mathematical tools of analysis, for example, to estimate the bounds of error and to show that an apparent effect could not reasonable be attributed to chance. Official statistics had always been engaged in systematic social observation. By 1900 it was being called on for data on specific matters that seemed relevant to pressing policy issues. Statisticians already recognized that samples should somehow represent the population, and before long began to emphasis the need to represent its heterogeneity. The distinctive value of random sampling was more readily visible to mathematicians, who perhaps also underestimated the difficulty of lining up a fair simulacrum of a large, dispersed population.[26]

[25] See for example Jean-Guy Prévost, *A Total Science: Statistics in Liberal and Fascist Italy* (Montreal and Kingston, 2009).

[26] On sampling in the history of statistics see Desrosières, *Politics of Large Numbers*. Especially good on the social survey is Sarah E. Igo, *The Averaged American: Surveys, Citizens, and the Making of a Mass Public* (Cambridge, 2007).

The tools of statistics arose partly in situations of practice, intersecting with yet never dominated by more academic forms. The latter, of course, had the advantage of their teaching roles--their close contact with students at a moment of relative openness or susceptibility. Later, however, they must face the challenge of implementing an academic program within a community of practitioners who have worked out tricks to elude somehow the rigidity of mathematical theory. Statistics, in short, presents a complex model of academic training for a multifarious occupation, and nothing so simple as the creation of a discipline through systematic university-based research training.

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8

The Training and Disciplinary Identity of Linguists in Europe's Long Nineteenth Century

John E. Joseph

Introduction

In the mid-nineteenth century, the centres of philological and linguistic study in Europe were a handful of German universities that led the way in organizing doctoral training. In seminars guided by a senior professor, students presented papers on specialized topics and had them critiqued and queried, as a way of preparing them for researching and writing the thesis on which the award of the doctoral degree would stand or fall.

This chapter examines the historical background and the eventual practice of such training, along with developments in the methodology and conceptual framework of linguistic study. It does this in a somewhat unconventional way that might be called cinematographic: the focus shifts from wide-lens establishing shots with an international or national panorama, to medium shots trained on particular universities, learned societies or journals, and down to close-ups on the experience of one Leipzig doctoral student who went on to lecture in Paris. That student, Ferdinand de Saussure (1857–1913), was responsible for some of the key conceptual and methodological shifts of the late nineteenth century, with his influence becoming ever greater as the twentieth century progressed.

The political and cultural relations between Germany and France in the two decades following the Franco-Prussian War and the annexation of Alsace and Lorraine coloured and complexified the importation of the German doctoral training model in the various branches of the University of Paris, and not least in the section of the *École Pratique des Hautes Études* in which Saussure was hired to lecture on Gothic and Old High German, to a student body made up disproportionately of displaced Alsatians.

John E. Joseph, *The Training and Disciplinary Identity of Linguists in Europe's Long Nineteenth Century* In: *A Global History of Research Education: Disciplines, Institutions, and Nations, 1840–1950*. Edited by: Ku-ming (Kevin) Chang and Alan Rocke. *History of Universities* XXXIV/1, Oxford University Press (2021).
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Saussure's teaching set the agenda for French doctoral training in linguistics and adjacent areas at least through the 1960s, and indeed across Europe and beyond – this despite the fact that he was never in a position to direct a single doctoral thesis himself.

In the wake of Napoleon

By the middle of the nineteenth century Continental European universities had not yet recovered from Napoleon's determined mission to destroy them as autonomous or ecclesiastical institutions. In so doing, he was extending both the centrism that had characterized the French state since its founding, and the egalitarian and anti-clerical aims of the French Revolution. Already in 1793 the universities of France, which had numbered 143 at the start of the Revolution in 1789,[1] had all been suppressed by the Revolutionary Convention. Specialized establishments were then founded under central government control, starting in 1794 with the *École centrale des travaux publics* (Central School of Public Works) for the training of civil engineers and the *École normale* (Normal School) for training teachers; the former was renamed the *École polytechnique* (Polytechnical School) in 1795, while the latter was shut down 'after four months of tumultuous activities',[2] and not re-established until 1830. These *grandes écoles* (great schools), as they came to be known, did not require completion of a secondary degree for admission, nor did they award degrees, but only prepared students for national examinations.

Also in 1795 the beginnings of a university sector were re-established with the creation of *Écoles de santé* (Schools of Health) in Paris, Montpellier and Strasbourg. That same year saw the opening of the first institution in France devoted to linguistic study, the *École des langues orientales* (School of Oriental Languages) in Paris.[3] Left untouched, apart from a change of name to the *Collège national*, the non-degree-granting *Collège royal* (now the *Collège de France*) founded in 1530 by François I was not a university

[1] Christophe Charle and Jacques Verger, *Histoire des universités (XIIe-XXIe siècles)* (Paris, 2012), 47.

[2] Walter Rüegg, 'European Universities and Similar Institutions in Existence between 1812 and the End of 1944: A Chronological List', in Walter Rüegg (ed.), *A History of the University in Europe,* iii. *Universities in the Nineteenth and Early Twentieth Centuries (1800–1945)* (Cambridge, 2004), 673–706, 692. Gathering definitive information on the history of universities is an ongoing enterprise. Some of the chapters in the volume just cited, for example, contradict other chapters. I have given the best information I can based on the wide range of sources I have consulted.

[3] See Louis Bazin, 'L'École des Langues orientales et l'Académie des Inscriptions et Belles-Lettres', in *Comptes rendus des séances de l'Académie des Inscriptions et Belles-Lettres*, 139/4, 1995, 983–996.

nor connected directly to the universities. Rather, it had always stood in an uneasy rivalry with them, and partly on this account, its 'courses were unmolested; the Convention even raised the salaries, by decree, from one and two thousand francs to three thousand'.[4]

Under Napoleon, other specialized schools or faculties were established in provincial towns in the first decade of the nineteenth century, and in 1806 the *Académie de Paris* was created, including faculties of letters, sciences, law, medicine, Catholic theology and Protestant theology. The remit of the *Académie de Paris* extended from primary education upward, including a tertiary level destined to be integrated into Napoleon's plan for replacing all the universities within his empire with a single, centrally-controlled *Université impériale* (Imperial University). The plan had only been partly instituted by the time of the French defeat at Waterloo and the subsequent reconfiguration of Europe at the Congress of Vienna in 1814–15. In its wake, from the west of Spain to the Russian border, lay a trail of universities in ruins, along with about a hundred that continued to function. None of these were in France, where what remained of Napoleon's plan were the *grandes écoles* and most of the faculties established in the previous decade, which remained separate until the Loi Liard of 1896 allowed faculties in the same towns to regroup into universities.[5]

Elsewhere, sparks had appeared among the ashes, the brightest being the founding of a new sort of civic/state university in Berlin in 1810, while it was under Napoleonic rule, and in London between 1826 and 1836. The University of Berlin (today the Humboldt University of Berlin) is credited with having 'constructed the modern doctoral candidate', with statutes stipulating that 'The candidate must have been matricultated for three years, must have actually attended some class or other, must swear a couple of oaths, and must furnish two documents', a *curriculum vitae* and a police certification of the candidate's honesty.[6] The awarding of doctorates took

[4] J. B. Delaunay, 'The Collège de France', *The Catholic Encyclopedia* http://www.catholicity.com/encyclopedia/c/college_de_france.html. Under Napoleon it became the *Collège impérial*, then again *royal* under the Restoration and again *impérial* under the Second Empire, with the name finally settled as *Collège de France* in 1870. On the earlier history of the *Collège royal*, when it was also known as the *Collège des trois langues* (College of the Three Languages, viz. Latin, Greek and Hebrew, clearly indicating its philological orientation), see Ina Baghdiantz McCabe, *Orientalism in Early Modern France: Eurasian Trade, Exoticism and the Ancien Regime* (Oxford and New York, 2008), 24–8.

[5] A number of faculties of letters closed in 1815, including those at Clermont-Ferrand, Lyon, Montpellier, Nancy, Orléans, Poitiers, Rennes and Rouen.

[6] William Clark, *Academic Charisma and the Origins of the Research University* (Chicago, 2006), 202. Until the late eighteenth century the degree of doctor was awarded only in law, medicine and theology, and it was with considerable struggle that the appellation 'doctor of philosophy' came to be accepted in some German and Austrian universities, with no clear rules for how it was to be awarded (see Clark, 194–6). Academic degrees were another tradition which the Napoleonic Empire wished to abolish, but which survived not only intact but strengthened.

decades to spread to the older surviving universities, which included the seven ancient universities of the British Isles, twenty-two other Reformed (Protestant) universities in Switzerland, the Netherlands and Germany, and some sixty Roman Catholic universities. The Catholic institutions were more inclined toward teaching accepted doctrine than establishing new knowledge through original research, but were nonetheless home to individual scholars of great originality and importance.[7]

Most of the young men who undertook university-level philological study did so as part of a career plan aimed at secondary school teaching or a religious vocation.[8] In 1850 the choice of a university career was determined in France by the competitive examinations for entrance into the *École normale supérieure*, which had been hived off in 1845 from the original *École normale* so as to focus specifically on the training of teachers for universities and for another Napoleonic innovation, the *lycées*, a system of state-financed late secondary schools created in 1802 for boys who performed best in a competitive entrance exam. Entry into the *Normale sup'*, as the *École normale supérieure* was (and is) popularly known, was as close as one could get to a guarantee of a future teaching post, though that post might be in the *lycée* of a remote provincial town rather than in the university. In other countries, there was rarely such a guarantee before undertaking one's training.

Those preparing for a career in their country's military or imperial service attended schools set up particularly for them. Of all the imperial powers, France had the strongest 'assimilationist' policy, with only the French language used in administration, courts, schools and other institutions in its overseas territories.[9] The first request by a French naval officer for leave from service to undertake study at the *École des langues orientales* was made in 1887 by Léopold de Saussure (1866–1925), Ferdinand's younger brother, who had to persuade his superiors that learning Chinese would be a valuable preparation for his planned career in the administration of Indochina,[10] whereas in the British colonial service

[7] See Walter Rüegg, 'Themes', in *A History of the University in Europe,* iii. 3–31.

[8] Details of the social composition of student bodies across Europe can be found in Christophe Charle, 'Patterns', in *A History of the University in Europe,* iii. 33–80, and in Charle, *Histoire des universités*. On France in the Third Republic see Charle, *La République des universitaires (1870–1940)* (Paris, 1994). On the social origins of those teaching in universities, particularly in Germany, where the most detailed records were kept, see Matti Klinge, 'Teachers', in *A History of the University in Europe,* iii. 123–61.

[9] The classic study is Raymond F. Betts, *Assimilation and Association in French Colonial Theory, 1890–1914* (Lincoln, 1960). See also John E. Joseph, 'Language and "Psychological Race": Léopold de Saussure on French in Indochina', *Language and Communication* 20, 2000, 29–53.

[10] Raymond de Saussure, 'Léopold de Saussure (1866–1925)', *Isis*, 27 (1937), 286–305, 287.

it had been taken for granted since the late eighteenth century that the training of administrators should include the languages of India or wherever else they were going to be posted.[11]

While earning their crust teaching in secondary school, men and eventually women who had earned a *licence*, or the equivalent in countries other than France of a 'license' to teach, might undertake the original research necessary for a doctoral thesis. Those who were successful often continued as school teachers, in addition to which, in countries such as Germany and Switzerland, they might get an appointment as *Privatdozent* in a university, which was an official recognition of someone's capability to tutor university students, who would pay them directly.[12] In France they would first have to pass a further examination, the *agrégation*, to qualify to teach in a university, where they would receive a salary as an *agrégé*.

Some universities employed lecturers and demonstrators as assistants to professors; these too were few in number. The young doctors might also publish their thesis, and articles in specialist journals in their area, and take part in the meetings of academic societies. A very select few might have the chance to replace temporarily a professor seconded to administrative duties or, more rarely, granted research leave. When a chair fell vacant, an election was held among the other professors to fill it; in the prestigious universities, the young and not-so-young doctors might have to compete against men already holding chairs in less prestigious universities.

How an individual's acceptance to candidacy for a doctorate was handled, and what support, if any, they were given for writing the thesis, varied by country and institution. In general, aside from medical studies, it was assumed that whatever knowledge could be taught through lectures and reading would be acquired in the course of a bachelor's or other first university degree. Hence, someone undertaking a doctorate in the university where they had gained their *licence* or other first degree would proceed directly to the thesis, while auditing any relevant courses they had not already taken. However, the great centres of philological and linguistic study attracted doctoral students who had done their first degree elsewhere – or, in

[11] See Thomas R. Trautmann, *Languages and Nations: The Dravidian Proof in Colonial Madras* (Berkeley and Los Angeles, 2006).

[12] In earlier times, and still in some universities in the mid-nineteenth century, students paid a fee to attend individual lectures, with the fee divided between the lecturer and the university. Professors received a salary, which tended to be low enough that they needed to supplement it with income from examination fees and extra tuition. Even in universities where the professorial lectures were open to the public free of charge, one of the reasons for the long survival of Latin as the language of lectures was that the professors could then offer paid tutorials in which they would explain the contents of the lecture in the vernacular. see Klinge, 'Teachers', 141.

some cases, had not even taken a first degree, as was the case with Ferdinand de Saussure.

Establishing Linguistics as a Field

The German universities led the way in organizing 'doctoral training' for students, in the form of seminars guided by a senior professor, where the candidates presented papers on particular topics and had them critiqued and queried. This model was exported to the USA with the founding of Johns Hopkins University in Baltimore in 1876, followed by the University of Chicago in 1890. It took considerably longer for anything comparable to be adopted in the UK.

In France, the *École Pratique des Hautes Études* had been established in 1868 in order to bring the German model of 'seminars' into French higher education. The 'Pratique' of its name signalled the intent for the students not to listen passively to professors' lectures but to *practice* their subjects while studying them.

> The Minister of Public Instruction, Victor Duruy, anxious to remedy the deplorable poverty of higher education, decided to establish, in Paris at least, something similar to the 'seminars' in which was delivered the 'familiar and direct' teaching that had been so fruitful across the Rhine. [. . .] In the Minister's mind the École 'should be in a close relationship with teaching in the Sorbonne and the Collège de France, and should complement the lectures given there with sessions in which the students, under the direction of tutors (*répétiteurs*), take the floor and present their own work, conceived according to a common plan and open to the criticism of all'.[13]

That was the design, but it does not appear to have taken hold. Duruy told Gabriel Monod after attending one of his seminars that it was very good, but not at all what he had been hoping for. In the view of one observer, Duruy's mistake had been to appoint serious young scholars to the drudgery of tutoring, and not to anticipate that they would do what scholars do in the classroom: teach.[14]

Germany was looked to as the model not just for organizing doctoral training, but also as the leading country in the study of language and

[13] Charles Bémont, 'Gabriel Monod', *École Pratique des Hautes Études, Section des sciences historiques et philologiques, Annuaire 1912–1913*, 1912, 5–41, 10, citing 'Mélanges publiés par la Section pour le dixième anniversaire de sa fondation', fasc. 35 de la Bibliothèque de l'École (1878), 1. Gabriel Monod (1844–1912), who had just returned from studies in Berlin and Göttingen, was among the first to be appointed as tutor in the historical section.

[14] Ibid, 11. For more on the teaching of linguistics in this period see Gabriel Bergounioux, 'Faire cours: L'enseignement de la linguistique au temps de Meillet et Saussure', *Langages*, 209 (2018), 19–34.

languages. In 1876 the manifesto of the *junggrammatische Richtung*, the Neogrammarian order, was published by two young lecturers, Hermann Osthoff (1847–1909) and Karl Brugmann (1849–1919).[15] It set out a programme for research on the historical development of languages that would be based on two seemingly simply principles, the mechanical (that is, neuro-muscular, unconscious and exceptionless) nature of sound change, and the (mental, semi-conscious) process of analogy whereby any apparent exceptions to mechanical sound change can be explained.[16] The simplicity of the programme gave it great appeal at a time when linguists were struggling to cope with the weight of all the diverse data gathered from ancient and living languages, and it had the added advantage of being interpretable in a way that fit with both the Darwinian theory of evolution and the dominant psychological paradigm of associationism, which preferred to locate knowledge in the neuro-muscular system as a whole rather than in some 'cerebral closet', and to recognize that the processes in which knowledge consists do not generally enter into conscious thought, except in the case of what would now be called cognitive dissonance.[17]

The success of the Neogrammarian order would not just cement the position of the University of Leipzig as the premiere centre in the world for linguistics and philology, but would establish in the academic and popular mind that linguistics was a *science*, with all the institutional prestige which that word carried. What kind of science – natural or historical – continued to be a matter of debate, notably between the leading Sanskritist of Britain, Friedrich Max Müller (1823–1900) of Oxford, and his American counterpart, William Dwight Whitney (1827–1894) of Yale, with Müller arguing for the natural side and Whitney for the historical. The two never met; their debates took place in separate lecture series and in print. In the 1860s, reports of their sniping at each other had helped to bring modern linguistics to the attention of a very broad international newspaper-reading public.

[15] Hermann Osthoff and Karl Brugmann, preface to *Morphologische Untersuchungen auf dem Gebiete der indogermanischen Sprachen* 1, (Leipzig, 1878), iii–xx. Brugmann reportedly drafted the preface single-handedly, though he is listed as second author—with his name spelled 'Brugman', as it would be for several more years until he, along with the rest of his family, added the extra n. The term 'Neogrammarian' had been hurled at Osthoff and Brugmann as a term of abuse by those who did not share their methodological scruples, so their embrace of it was somewhat light-hearted.

[16] On how the Neogrammarian approach fits into the broad sweep of the history of linguistics, see 'Nineteenth Century', Chapter 7 of John E. Joseph, *Language, Mind and Body: A Conceptual History* (Cambridge, 2018).

[17] 'Cerebral closet' is the disdainful term used by Alexander Bain (1818–1903), the principal figure in mid-nineteenth century associationism, in *The Senses and the Intellect* (London, 1855), 332.

The term *Linguistik* is first attested in German in the eighteenth century, then in French as *linguistique* (1812), but it took decades to catch on as the designation of an academic field. The earliest attestation I have found of the word *linguistics* in English is in an 1837 review article in *The North American Review*.[18] Most of the early attestations come from American publications, including the writings of Whitney, in the 1860s and 1870s.[19] In institutional terms, the *Société de Linguistique de Paris* was founded in 1864,[20] but university chairs in linguistics were slow to be established in France or any other country. The Linguistic Society of America was founded in 1924, almost seventy years after its French counterpart, and it would take another thirty-five years for the founding of the Linguistic Association of Great Britain in 1959. Linguistics was particularly slow to develop in countries such as the UK where language study remained strongly rooted in the older tradition of philology.

What distinguished linguistics from earlier approaches was no single criterion, but a constellation.[21] Unlike philology, it was not bound up with the interpretation of classical or medieval texts; unlike etymology, its principal concern was not the origin of particular words; unlike the *grammaire générale* tradition of seventeenth and eighteenth century France (later to be revived by Noam Chomsky), it was not linked to enquiries into logic; unlike the pedagogical grammar tradition it was not aimed directly at the teaching of the standard language or of classical or modern foreign languages. At the same time, the proponents of modern linguistics did not cut their ties with these more venerable enterprises, but instead asserted dominion over them, based on a claim of scientific authority. This they staked largely on redefining their object of study as the language conceived

[18] Anon., 'History of Navigation in the South Seas' (review), *North American Review*, 45/97 (1837), 361–90. Not much eludes the attentive eye of James Turner, but his *Philology: The Forgotten Origins of the Modern Humanities* (Princeton, 2014), 146, dates the first English attestation to 1839. The *Oxford English Dictionary* gives an 1840 citation for the noun *linguistic*, designating 'the science of languages', occurring in William Whewell, *The Philosophy of the Inductive Sciences, founded upon their history*, (London, 1840), I/cxiv; while its earliest citation for *linguistics* is from Webster's American dictionary of 1847, which is surprising, since dictionaries are meant to record, not create words. *Linguistics* also appeared in Ogilvie's *Imperial Dictionary* in 1855.

[19] See William Dwight Whitney, *Language and the Study of Language: Twelve Lectures on the Principles of Linguistic Science (*New York and London, 1867), and *The Life and Growth of Language: An Outline of Linguistic Science* (New York and London, 1875); Stephen G. Alter, *William Dwight Whitney and the Science of Language*, (Baltimore and London, 2005); John E. Joseph, *From Whitney to Chomsky: Essays in the History of American Linguistics* (Amsterdam and Philadelphia, 2002).

[20] Two earlier Sociétés de Linguistique had been founded, one in 1837 about which little is known, and a second in 1854, headed by Casimir Henricy and disbanded in 1860.

[21] A very full account can be found in Turner, *Philology*.

as a self-contained system, which they approached without value judgements about what aspects of it might be reckoned good or bad.[22]

Methodologically, modern linguistics was to be descriptive rather than prescriptive, and by the 1950s the consensus among its practitioners was that 'All languages are equally complex'.[23] This is the sort of dogmatic assertion that not only defies empirical investigation into its veracity, but would close investigation down altogether. Its rise becomes understandable when we look back to how commonly authors of accounts of 'exotic' languages from the sixteenth until the early twentieth century treated structures that differed from the familiar Indo-European ones as fundamentally illogical. Either the exotic structure appeared more economical than that of the European languages, in which case the language and its speakers were labelled as underdeveloped, or the structure codified some distinction which European grammars do not make, in which case the languages and their speakers were described as quaint at best, and at worst, wasteful of mental energy. Both positions served to characterize the non-European languages as primitive and inferior.[24]

The Müller-Whitney debate is a classic instance of the polarization between science and the human (subject/society) that Bruno Latour sees as defining the modern era.[25] Latour argues that modernism, antimodernism and postmodernism are all equally grounded in a 'Constitution' that took shape in the seventeenth century, whereby Nature and Society were separated, then gradually made into irreconciliable opposites. By the early nineteenth century this Constitution had become impervious to criticism. It undid the premodern incapacity to tamper with either nature or society, each being conceived as inexorably bound to the other at every point, under the authority of God. The moderns 'crossed out' God, allowing them to depict their Constitution as 'humanism'—but this produced an asymmetry, which Latour considers the true mark of the modern, and the source of its ultimately fatal contradictions.

[22] For every instance of usage purported to be bad, because illogical, a linguist will cite examples from a range of the world's languages in which the same structure is treated as perfectly logical. The double negative, for example, is scorned as illogical in English (*I don't have nothing*), but is the only way to form a negative sentence in Italian (*Non ho niente*). To challenge linguists on this would be to paint oneself into the pre-modernist corner of having to assert absurdly that Italians, as a people, are illogical.

[23] See John E. Joseph and Frederick J. Newmeyer, ''All Languages Are Equally Complex': The Rise and Fall of a Consensus', *Historiographia Linguistica*, 39/3 (2012), 341–68.

[24] See Matthew Lauzon, *Signs of Light: French and British Theories of Linguistic Communication, 1648–1789* (Ithaca, NY and London, 2010).

[25] Bruno Latour, *Nous n'avons jamais été modernes: Essai d'anthropologie symétrique* (Paris, 1991). English version, *We Have Never Been Modern*, trans. Catherine Porter (Cambridge, MA, 1993).

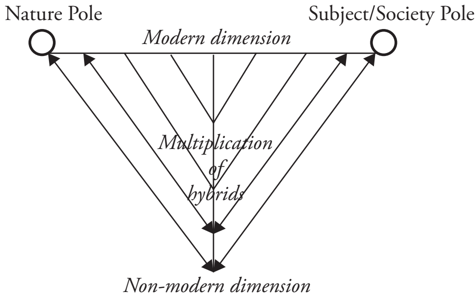

Figure 8.1 The modern 'Constitution' of knowledge according to Latour (1991), from John E. Joseph, *Language, Mind and Body: A Conceptual History* (Cambridge University Press, 2018), with permission.

Modernity is often defined in terms of humanism, either as a way of saluting the birth of 'man' or as a way of announcing his death. But this habit itself is modern, because it remains asymmetrical. It overlooks the simultaneous birth of 'nonhumanity'—things, or objects, or beasts—and the equally strange beginning of a crossed-out God, relegated to the sidelines. Modernity arises first from the conjoined creation of the human, the non-human and the crossed-out God, and then from the masking of their creation, while, underneath, hybrids continue to multiply as an effect of this separate treatment. The double separation is what we have to reconstruct: the separation between humans and nonhumans on the one hand, and between what happens above and what happens below, on the other.[26]

The human pole will be split between what Latour designates as Society and Subject. He directly addresses that split in other work, but here refers to Subject/Society as though they were conflatable. They are not, but his reader's willing suspension of disbelief is repaid with a grand narrative of modernism as the proliferation of 'hybrids' which mediate between the natural and the social. The Constitution denies the existence and even the possibility of such hybrids, being committed instead to 'purifying' the split. And yet, Latour maintains, the split, being artificial, has to be mediated. The Constitution thus ends up surreptitiously demanding the proliferation of hybrids it claims to forbid. Because we have never actually practiced the absolute separation which is preached, Latour says that we have never been modern. Hence the idea of a postmodernism is as absurd as the thought of returning to premodernism.

[26] Ibid, 13.

For Müller, the realization that language is a natural phenomenon was the great breakthrough that positioned linguistics at the centre of the academic universe. As understanding of language grew, it would, he believed, provide the keys to unlocking the secrets of the human mind and its evolution. A language was a living thing, an organism, that grew following the same laws as other organisms, such as plants. For Whitney, on the contrary, languages were human 'institutions'. Language had not grown organically out of the evolution of the vocal apparatus, as Müller thought; rather, the vocal apparatus was chosen, by a combination of chance and convenience – sign language could have developed equally well – and all languages contain elements created by haphazard accident, and ratified through an implicit democratic process among those in the community, who determine which creations are rejected and which retained.[27]

The naturalist position of Müller and his allies had been formed through a Latourian purification, in an attempt to position linguistics among the hard sciences as their prestige was now outstripping that of the law, theology and medicine faculties that had traditionally ruled the roost in universities.[28] Whitney, in response, was undertaking a hybridization, not denying that linguistics had natural aspects but arguing that they needed to be balanced with its institutional ones, which, when push comes to shove, have the upper hand.

The Müller-Whitney debate raised the profile not only of linguistics generally, but in particular of Oxford as the centre for linguistic study in Britain. Copenhagen was another centre, with a number of high profile Indo-Europeanists. Other great figures in the field – the Italian Graziado Ascoli (1829–1907), the Pole Jan Baudouin de Courtenay (1845–1929), the Russian Filip Fedorovich Fortunatov (1848–1914) – were scattered. In both the scholarly and the popular mind, linguistics was a German science, and Oxford its outpost.

The success of the Neogrammarian order had another strong impact, in that it brought to the fore a generation gap within philological and linguistic studies, with the younger generation perceived as leading the field forward into a scientific future. The older generation included some figures to whom the Neogrammarians looked for inspiration and guidance, along with many others who were dubious about the possibility of reducing all the complexity of language into regular laws, though these others were

[27] See Stephen G. Alter, *Darwinism and the Linguistic Image: Language, Race, and Natural Theology in the Nineteenth Century (*Baltimore and London, 1999); and *William Dwight Whitney* (cit. n. 19); Joseph, *From Whitney to Chomsky*, 20–7.

[28] On the 'naturalist' school in France, see Piet Desmet, *La linguistique naturaliste en France (1867–1922): Nature, origine et évolution du langage* (Leuven and Paris, 1996).

not averse to piggybacking onto the great international and interdisciplinary recognition of the Neogrammarians' success. In the case of Brugmann, he owed his initial prominence to the senior professor of Indo-European linguistics at Leipzig, Georg Curtius (1820–1885), who in 1876 made Brugmann co-editor of his journal *Studien zur griechischen und lateinischen Grammatik* (Studies on Greek and Latin grammar), known generally as *Curtius' Studien*. The first issue for which Brugmann shared editorial responsibility went to press while Curtius was away from Leipzig. Without consulting the senior co-editor, Brugmann decided to include an article of his own in the issue, in which he put forward a proposal about the Indo-European vowel system that caused a great stir and was hailed as revolutionary.[29] When Curtius saw the printed issue and read Brugmann's article for the first time, he was displeased, to put it mildly, and added a note at the end of the volume explaining that he had not had a chance to vet Brugmann's article. 'I must therefore leave to him alone the responsibility for his far-reaching conclusions', Curtius wrote – and after one further volume of the journal, he announced that it would cease publication.[30] The next year Curtius started up another journal, without inviting Brugmann to collaborate. The effect of this was not what Curtius intended: it fed what was for linguistics, as for many other fields, a sense of real excitement about postgraduate training – the perception that the old masters knew less than their young apprentices, and that doctoral seminars were where the cutting edge of the field was being defined and honed.

Saussure's Doctoral Studies

Ferdinand de Saussure arrived at the University of Leipzig to begin doctoral studies in October 1876, a month before his nineteenth birthday.[31] He had attended the University of Geneva for the preceding academic year, taking a wide range of courses, though deliberately avoiding the course in general linguistics, which did not have a good reputation. Instead he arranged an independent study of foundational works in comparative-historical linguistics with the *Privatdozent* Louis Morel (1851–1917), who had himself spent the year prior to that studying at Leipzig. The precocious Saussure began sending papers to the *Société de Linguistique de Paris*, where they were read out in meetings and published in the Société's journal; he

[29] Karl Brugmann, 'Nasalis sonans in der indo-germanische Ursprache', *Studien zur griechischen und lateinischen Grammatik*, 9 (1876), 287–338.

[30] See Holger Pedersen, *The Discovery of Language: Linguistic Science in the 19th Century*, transl. by John Webster Spargo (Cambridge, MA, 1931), 293.

[31] For an account of his life and work see John E. Joseph, *Saussure* (Oxford, 2012), where full references are provided for the information in the following pages.

thus already had publications forthcoming when he began his doctoral studies at Leipzig, something as unusual then as it would be now.[32]

Saussure's education had given him a firm grounding in Latin and Greek, and he had taught himself Sanskrit, with the help of a family friend. At Leipzig Saussure signed up for courses in a range of Indo-European languages: Lithuanian, Old Persian, Celtic; and he regularly attended the seminar in comparative Indo-European grammar given by the senior professor, Curtius, as well as courses in historical phonology and the history of linguistics. During that first semester, he gave two *Vorträge* (lectures or presentations) in Curtius's seminar, although he was not officially enrolled in it. These he was expected to present in German, though when it came to his doctoral thesis, no objection was raised to his writing it in French.[33]

The first semester went from November to February, the second March to July. The students were also invited, and expected, to accompany their lecturers and professors to a local pub one evening a week, for informal discussions; but Saussure stayed away, apparently feeling uncomfortable among them, partly because he was a foreigner, but mainly because he had grown up in an aristocratic milieu and found it hard to fit in with his teachers and most of his fellow students.

In his second year at Leipzig, 1877–78, it does not appear to have caused consternation among his teachers that he was not attending all his lectures. He later claimed to have attended none at all, but his notes of various courses have survived and suggest that he was actually rather assiduous. Still, he had hunkered down to write a long and intricate paper, not as part of his university studies, but with the intention of having it published. It ended up being so long that it had to appear as a book.[34] It was issued in December 1878. The title page says 'printed by B. G. Teubner', and the printing was paid for, at great expense, by Saussure's father. Not enough is documented as yet about scholarly editorial practices in this period, but it is doubtful that any publisher would have risked their capital on a highly technical linguistic study by a young student with no university degree.

[32] He sent in the first paper in April 1876, together with his letter applying for membership in the Société. Intended as proof of his worthiness to join, the paper was impressive enough not only for him to be made a member, but to be accepted for publication, appearing as 'Le suffixe –t–', *Mémoires de la Société de Linguistique de Paris*, 3/3 (1877), 197–209. Five additional papers by Saussure would appear in the 1877 volume, which is all the more remarkable given that he would have only some two dozen publications over his entire career.

[33] Saussure did not consider himself to be bilingual. He understood German without difficulty but was uncomfortably aware of his limitations in speaking and writing it.

[34] Ferdinand de Saussure, *Mémoire sur le système primitif des voyelles dans les langues indo-européennes* (Leipzig, 1879).

It made an immediate splash, as it proposed a radically new way of conceiving historical Indo-European phonology. It arguably also introduced the approach that in later decades would come to be called structuralism. Saussure wrote it because he was anxious to get his ideas into print before anyone else did. He was afraid that someone—perhaps Brugmann, the one lecturer with whom Saussure struck up a friendship, or Osthoff, Brugmann's collaborator—was following the same path as he was. In fact they were not. But for their part they felt, on reading the book, that he had appropriated certain ideas of theirs without proper citation. He sensed, exaggeratedly, that he had become *persona non grata* in Leipzig, and for his third year, 1878–9, he decamped to Berlin, where he undertook the research for his doctoral thesis, choosing to do it on a completely different area of linguistics.

That Saussure could have submitted his book on the Indo-European vowel system for his doctoral degree is implied in the reports filed by his examiners on the thesis that he eventually submitted (see Appendix), and indeed it was perceived as strange that he chose to undertake a new thesis on an obscure topic, when his book had aimed right at the heart of what linguists of the time were focussed on. The reason was that he had decided to obviate any possibility of the whispers of plagiarism being voiced in opposition to his doctoral award.

He was not assigned a supervisor for his thesis; there does not appear to have been a formal system for supervision, though most doctoral students would have been under the wing of a *Doktorvater*, a senior professor whose teaching had inspired them and who was inclined to take them on as protégés. The one requirement Saussure had to meet before undertaking the doctoral thesis was to pay a personal visit to every professor in the Leipzig faculty of philology, at home, in order to explain the plan for his thesis and get their approval. Unfortunately for our purposes, he had no difficulty – if he had, I might be able to report on how the process went when the doctoral plan met with objections. The one remarkable thing in Saussure's case occurred when one of the professors asked him whether he was related to the 'famous' Saussure; Ferdinand replied, 'Yes, I am his great-grandson', thinking that the professor meant Horace-Bénédict de Saussure (1740–1799), a great scientific name of the previous century. But in fact he meant the famous author of the recent book on the Indo-European vowel system.

Saussure stayed in Berlin from November 1878 to early April 1879. At the end of his stay he chanced to meet Whitney, who was visiting Germany and paid a call at the home of Heinrich Zimmer (1851–1910) during a tutorial session he was giving Saussure in Celtic languages. At the time Zimmer was also translating Whitney's *Sanskrit Grammar* into German.

Saussure returned to Geneva with his accumulated research notes from the five months of reading Sanskrit texts, and completed the thesis by the end of the year. He then went back to Leipzig to submit it for examination.

That made nine months of self-directed analysis and writing up—during which he decided to drop the third part of the thesis, the part that interested him most, in which he was to draw out theoretical issues concerning language and its evolution. The three-part thesis had been the plan approved by the professors of the faculty, but, being in Berlin, he could not – or perhaps would not—go back to them with a revised plan. He was aware of taking a risk in submitting just the first two parts for his doctorate. On 15 February 1880 the thesis was certified by Ernst Windisch as acceptable for oral defence, and on 17 February, Curtius, wrote his concurring report, admitting that he had to rely on Windisch for the correctness of the details contained in the thesis. Their reports are contained in the Appendix to this chapter.

The oral defence took place on 28 February. These were public events, and a cousin of Saussure's who attended would later remark that 'You can guess how he passed his examinations; had he not been so modest, the roles could have been reversed: the young examinee could have put his learned examiners' feet to the fire'.[35] The examiners unanimously awarded him a pass *summa cum laude* for the oral defence, in addition to the *egregia* for the written thesis.

We do not know what indication if any Saussure was given concerning the outcome on the day. That evening he treated Brugmann to dinner at one of the best restaurants in Leipzig, along with one of the two fellow doctoral students with whom Saussure had made friends. Brugmann, eager to mend fences with Saussure after their earlier rift, greatly appreciated the gesture, but then was surprised to find in succeeding years that Saussure remained cool toward him, politely declining an invitation to attend Brugmann's wedding the following year and, so far as we know, never seeing him again.

Saussure went home to Geneva, returning to Leipzig in April to receive his degree, and staying there through July doing revisions to the manuscript thesis before having it printed. As with his first book, the doctoral thesis was printed with Saussure paying the costs—which was the common practice at the time. There is no indication of a refereeing process. Saussure had not completed his revisions when he set off for Paris in the autumn, so

[35] 'Allocution de M. Édouard Favre, Président de la Société d'Histoire et d'Archéologie de Genève', in *Ferdinand de Saussure (1857–1913)*, assembled by Marie de Saussure (Geneva, 1915), 27–34, 30.

continued doing them there. Finally in April 1881 the book was in press with a publisher in Geneva, who issued it later that year.[36]

The PhD from Leipzig was Saussure's first university degree. He quickly converted it into a second one, submitting his thesis the Faculty of Letters of the University of Geneva for the conferral of the *docteur ès lettres*, granted him in 1881.[37] There was special provision for this for Genevese citizens who had completed a doctorate in a foreign university. But that was still not enough: Saussure decided to go to Paris to do another doctorate, in the very different French system, where one had to submit both a major and a minor thesis, with the minor one written in Latin. This would qualify him for teaching in a wide range of institutions in France or Geneva. He arrived in Paris in late November 1880, and attended a wide range of courses during that first winter semester, while also participating in meetings of the Société de Linguistique de Paris, and, again, revising his Leipzig doctoral thesis, before finally enrolling as a student in the *École des Hautes Études* on 15 February 1881.

Saussure's Teaching in Paris, Its Impact on Doctoral Training in Linguistics, and the Role of the Learned Societies

Given France's massive defeat in the Franco-Prussian War of 1870–71, one might have expected the country's academic position to have weakened, while that of the newly-established Germany rose. In fact the universities of both countries entered a period of heightened prestige. The French Third Republic was determined to reassert the nation's cultural dominance, and strong support was given to study of the history of the French language and to historical linguistics generally. It was a language scholar, Ernest Renan (1823–1892), who reformulated the country's thinking about language and nationhood following the loss of Alsace to Germany.[38] Dozens of displaced Alsatians wound up at the *École des Hautes Études* in Paris studying the mediaeval Germanic languages from which their dialect descended. The courses in Gothic and Old High German were given by

[36] Ferdinand de Saussure, *De l'emploi du génitif absolu en sanscrit, thèse pour le doctorat présentée à la Faculté de Philosophie de l'Université de Leipzig* (Genève, 1881).

[37] This is recorded in the *Livre du recteur* (Rector's book) for the Université de Genève for that year.

[38] Ernest Renan, *Qu'est-ce qu'une nation? Conférence faite en Sorbonne, le 11 mars 1882* (Paris, 1882). On the enduring importance of this book see Benedict Anderson, *Imagined Communities: Reflections on the Origin and Spread of Nationalism*, 2nd ed. (London and New York, 1991) [1st ed. 1983]; John E. Joseph, '842, 1871 and All That: Alsace-Lorraine and the Transformations of Linguistic Nationalism', in Wendy Ayres-Bennett and Mari C. Jones (ed.), *The French Language and Questions of Identity* (London and Cambridge, MA, 2007), 44–52.

the Alsatian Michel Bréal (1832–1915). In 1879 Bréal was named *Inspecteur général de l'enseignement supérieur* (General Inspector of Higher Education) by the Third Republic. By late 1881, the burden of this national responsibility had become such that Bréal, having recognized Saussure's talents through their interactions at the Société de Linguistique de Paris, asked him to take over the teaching of his courses.

High administrative posts were the primary means by which senior professors in France could afford the upper-middle class lifestyle that their university salaries would not support, and the vacancies they created were the main stepping stones toward a professorial post for young scholars who had completed their doctorate. Saussure had a Leipzig doctorate and two published books, the second focussed on Sanskrit. Whether this was enough to qualify him to teach at university level Gothic and Old High German, languages which he had never formally studied, when he had no previous teaching experience whatever, might seem debatable—but no one was likely to question the choice of the General Inspector of Higher Education himself, Bréal.

A more ticklish problem was posed by the formal requirement imposed by the Third Republic for all those teaching in its universities to be French citizens, which Saussure was not. As a citizen of the Republic of Geneva, and of Switzerland, both proudly neutral toward other nations, he was disinclined to take the French citizenship to which he was also entitled, as his brother Léopold had done in order to become a French naval officer. In Léopold's case this had been accepted within the family and their wider Genevese circle on the grounds that, whatever else the Swiss might boast of having, a navy was not among them. For Ferdinand, however, this would have provoked discomfiting tensions: his father was a pragmatic Francophile, and his paternal uncle a committed neutralist, while his mother's family supported Germany. Bréal managed to get a dispensation for Saussure on the nationality requirement, but it would store up trouble for later years as Saussure's hopes grew for appointment to a chair, where no such dispensation would be possible.

Saussure threw himself into the teaching to the point that his plans to do a French doctorate fell by the wayside. He was in the French academic system now, and would remain there for ten years, seemingly on track eventually to succeed Bréal in his chair, though in the event Bréal would not retire for another twenty-plus years. Hence Saussure was never in a position to direct anyone's doctoral research in Paris. But the unique value of his teaching came to be widely recognized, and he exerted a strong influence on a generation of French doctoral candidates across various branches of Indo-European linguistics. In the 1850s linguistics had still been in the process of becoming distinct from the broader aims of traditional philology. By the 1880s, the separation was clear, yet linguistics retained its philological orientation toward ancient texts. Hundreds of doctoral theses were written on Ancient Greek, Classical Persian and Sanskrit, with scant interest shown in Modern Greek or Persian, or contemporary languages of northern India. There were speakers of all these languages living in French and German cities, so it was not a matter of the difficulty and expense of travel to foreign climes. Even studies of Celtic languages were oriented toward old texts, despite the fact that a living Celtic language, Breton, was spoken within France.

Behind this orientation was a combination of tradition and ideology. Just as modern literature was a long time in gaining acceptance as a fit subject for university study, so too were modern languages, unless, like Arabic and Chinese, they had a 'classical' version, or were exotic enough to qualify for anthropological investigation. This takes us back to the Müller-Whitney debate and Latour's polarization, in as much as anthropology pointed toward the Nature pole, whereas the faculties of letters in which linguistics was housed saw themselves as the domain of the Subject, with Society as its adjunct.

Although, as explained earlier, courses at the *École Pratique des Hautes Études* were nominally seminars but actually teacher-led, Saussure's classroom method was seminar-like in the level of active responsibility turned over to the students. They were surprised to hear him insist that the way to understand a language was not to study the most authoritative grammars of it, but to sit down with texts written in the language and deduce the grammar for themselves; and, moreover, if the language had a living variety, to go out, listen to it and record texts for analysis.[39] Three of Saussure's Breton students, Joseph Loth (1847–1934), Émile Ernaut (1852–1938) and Georges Dottin (1863–1928), became leading lights in Celtic studies after being inspired by his teaching. Loth was preparing for the *agrégation* in grammar, and would begin teaching the following year at the renowned secondary school Collège Stanislas. In 1883 he would return to Brittany, becoming professor of Celtic languages and eventually Dean of the Faculty of Letters at Rennes. In 1884 he won the coveted Prix Volney for his Old Breton vocabulary,[40] and in 1910 he was appointed to a chair in the Collège de France. Nine of his works, dating from 1870 to 1909, were in Saussure's personal library, mostly offprints that Loth had sent to

[39] On Saussure's own attempt to do this in Lithuania in 1880, see John E. Joseph, 'Why Lithuanian Accentuation Mattered to Saussure', *Language and History*, 52/2 (2009), 182–98.

[40] Joseph Loth, *Vocabulaire vieux-breton, avec commentaire, contenant toutes les gloses du vieux-breton, gallois, cornique, armoricain connues, précédé d'une introduction sur la phonétique du vieux-breton et sur l'âge et la provenances des gloses* (Paris, 1884).

his old teacher.[41] Dottin published widely, became Dean of the Faculty of Letters at Rennes, which now has a Rue Georges Dottin in his honour. Ernault made his mark as a specialist in Old and Middle Breton at the Faculty of Letters in Poitiers, and, as 'Emil Ernod', was a leader of the Breton revival movement. A quarter-century later he sent Saussure a copy of his book on French orthography.[42] Ernault had already begun calling for study of the living Celtic dialects in the 1870s; Loth, within a few years of his studies with Saussure, took up the call in more strident terms. He directly criticized linguists for having done so little done on the existing dialects, preferring to rely on the very partial information supplied by medieval texts. Echoes of Saussure's lectures can be heard in an article Loth published in 1896: 'the exact and precise knowledge of the sounds of a still living language must be the very foundation of all research concerning the life and history of this language'.[43]

Saussure's most devoted student of all would prove to be Antoine Meillet (1866–1936), who first attended his courses in 1887, and went on to be Bréal's successor and the *doyen* of linguistics in France for decades to come. Meillet was studying the Armenian language, in the traditional way until, with Saussure's encouragement, he joined an excursion to Armenia in 1891 to research the living language. For more than thirty years after Saussure's death, Meillet would continue to point doctoral students in the directions Saussure had indicated: understanding language as a social fact, and one that needed to be understood synchronically, that is, as a self-contained system existing at a given point in time.[44] Even historical study

[41] See Daniele Gambarara, 'La bibliothèque de Ferdinand de Saussure', *Geneva*, n.s., 20 (1972), 319–68, 348–9.

[42] Ibid, 338.

[43] Joseph Loth, 'Alphabet phonétique', *Annales de Bretagne*, 11 (1896), 233–5, on 233.

[44] Meillet's influence would extend beyond linguistics proper: a notable example is the work of the American classicist Milman Parry (1902–1935), who did his PhD on Homeric meter under Meillet's supervision, and then, inspired by Meillet, travelled to the Balkans to record contemporary epic song. Parry's work would have a wide posthumous influence through his associate Albert B. Lord's (1912–1991) book *The Singer of Tales* (Cambridge, MA, 1960), and through Lord's Harvard colleague Eric Havelock (1903–1988), whose *Preface to Plato* (Oxford, 1963) mounted a serious challenge to traditional presumptions about the limitations of oral tradition. Those presumptions would be challenged even more strongly a few years later by Jacques Derrida (1930–2004), whose linguistic interests had been shaped in part by his reading of Saussure, in part by the lectures of Meillet's student Émile Benveniste (1902–1976): Derrida, *De la grammatologie* (Paris, 1967) (English version, *Of Grammatology*, trans. Gayatri Chakravorty Spivak, 2nd ed. (Baltimore, 1997)) and *L'Écriture et la différence* (Paris, 1967), English version *Writing and Difference*, trans. Alan Bass (Chicago, 1978); and Émile Benveniste, *Dernières leçons, Collège de France, 1968 et 1969*, Jean-Claude Coquet and Irène Fenoglio (eds.) (Paris, 2012). English version, *Last Lectures: Collège de France, 1968 and 1969*, trans. John E. Joseph (Edinburgh, 1999).

needed to take this orientation: in Saussure's view, it was chasing phantoms insofar as it traced the evolution of individual sounds or forms through the centuries. It needed to be rethought as a 'diachronic' study, in which a whole language system as it existed at time A is compared with the whole system as it existed at time B. This was because, for Saussure, the individual elements of a language mean nothing in isolation; their value is generated by their difference from all the other elements in the system.

If the 'social' nature of language as professed by Saussure and Meillet suggests that they were located squarely at one end of Latour's polarization, its status as a 'system' in which everything connects to and supports everything else (*tout se tient*) pulls it in the opposite direction, making it well and truly a hybrid. The tension between these pulls would affect developments in linguistics through the twentieth century and beyond.

Saussure decided to return home to Geneva in 1891, for a constellation of reasons, one of which directly involves the disciplinary separation of philology and linguistics. The very unusual circumstance arose that two chairs of Sanskrit fell vacant in Paris within a short time, one of them through the accidental death of the still-youngish incumbent. The first chair went to a student of Saussure's who was seen as the rising star in Sanskrit studies. The second one came to be disputed between two men a few years older than Saussure, neither particularly distinguished as a Sanskritist nor exhibiting anything like Saussure's genius. Despite having written a hugely important first book on Indo-European languages and a second book specifically on Sanskrit syntax, Saussure was never considered for the chair – probably because he had never become a member of the *Société Asiatique* (Asiatic Society) or attending its meetings. His affiliation was strictly to the *Société de Linguistique*, to which he devoted great energy. Most Indo-Europeanists went to both; but the *Société de Linguistique* had broken off from the *Société Asiatique* in 1866 precisely because the older organization was 'philological' in scope, including linguistic study but putting it on a par with religious, literary and cultural topics. When the chairs of Sanskrit fell vacant, everyone's thoughts turned to which scholars of the *Société Asiatique* might fill them. There is ample evidence that Saussure was wounded by being passed over for men of inferior talent. When he was offered a professorship at the University of Geneva, he chose to designate it as the Chair of Sanskrit and Comparative Indo-European Linguistics, and to make Sanskrit his main teaching subject, although he had never taught it previously.

Saussure and General Linguistics

By the first decade of the twentieth century, linguistics was no longer perceived as the dynamic field of study that it had seemed in the years leading up to 1876 and even more so in the years following it. The historical study of Indo-European languages had settled into being a rather comfortable institutionalized discipline. Germany continued to be perceived as the great powerhouse of linguistics, a field understood in this period to mean the historical study of languages, until the First World War. The study of language was certainly progressing, and in new directions, but ones led by people whose institutional commitments were to other fields, sometimes jointly with linguistics, but in other cases quite separate from it. These included psychology and psychoanalysis, sociology, philosophy, aesthetics and anthropology.

Other things were happening at the time, in Geneva as well as in France and Germany, that were changing the division of labour in the linguistics-philology field. The study of phonetics had come into its own, in Paris with Father Pierre-Jean Rousselot (1846–1924), for whom a phonetics laboratory with equipment for recording and visually analysing speech was established in the university;[45] and in Oxford, with Henry Sweet (1845–1912), one of the models for Bernard Shaw's Professor Henry Higgins.[46] In Germany, another sort of laboratory gained great attention: Wilhelm Wundt's (1832–1920) laboratory for psychological research, including into language. At the same time Saussure was hired at Geneva, so was Théodore Flournoy (1854–1920), who had done his doctorate in Germany under Wundt and was provided with a lab similar to Wundt's at Geneva. Saussure himself never directed a doctoral student: when one of his students or colleagues wanted to undertake doctoral studies in linguistics, he helped to arrange their studies at a French or German university; and if it was on the mechanisms of language generally, as opposed to the historical study of languages, it would be done in the psychology faculty. Meanwhile, in France, Meillet had become the principal linguist on Émile Durkheim's (1858–1917) team for the *Année sociologique*, where psychology was the crux of the famous debate between Durkheim and Gabriel de Tarde (1843–1904) about sociological method, which Durkheim won by default when the psychologically-inclined Tarde died in 1904.

[45] See Haun Saussy, *The Ethnography of Rhythm: Orality and its Technologies* (New York, 2016).

[46] See Beverley Collins, 'Sweet, Jones, and Bernard Shaw', *Bulletin of the Henry Sweet Society for the History of Linguistic Ideas*, 9 (1987), 2–7.

In Geneva, the course in general linguistics that Saussure had avoided as a student fell upon him to teach. In the three goes he had at giving it between 1907 and 1911, Saussure—all of whose published work was historical in nature—famously articulated the need for synchronic study, as the study of a language system at a given point in time, which would be the starting point for a reconceived diachronic linguistics, that comparison of synchronic states of whole systems intended to replace the atomistic historical linguistics at which the German universities excelled. After the War, Saussure's call would gradually be put into practice in various universities across Eastern and Western Europe. In Britain and the USA, synchronic study grew in tandem with anthropology. In Germany, things took a different course, with the rise of Neo-Idealism in linguistics,[47] although historical study in the Neogrammarian vein continued to be carried on.

Saussure saw none of these developments, having died in 1913, believing that he had squandered all his early promise and was quite forgotten. When two of his colleagues gathered his and his students' notes to assemble the book they published in 1916 as the *Cours de linguistique générale* (Course in General Linguistics),[48] they did more than produce a textbook: they completed, or nearly completed, the break with philology that had begun a century before, and laid the ground for a modern disciplinary identity that ultimately reunited the various directions of enquiry that had been parcelled out to adjacent fields, and that continues to, maybe not thrive, but survive, a century on.

The story of doctoral training in linguistics after 1914 is generally one of continuity with the preceding period, apart from how the reorientation from classical to living languages, in tandem with the anthropological turn, resulted in fieldwork and other forms of empirical research becoming the expectation rather than the exception. The basic structure of training through doctoral seminars, followed by the supervised writing of a monographic thesis, has remained intact until recently, when the submission of a thesis structured as journal articles (published or potentially publishable, and in some cases co-authored) rather than as a single-thread monograph, has become acceptable and indeed may soon be the norm.

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[47] See John E. Joseph, 'Saussure: The Accidental Father of Structuralism', *Times Literary Supplement*, Footnotes to Plato (online series), 22 Jan. 2019, https://www.the-tls.co.uk/articles/public/ferdinand-de-saussure-accidental-father-structuralism/.

[48] Ferdinand de Saussure, *Cours de linguistique générale*, Charles Bally and Albert Sechehaye with the assistance of Albert Riedlinger (eds.), (Lausanne and Paris, 1916). (2nd ed. 1922, subsequent eds. essentially unchanged.) Critical ed. by Rudolf Engler, *Ferdinand de Saussure, Cours de linguistique générale, édition critique*, i, 1968; ii, fascicule 4, 1974. Wiesbaden: Otto Harrassowitz. English version, *Course in general linguistics*, trans. Wade Baskin (New York, 1959); another by Roy Harris, London: Duckworth, (LaSalle, IL, 1983).

Appendix: Examiners' Reports on Saussure's PhD Thesis (my translation: JEJ)

Ernst Windisch, 15 Feb. 1880:

Mr F. de Saussure has already proved his brilliant scientific talent through other work, particularly his book *Mémoire sur le système primitif des voyelles dans les langues indo-européennes* (1879), published by Teubner, which here goes completely unmentioned. In the present treatise he shows again, with reference to another area, with what sharpness he is able to grasp scientific questions, and with what clarity he is able to present them. His past productions were focussed on the area of comparative phonology, but he has preferred to submit as his dissertation the discussion of an interesting syntactic phenomenon of Sanskrit, on which the position he took in the earlier area can in no way be applied. The genitive absolute construction in Sanskrit has never before been the subject of a specialized treatment, neither to what extent it occurs, nor how far its use agrees with what Panini noted concerning its meaning. The rich collection of examples of these constructions, (over 400, demonstrated from p. 46 on in very useful applications, by which the formal use of this idiom jumps immediately to the eyes), which actually are rather rare, the fine manner in which is brought to light what really matters, and on which the characteristic of the genitive absolute vis-à-vis the usual locative absolute and the variation of its meaning within certain limits depends, all this one may regard as a pure profit. One misses reluctantly the 3rd Part, which is to treat the origin of the genitive absolute, but still the treatise is in itself final and extensive enough. I found only a very few details to remark upon. Most quotations would not require translation, since they are taken predominantly from the relatively easy epic literature, and in more difficult places the author always communicates what is necessary for understanding along with his interpretation, and here one can occasionally be of a different opinion. I take the liberty to propose the following:

1) That Mr de Saussure be certified for oral examination on the basis of this paper, and

   that this thesis be awarded the mention of *egregia*.[49]

[49] Ernst Windisch, 'Report on doctoral dissertation of Ferdinand de Saussure, University of Leipzig', 15 February 1880, in Paola Villani, 'Documenti saussuriani conservati a Lipsia e a Berlino', *Cahiers Ferdinand de Saussure,* 44 (1990), 3–33, 10–11.

Georg Curtius, 17 Feb. 1880:

For the correctness and sufficiency of the facts here demonstrated about the usage of the Indic languages I must defer to colleague Windisch alone. But in regard to clarity of presentation, the clear arrangement and the perfection with which the crucial points are discussed, I can attach myself with full conviction to his laudatory judgement. It is however regrettable that the projected third part on the origin of the construction has not been executed. This would surely have a high interest for comparative syntax. However what was required is splendid, and when one adds in de Saussure's other writings, one is astonished at the gift, the knowledge and the industry of this young man of just 23 years, who from pure love for science—he seems to live in brilliant financial circumstances—has delved into such problems in such early years with so much success. An oral examination is actually redundant in this case. However I would like to request no precedent for setting it aside and am convinced that the Candidate himself would much rather go through the regular course.

Thus likewise for permission and the mention of *egregia*.[50]

[50] Georg Curtius, 'Report on doctoral dissertation of Ferdinand de Saussure, University of Leipzig,' 17 February 1880, in Villani (cit. n. 49), 11. In fact Saussure's twenty-third birthday would not be for another nine months, and while his financial circumstances may have appeared brilliant to someone who had to get by on a professorial salary and such accompanying emoluments as he could arrange, Saussure's father had nearly ruined himself with risky investments, and his children were on very modest allowances.

9

Field, Ears, and Laboratory: Training Language Scholars, 1920–1940*

Ku-ming (Kevin) Chang

Introduction

Language studies (or *Sprachwissenschaft* in German), as the previous chapter in this volume shows, was for the most part represented by comparative philology (or *grammaire comparée* in France) of Indo-European languages in the nineteenth century. Traditionally, philology had placed great emphasis on the grammar of an individual language, especially Greek or Latin, as it was an indispensable tool for understanding the language and the texts written in it. Pioneers like William Jones (1746–1794), Franz Bopp (1791–1867), and Jacob Grimm (1785–1863) began to study multiple languages of the Indo-European family. This family includes modern European languages—such as English and German (Germanic), French and Italian (Romance), and Russian and Polish (Slavic)—and their medieval predecessors such as Gothic. It also includes classical languages—Latin and Greek—as well as non-Western languages like Persian and Sanskrit, the subjects of Oriental philology. Philologists compared cognate verbs and nouns in related languages (hence 'comparative' philology) and analyzed the differences in their inflectional patterns. Thus they were able to show the transformation of a particular language from its ancient (or medieval) to its modern forms or, conversely, to trace it back to its origin. They even worked to reconstruct the ancestral language of all related modern ones by reversing the patterns induced from their morphological

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and phonological evolutions. These were vertical tracings. Horizontally, scholars classified individual languages into various branches of a family tree. Comparative philology is thus historical, comparative, or often both. Scholars were amazed by its power and value and applied this historico-comparative approach to studying languages of non-Indo-European families—the Semitic, Turkic, Finno-Ugric, and Sino-Tibetan, for example.

Until the late nineteenth century, language scholars were students of letters. They received a solid education in classical philology at university (after serious classical education in secondary school). They also studied the philology of several modern European languages, Sanskrit, Persian, and perhaps several other languages of the Indo-European family. Some even reached into non-Indo-European languages. Their study, reflecting the traditional nature of philological investigation, was based on historical documents. Even phonological investigations were at first based on texts.

The Young Grammarian movement of the 1870 and '80s, which John Joseph refers to in his chapter, gave an important momentum to two new related developments. First, the center of the movement was the sound laws, the pattern of phonological transformations. The attention to sound led to the first development, the study of spoken languages, also known as 'living languages'. These were the modern European languages, including their 'standard languages', dialects, and local accents. The other development went a step further: the study of languages that were never written, such as native American (then known as American Indian) and African languages. Both subjects involved grasping sounds, which could not be done by studying letters in the library alone. Language scholars therefore turned to other methods for their work on sounds and for training junior scholars. In this context, phonetics emerged as a new discipline and linguistics gradually gained its disciplinary identity.

This chapter surveys the training of language scholars in the United States, Britain, France, and Germany in the 1920s and '30s, focusing on certain figures, including men and women, in selected programs of language studies. It follows the paths of their study to illustrate the curricula and the 'instruments' of training, including fieldwork, ears, and laboratory. The survey concludes with a consideration of James Turner's question in the first chapter of this volume: Does training generate a discipline, or does a discipline generate a specific type of training? The discussion also addresses the institutional structure for language studies and the employment conditions for male and female language scholars in the two decades under study.

Fieldwork and American Linguistics

The great majority of American language scholars in the early twentieth century received philological training. Carl Darling Buck (1866–1955), a leader of Indo-European philology in the United States and the president of the Linguistic Society of America (1927), for example, studied Sanskrit philology for his BA and PhD at Yale and then, like many American scholars of his time, pursued advanced work at Leipzig, the mecca of Indo-European comparative philology.[1] Leonard Bloomfield (1887–1949), a superstar in American linguistics in the first half of the twentieth century, completed his BA at Harvard and his PhD in Germanic philology at Chicago and thereafter received further training at Leipzig and Göttingen.[2] Buck, Bloomfield, and many of their colleagues took courses and especially seminars at American universities that were deliberately modeled on German academic training.[3] Training in specialized original research and the application of that training to the doctoral dissertation were required for the Doctor of Philosophy degree, which had become the expected credential for an academic appointment in prestigious American institutions.[4]

A new trend started with the emergence of anthropology around the turn of the twentieth century. The birth of this field in the United States owed much to Franz Boas (1858–1942), who started at Clark University the first department of anthropology in the country, and then taught at Columbia, where he trained a generation of prominent anthropologists in North America. Boas saw language as an integral part of anthropological work and trained his students accordingly. His first doctoral student at Columbia, Alfred Kroeber (1876–1960), investigated American Indian cultures and languages. Edward Sapir (1894–1939), another superstar of American linguistics in the second half of the twentieth century, did the same with Boas, though he differed somewhat from Kroeber in that he had had substantial undergraduate education in German and Sanskrit philology before he turned to anthropology.[5] Both Kroeber and Sapir did fieldwork for their dissertations, signaling a new trend for graduate training, at least in anthropology.

Indeed, fieldwork became a regular component of anthropological work for Boas' students, though the advanced, systematic training it demanded

[1] Buck was the third president of the LSA. The first and second presidents, Hermann Collitz (1855–1935) and Maurice Bloomfield (1855–1928), had similar resumes. Collitz was born in Germany and immigrated to the United States, while Bloomfield was born in Austria and grew up in the United States. Both studied the philology of Sanskrit and other Indo-European languages, and both settled into teaching at Johns Hopkins University.

[2] Bloomfield wrote his dissertation on 'a semasiologic differentiation in Germanic secondary ablaut' at the University of Chicago in 1909. Bernard Bloch, 'Leonard Bloomfield', *Language*, 25/2 (1949), 88.

[3] Roger L. Geiger, *To Advance Knowledge: The Growth of American Research Universities, 1900–1940* (New York, 1986), 20.

[4] Geiger, *To Advance Knowledge*, 30.

[5] Regna Darnell, *Edward Sapir: Linguist, Anthropologist, Humanist* (Berkeley, 1990), 7.

was not necessarily provided. Teaching his students Eskimo vocabulary and myths, Boas worked with them to induce the grammars of American Indian languages from transcriptions. He invited Eskimo speakers to his class, which took place either at his home or at the American Museum of Natural History, the latter of which he was affiliated with.[6] Little is known about the way Boas trained his students for fieldwork. If there was any training, it was informal. On the other hand, it is known that Boas helped students apply for and receive funding for their dissertation fieldwork.[7] Thus, at least they did not work in the field at their own expense.

Fang-Kuei Li (1902–1987) was one of the very few scholars who studied with both Sapir and Bloomfield. In 1926, Li started his graduate study at Chicago in the Department of Comparative Philology, General Linguistics, and Indo-Iranian Philology, with a small but stellar faculty.[8] At the time, Buck was the chair of the department. Sapir arrived at Chicago in 1925, with his major appointment in the Department of Sociology and Anthropology. Prior to his appointment, he had been the head of the Anthropology Section at the Canadian Geographical Survey. Bloomfield came to Chicago from Ohio State University in 1927 to replace his doctoral supervisor, Francis Wood (1859–1948), a professor of German philology who had just retired. Thanks to the interdisciplinary culture at Chicago, Buck, Sapir, and Bloomfield taught courses that were co-listed in Li's department, despite their major appointments in three different departments.[9]

What distinguishes American graduate school then and now from its European counterparts is the substantial and structured doctoral coursework that the student is expected to complete. A native Chinese, Li received undergraduate education at Michigan, where he studied Latin, Old English, Middle English, Gothic, Middle-High German, and modern German.[10] Li remembered taking courses with Sapir in his first year (1925–26) at Chicago ('General Introduction to Linguistics' and 'Types of Linguistic Structure') and with Bloomfield in his second year ('Gothic' and 'Old High German'). He probably worked with Buck both years,

[6] Theodora Kroeber, *Alfred Kroeber: a Personal Configuration* (Berkeley, 1970), 46–8.

[7] Edward Sapir, 'To W. H. Holmes, Chief of Bureau of Ethnology', 5 July 1906, Bureau of American Ethnology Records, Letters Received 1888–1906, Box 113, National Anthropological Archives, Smithsonian Institution, Suitland, MD.

[8] From 1893 to 1938, this department turned out only sixteen PhDs, and only five in the decade between 1921 and 1930.

[9] Two more scholars taught courses listed in this department: the Sanskrit scholar Walter Eugene Clark (1881–1960) and a scholar of Romance languages, Clarence L. Parmenter (1890–1965), who taught phonetics.

[10] Fang-Kuei Li, 'Fang-Kuei Li, Linguistics East and West: American Indian, Sino-Tibetan, and Thai: Oral History Transcript' (1988), 7–8, Regional Oral History Office, The Bancroft Library, China Scholars Series.

when Buck taught 'Introduction to the Historical Study of Language', 'Outlines of the Comparative Grammar of Greek and Latin', several historical Indo-European languages (including Greek, Latin, Sanskrit, Avestan, Old Persian, and Lithuanian, among others), and the department seminar.[11] Though not all these courses were seminars in name, they fostered close interaction between the professor and his students. Bloomfield personally explained difficult works to Li, the only student in class, and Sapir regularly assigned to Li readings that he had just come across and had not yet included on the syllabus.[12] Li developed from one of Sapir's classes his MA thesis on the verb stems of Sarcee, an American Indian language of the Athabaskan family. As Sapir had not supervised any students at the Canadian Geographical Survey, which was not an educational institution, Li became Sapir's first MA and doctoral student.

Li learned fieldwork on site instead of in school. Sapir took Li to Northern California in the summer of 1927, where they worked together for two weeks interviewing speakers of American Indian languages in the Hoopa Valley. Thereafter, Sapir and Li did similar interviews with a different language group nearby.[13] Then Sapir left Li alone. Li continued on his own, applying his newly acquired skills in Mattole by interviewing the last speaker of the language. When he thought he had reached the point of diminishing returns, he stopped and moved on to another tribe, again on his own. Li's transcription and analysis of the Mattole language was completed late in 1927. When Sapir read it, he suggested that Li submit it as his doctoral dissertation.[14]

Fieldwork for a doctoral degree in language studies was relatively new. For comparative philology, work was usually done in the library or the personal study. Even Bloomfield, an accomplished scholar of American Indian languages by then, completed his dissertation in German philology without fieldwork. Sapir, however, took fieldwork for language studies seriously, thanks to his previous training in anthropology. 'Fieldwork among primitive peoples is the very life of [the anthropologists'] discipline', Sapir said. He wanted to let Li 'develop a first-hand acquaintance with field methods in the study of aboriginal languages.'[15]

[11] Sapir offered a 'Psychology of Language' course in 1927–28, which Li never mentioned taking. *The University of Chicago Announcements: Annual Register, 1926–1927* (Chicago, 1927), 172–3; *The University of Chicago Announcements: Annual Register, 1927–1928* (Chicago, 1928), 196–7; Li, 'Fang-Kuei Li', 10–12. For the early curriculum of language studies at Chicago, see also Michael Silverstein, 'The History of Organization of a University of Chicago Unit Dealing with Linguistics', 2006, 1–2 <http://home.uchicago.edu/~merchant/History.of.Linguistics.Department.Chicago.pdf>.

[12] Li, 'Fang-Kuei Li', 9–13. [13] Ibid, 14–16. [14] Ibid, 17, 18.

[15] Edward Sapir, 'An Expedition to Ancient America: A Professor and a Chinese Student Rescue the Vanishing Language and Culture of the Hupas in Northern California', *The University of Chicago Magazine*, 20 (1927), 10.

Sapir and his contemporaries wrote very little about the content of field methods. Presumably Li just picked them up directly from Sapir as the two of them worked alongside one another in the field. Li directly observed Sapir selecting and interviewing informants and saw his advisor take down and organize transcriptions first hand. The characteristics of language fieldwork from this period can only be partly induced from Li's study record, his oral history, and the few of Sapir's writings that touched upon this. The first of these common characteristics was the selection of an informant (or informants) who spoke both English and the native language; an interpreter was used if no such informant existed.[16] The goal of the fieldwork was not to learn to speak the language, but instead to record it and analyze it on paper.

Second, the recording depended mainly on transcription, especially transcription in phonetic symbols. American language scholars did not bring recording devices with them into the field, for at this time the cylinder phonograph allowed very short recording times and was hard to transport and operate on the Indian reservations.[17] Nothing in Li's oral history suggests that he learned transcription or phonetics with Sapir or anyone else before the field trip. Yet, since he studied Sarcee for his MA thesis, which had previously only been available in transcription, we can deduce that he must have learned to read transcriptions in class (probably with Clarence E. Parmenter, the phonetics instructor at Chicago) or by working in private with one of his teachers, most likely Sapir.[18] In the field, Sapir allowed Li to observe the way he interviewed the informant. Sapir often started by asking the informant to say, for example, 'I am gone' and 'he is gone' in the Indian language. Sapir and Li each wrote down what they heard and compared their notes only in the evening. Li learned or consolidated his hearing and transcription by corroborating it with Sapir's side by side.

Third, funding for dissertation fieldwork was available. As seen above, Sapir had received financial support for his fieldwork in graduate school.

[16] Ibid, 11.

[17] Julia S. Falk, *Women, Language and Linguistics: Three American Stories from the First Half of the Twentieth Century* (London, 2002), 117.

[18] At Chicago, Clarence L. Parmenter, taught 'Physiological Phonetics' and 'Experimental Phonetics', courses also listed under Li's department. *The University of Chicago Announcements: Annual Register, 1925–1926* (Chicago, 1926), 173. According to Julia Falk, phonetic transcription was not formally taught anywhere in the United States in the 1920s and '30s. Falk, *Women, Language and Linguistics*, 117. Sapir indicated in a letter that he taught a phonetics course in the academic year 1926–27, and that eleven students were in that class. Edward Sapir, 'To Alfred Kroeber', 11 February 1927, 3, A. L. Kroeber Papers (1869–1972), Bancroft Library, The University of California at Berkeley. This might have been the course 'General Introduction to Linguistics'.

Li received his aid from the Committee on Native American Languages, which, supported by the American Council of Learned Societies, consisted of Boas (chair), Sapir, and Bloomfield. Sapir wrote a letter of strong support to Boas and secured the funding for Li's fieldwork. Sapir wrote another letter to Kroeber, who after completing study with Boas had been teaching at the University of California in Berkeley, obtaining an institutional sponsorship for Li.[19]

Fourth, the objective of fieldwork was the empirical description and analysis of an Indian language, though for Sapir there were other incentives. Li's dissertation, which derived from his fieldwork, studied the phonology (consonants and vowels), morphology (prefixes of several kinds and classifiers), and lexicon (verb stems, noun stems, pronouns, numerals, and particles) of Mattole, and produced a transcription of Mattole stories.[20] Sapir, in addition, sought the original features of the whole Athabaskan family, to which Mattole belonged, based on the work by himself, Li, and others on Navajo, Sarcee, and more Athabaskan languages.[21] Sapir acknowledged that the work was largely an application of the Indo-European comparative method to American Indian languages.[22] In a paper that was published posthumously, Sapir elaborated on the significance of the fieldwork on American Indian languages that went beyond Indo-European philology:

> It is of great pedagogical importance for a young Indo-Europeanist or Semitist to try to work out inductively the phonetic system and morphology of some language which is of an utterly different structure from those that he has been studying. Such an experience frees him from numerous misconceptions and gives him the very best evidence that he could wish for the phonetic and grammatical consistency of a language that is handed down entirely by word of mouth. One may go so far as to say that only students who have had this type of experience have a thoroughly realistic idea of what language is.[23]

Lastly, the success of the fieldwork depended primarily on the investigator's ears. Linguists from this period constantly praised their colleagues for their good ears or complained about others for their bad ears. Li was

[19] Edward Sapir, 'To Franz Boas', 9 May 1927, 13, Franz Boas Papers, American Philosophical Society; Sapir, 'To Alfred Kroeber'.

[20] Fang-Kuei Li, 'Mattole, an Athabaskan Language' (unpublished Ph.D. Dissertation, University of Chicago, 1928).

[21] Sapir, 'An Expedition to Ancient America: A Professor and a Chinese Student Rescue the Vanishing Language and Culture of the Hupas in Northern California', 11.

[22] Edward Sapir, 'The Status of Linguistics as a Science', *Language*, 5/4 (1929), 207.

[23] Edward Sapir, 'The Relation of American Indian Linguistics to General Linguistics', *Southwestern Journal of Anthropology*, 3/1 (1947), 4.

distinguished in Sapir's mind by his excellent ears.[24] Interestingly, they spoke of ears as a gift, and do not seem to have discussed the possibility that good ears could be the result of proper training. The training of ears, or auditory training, will be considered in the discussion of Daniel Jones's Department of Phonetics at University College London below.

Like Boas, Sapir continued to train all his students, except Li, in both anthropology and linguistics. Only Li was allowed to specialize in linguistics alone. Sapir expected Li to do fieldwork, as did students of anthropology; he never asked him to take any courses in that department or to do any ethnographic observation in the field or for his dissertation. Understandably, the bond between anthropology and linguistics was easier for Li to break, for after all, his departmental affiliation was comparative philology and linguistics.

Bloomfield formed an intriguing contrast to Sapir. In one class Bloomfield assigned a medieval document to Li,[25] asking him to find any Germanic use of case in Old English. Li reported a particular use of the genitive. When Li completed an outline of his finding, Bloomfield asked him to expand it into a dissertation. Li did not follow the suggestion, because he had already written a dissertation with Sapir—which Bloomfield had not known.[26] While Sapir arranged for Li to keep linguistics as his sole discipline, Bloomfield asked Li to stay within the terrain of textual studies, the traditional subject of philology, for his dissertation. This is significant, for Bloomfield himself had begun work on American Indian languages by then. What he did with Li was not an exception. The few other PhDs in Li's department in the 1920s and '30s worked on classical, Germanic (including Norwegian), and Iranian philology based on textual studies.[27] Li was the only person who worked for his PhD on a subject not traditionally defined as philology.

Those pursuing language studies, both men and women, did fieldwork for their dissertations if they were in the department of anthropology. Harry Hoijer (1904–1976) completed at Chicago a dissertation based on his fieldwork under Sapir in 1931. He received more organized fieldwork

[24] Sapir, 'To Alfred Kroeber', 4; Li, 'Fang-Kuei Li', 19, 20, 21.

[25] King Alfred the Great's Old English translation of *Pastoral Care* from the ninth century. Ibid, 11–12.

[26] In fact Bloomfield advised very few doctoral students throughout his career.

[27] Clive Harcourt Carruthers (PhD 1926) was a classical philologist, Guy Richard Vowles (also 1926) became professor of German but specifically worked on Norwegian philology. Francis Ralph Preveden (PhD 1927) did work in classical philology and attempted to create a chair in Croatian studies in the United States. George Sherman Lane (1930 PhD) studied Sanskrit and came to work on Tocharian, an Iranian language. *Register of Doctors of Philosophy, June, 1893-April, 1938* (Chicago, 1938), 47–8.

training in the Laboratory of Anthropology Field School in New Mexico that Sapir directed. Though it was a laboratory of anthropology, both linguistic and anthropological fieldwork was carried out.[28] Mary Haas (1910–1996) first studied with Sapir in Chicago, moved with him to Yale in 1931, and received her doctorate there. She did her first fieldwork with her husband and fellow student Morris Swadesh (1909–1967). Haas entered language studies after another woman, Gladys A. Reichard (1893–1955). While studying with Boas at Columbia, Reichard did her fieldwork with the senior scholar Pliny Earle Goddard (1869–1928) and received her PhD in 1925.[29] Reichard, Hoijer, Haas, and Swadesh all did both ethnographical and linguistic work in the field. Hoijer especially continued to work on both through his career.

In the 1930s, however, there emerged a distinction between two groups of Sapir's students at Yale. One was composed of 'not very linguistic anthropologists' and the other of 'not very anthropological linguists'.[30] Swadesh and Haas belonged to the linguist group. Employment conditions were difficult during the Depression. They were perhaps somewhat better for anthropologists, as there were already anthropology departments and museums in the United States, but not favorable to linguists, and even less to women linguists. Haas went from one grant to another, finally joining the faculty of the Department of Oriental Languages at Berkeley in 1948.[31]

Britain

Britain required no graduate degree for academic appointments in almost all fields (and in language sciences in particular), and offered limited graduate courses, until quite late in the twentieth century.[32] Daniel Jones

[28] The objective of the laboratory school was to study the culture and language of the Navajo tribe. It began with a week of preliminary lectures, four hours a day, on Navajo morphology and then worked directly with Navajo informants and interpreters. David W. Dinwoodie, 'Textuality and the "Voices" of Informants: The Case of Edward Sapir's 1929 Navajo Field School', *Anthropological Linguistics*, 41 (1999), 170.

[29] For Reichard, see Falk, *Women, Language and Linguistics*, 111–19.

[30] Stephen O. Murray, 'A 1978 Interview with Mary R. Haas', *Anthropological Linguistics*, 39/4 (1997), 695, 698; Regna Darnell, 'Mary R. Haas and the "First Yale School of Linguistics"', *Anthropological Linguistics*, 39/4 (1997), 557.

[31] Victoria Golla, 'The Formative Influences on Mary R. Haas's Career', *Anthropological Linguistics*, 39/4 (1997), 553; Darnell, 'Mary R. Haas and the 'First Yale School of Linguistics', 562.

[32] The PhD became an expected credential for a university teaching position first in the natural sciences and technology, around the mid-twentieth century. This happened later in the humanities and social sciences. See, for example, Renate Simpson, *How the PhD Came to Britain: A Century of Struggle for Postgraduate Education* (Guildford, Surrey, England, 1983), 162; Ernest Rudd, 'The Value of a Ph.D in Science or Technology in Britain', *European Journal of Education*, 21/3 (1986), 232.

(1881–1967), the most important British scholar of language in the first half of the twentieth century, had no graduate degree. Instead of philological training, he earned a bachelor's degree in law, though without interest in a legal career. He was exposed to phonetics when learning German in a language program that was led by William Tilly (1860–1935), a follower of Wilhelm Viëtor (1850–1918), professor of English philology at Marburg and the champion of the Reform Movement in language teaching.[33] For Viëtor and Tilly, language learning should no longer be limited to memorization and translation exercises on paper, and must include actual and precise listening and speaking. They proposed the use of phonetic symbols to convey accurate pronunciations in their heavy emphasis on listening and speaking. After German, Jones learned French in another language program that followed Viëtor's method. This program was run by the French phonetician Paul Passy (1859–1940) in Paris. While learning French in Paris, Jones took the opportunity to sit in on a course that Passy led at the École Pratique des Hautes Études. This course ran like a seminar, in which students took turns presenting a paper based on their phonetic analysis of a dialect or a minor language.[34] This was where Jones learned research methods. Though he received no degree from the Sorbonne,[35] his performance won Passy's enthusiastic support for a position at University College London (UCL).

The timing was great for Jones's appointment at the UCL in 1906. His predecessor, Ernest Edwards (1871–1948), had also studied with Passy. Thus, his French master's recommendation worked in Jones's favor. In addition, Edwards left to be the inspector of schools in London. In that position he encouraged all language teachers in schools to apply phonetics to their teaching. Indeed, London's board of education added phonetics to regular training of elementary schoolteachers. This addition ensured that Jones had a steady stream of schoolteachers in his evening class on phonetics, the only one in London at the time, or rather, Britain.[36] In addition, different language departments at UCL, inspired by the precedents of Viëtor in Germany and Passy in France, also developed an interest in phonetics. Jones was first hired by the French department, though the Department of German also had offered a course in phonetics shortly

[33] A. P. R. Howatt, *A History of English Language Teaching* (Oxford, 1984), 131–8, 161–79.

[34] Beverley Collins and Inger M. Mees, *The Real Professor Higgins: The Life and Career of Daniel Jones* (Berlin & New York, 1999), 25.

[35] Jones did take the examination for a certificate in the phonetics of French and received an excellent score. Ibid, 25–6.

[36] Daniel Jones, *The Pronunciation of English* (Cambridge, 1909), viii; Collins and Mees, *The Real Professor Higgins*, 29, 30.

before his arrival. Jones had his own department for phonetics in just a few years. In the academic year 1915–16, ten years after Jones's arrival at UCL, there were fifty-two courses listed in the offerings of his department, most of which were provided for students from the individual language departments.[37] By 1922, he had nine full-time assistants in his department.[38] The interest in phonetics therefore was high at the time of Jones's appointment and soared shortly thereafter.

New factors after World War I further elevated the political and cultural value of phonetics. The war spurred the proposal of a national committee, commissioned by Great Britain's board of schools, to consolidate national identity by enhancing the teaching of the English language and literature in elementary and higher education. The methods they recommended included 'correct pronunciation and clear articulation in the sounded speech of Standard English' and 'clear and correct oral expression and writing in Standard English',[39] both of which required phonetic expertise. Meanwhile, the British government directed resources to the teaching of colonial languages to officials, officers, traders, and missionaries who would set off overseas. Resources also went to the teaching of English in the colonies, as the education of colonial subjects in English was considered essential to instilling loyalty to the British crown. Besides, Jones was invited to sit on the Advisory Committee on Spoken English of the BBC (the British Broadcasting Company), which was started in the 1920s to give counsel on the announcers' pronunciation.[40]

Jones's department actively participated in these efforts. He even traveled to India to teach phonetics to English teachers. The tremendous need for phonetics generated a spinoff of his department at the School of Oriental Studies, an institution established to serve Britain's imperial cause. This new phonetics department, opened in 1927, was headed by Jones's assistant Arthur Lloyd James (1884–1943).[41]

Like Jones, most of the students and assistants who worked with him in the 1920s and '30s started their academic careers with no graduate degree and little, if any, philological training. The best known of them were Lloyd James, Stephen Jones (no relation to Daniel, 1872–1942), Harold E. Palmer (1877–1949), Lilias Armstrong (1882–1937), Ida C. Ward (1880–1949), and J. R. Firth (1896–1960). Of them all, only Lloyd James came with

37 Ibid, 139.

38 Daniel Jones, 'The London School of Phonetics (1946)', in Beverley Collins and Inger M. Mees (eds.), *Selected Works,* viii (London & New York, 2003), [3].

39 Brian Doyle, *English and Englishness* (London & New York, 1989), 50.

40 Collins and Mees, *The Real Professor Higgins*, 316, 367.

41 Ibid, 275.

some previous training in philology.[42] Except Palmer, who joined Jones's department as a distinguished language teacher, all of them took Jones's postgraduate research course, which was modeled on Passy's course in Paris.[43] Jones then selected the highest performing of them to work as assistants or lecturers and share the load of teaching in a wide range of languages. He trained them on the job, so to speak, and let them specialize in phonetics for the teaching of an individual language, African languages, experimental phonetics, or even speech defects. Most of them first started as teachers of modern languages at schools or colleges.[44] Though without graduate degrees, several of them moved on to become chairs in phonetics or linguistics later, on the strength of their publications.

Jones's department emphasized the training of ears, which was first imparted to his early students and seriously applied to the courses that the department offered. As seen above, American scholars of language emphasized the importance of ears, although they were notably silent about auditory training. Their British colleagues, on the other hand, made the training of ears explicit. 'Without a highly trained ear, an accurate pronunciation is impossible', they declared. One who could hear only outstanding features of pronunciation could not speak well, and 'such a teacher will never teach a good pronunciation.'[45] So Jones's phonetics department trained students to discriminate with accuracy the sounds of their native languages. They also did systematic exercises in which sounds and successions of sounds in invented meaningless words were dictated to them. Students then wrote down the sounds in the International Phonetic Alphabet devised by Daniel Jones and Paul Passy. If they did not get the sounds right, the instructor would repeat alternately what the student wrote down and what was actually said. Thereby the students gradually came to perceive the differences between sounds that they had confused.[46]

[42] Arthur Lloyd James received undergraduate education in French at University College, Cardiff, and then studied as an 'advanced student' at Trinity College, Cambridge, specializing in Old French and Provençal. He could have had some French philology, and perhaps also some training in phonetics. He taught French and phonetics at a teacher training college in London before he began his work at UCL. Ibid, 275.

[43] In the 1920s, it was listed as 'An Advanced Course for Those Desiring to Qualify as Teachers of Phonetics'. Students who wanted to take this course had to pass a preliminary examination. *University College Calendar 1925–26* (London, 1925), 47. On Palmer, see Collins and Mees, *The Real Professor Higgins*, 140.

[44] Firth, who taught as professor of English at the University of the Punjab, Lahore, also fitted this pattern. One exception was Stephen Jones, who was a schoolteacher of physics. Ibid, 320, 132.

[45] Ida C. Ward, 'The Phonetics Department, University College, London', *Revue de Phonétique*, 4 (1928), 48.

[46] Ward, 'The Phonetics Department, University College, London', 49.

The emphasis on ear training was indicated in the course descriptions of the department in the UCL Calendar.[47]

British phoneticians also emphasized the ability to reproduce sounds. The primary goal of Jones's phonetic training, derived from language teaching, was always to pronounce the national or foreign language accurately. Thus students practiced to control their speech organs to reproduce the native speaker's pronunciation. It was not just the reproduction of individual sounds, but also of correct stress, intonation, and fluency.[48]

Experimental phonetics supplemented Jones's applied phonetics, used for language teaching and learning. The experimental section of Jones's department was entrusted to Stephen Johns, previously a schoolteacher of physics and the longtime superintendent of the lab. Experimental phonetics was based in the laboratory and can be seen as a graphical analysis of sounds. This subject will be examined in the section on France, where this approach first started.

The areas of research in Jones's department at the UCL and its spinoff at the SOAS were manifold. His students usually started with the phonetics of English and French, and then often applied phonetical methods to empirical studies of other European, Asian, or African languages. The first goal was learning and teaching those languages, and the second was to establish or reform the alphabet and orthography of unwritten languages.[49] For foreign languages, the investigators worked with native speakers who lived in London. They investigated the phonetic structure of individual languages, which consisted of pronunciation of words and sentences, stress, intonation, rhythm, and other features. They also produced transcriptions of sentences, conversations, and stories with a phonetic alphabet.[50] The department also had theoretical interest in the physical, mental, and functional nature of the phoneme, the unit of sound. Empirical knowledge of the phoneme in different languages helped investigators pursue their theoretical studies.[51]

Women language scholars rose in Daniel Jones's department probably earlier and faster than elsewhere. In the academic year 1925–26, there were eleven members on the faculty of Jones's department, including himself. Seven were women, including Armstrong, the only senior lecturer.[52] Armstrong started as a schoolteacher and was a part-time student in Jones's evening course. Her gift in phonetics won her the first full-time assistantship

[47] For example, *University College Calendar 1925–26*, 42–50.
[48] Ward, 'The Phonetics Department', 50.
[49] Ibid, 51.
[50] Ibid, 52.
[51] Jones, 'The London School of Phonetics (1946)', [8]–[11].
[52] *University College Calendar 1925–26*, xl–xli.

in Jones's department in 1918.[53] Ward likewise was first a teacher and became a full-time assistant a year later.[54] Both of them began with English phonetics and then applied their training to African languages. Armstrong stayed in Jones's department until her untimely death in 1937, while Ward moved in 1932 to the new Department of Phonetics at the SOAS that was headed by Lloyd James, and acquired the Professorship of West African Languages in 1944.[55]

France

In France, leading language scholars Passy (1859–1939), Antoine Meillet (1866–1936), and Joseph Vendryes (1875–1960) were trained in philological work in the classroom. The eldest of the three, Passy was home schooled and then studied Sanskrit, Gothic, and Latin at the École Pratique des Hautes Études. He found his love for phonetics while teaching English and German in training schools for primary teachers. He defended his doctoral thesis in 1891 and three years later became a *maître de conférence* (roughly equivalent to assistant or associate professor on the American academic scale) in general and comparative phonetics at the École Pratique, a position created specifically for him.[56] Meillet studied Classical, Iranian, and Sanskrit philology at the Sorbonne and took courses at the École Pratique. Thereafter he taught secondary school, passed the *agrégation* (a qualifying examination for senior appointments in secondary school) in 1889, and began teaching as *maître de conférence* at the École Pratique des Hautes Études (in old Iranian and comparative grammar) in 1894. He gained his doctorate in 1897, and then a chair in comparative grammar (i.e., comparative philology) in the Collège de France in 1906.[57] Vendryes studied Classical and Oriental philology, plus German and Celtic, at Paris, passed *agrégation* in 1896, visited the University of Freiburg in Germany

[53] Collins and Mees, *The Real Professor Higgins*, 194–5.

[54] Ibid, 256–7.

[55] R. E. Asher, 'Armstrong, Lilias Eveline (1882–1937), Phonetician', *Oxford Dictionary of National Biography* (Oxford, 2004); B. S. Collins and I. M. Mees, 'Armstrong, Lilias Eveline (1882–1937)', Keith Brown (ed.), *Encyclopedia of Language & Linguistics* (Oxford, 2006), 478–9; Diedrich Westermann, 'Professor Ida Ward, An Appreciation', *Africa: Journal of the International African Institute*, 20/1 (1950), 2–4; E. L. Lasebikan, 'Ida Ward', *African Affairs*, 49/194 (1950), 30–2.

[56] Richard C. Smith, 'Paul Passy's Life and Career', Center for Applied Linguistics, Warwick University, 2007 <http://www2.warwick.ac.uk/fac/soc/al/research/collect/elt_archive/halloffame/passy/life> [accessed 21 November 2015]; Enrica Galazzi, '1880–1914. Le combat des jeunes phonéticiens: Paul Passy', *Cahiers Ferdinand de Saussure*, 46 (1992), 118.

[57] Joseph Vendryes, 'Antoine Meillet', *École pratique des hautes études, Section des sciences historiques et philologiques*, 70/1 (1937), 5–37; Karl Krippes, 'Meillet, the Researcher and the Teacher', *Histoire Épistémologie Langage*, 10/2 (1988), 277–83.

for a year (1888–1889), and taught as a *mâitre de conférence* at the newly founded University of Clermont-Ferrand before defending his doctoral thesis in 1902. He received a professorship at Caen and eventually was awarded the chair of comparative grammar at Paris and the directorship of Celtic philology at the École Pratique des Hautes Études.[58]

French scholars' common career path had no equivalent in other countries. They received what may be called undergraduate education at the École Normale Supérieure or a university (usually Paris). The academically minded of them received specialized training in lectures and seminars at the École Pratique des Hautes Études, affiliated with the University of Paris, that was founded on the German model of research education. Generations of scholars down to Passy and Meillet usually taught for a few years at *lycée* (French secondary school) after completing their undergraduate degree (*licence*). University (or École Normale) graduates of Vendryes' generation and later could skip secondary school teaching and instead begin their academic career as *maîtres de conférence* in the university or École Pratique des Hautes Études. While teaching, they prepared for the *agrégation* and, if successful, then did their doctoral research side by side with high school or junior university teaching. Supervision by doctoral advisors was often distant, and their meetings with their advisees were infrequent. Only with a doctorate in hand and good publications could junior scholars expect to receive a professorship in a provincial university. The best of them would move from the province to elite institutions in Paris, such as the Sorbonne and the Collège de France.

Continuing on this path, the younger generation of language scholars benefited from three recent trends that had been strong in France since the late nineteenth century: applied phonetics, experimental phonetics, and dialectology. Inspired by Viëtor, Passy taught himself phonetics and applied it to language teaching in the language program he organized. He worked with his former student Daniel Jones on the International Phonetic Alphabet (Figure 9.1), making it the internationally accepted system for phonetic transcriptions.[59]

The world leader in experimental phonetics then was Pierre-Jean Rousselot (1846–1924). Starting in the late 1870s to work on unwritten French dialects, known as *patois*, Rousselot studied with Gaston Paris (1839–1903) and Paul Meyer (1840–1917), both philologists. Thus his doctoral thesis on Gallo-Roman dialects may be seen as an offshoot of

[58] Édouard Bachellery, 'Joseph Vendryes (1875–1960)', *École pratique des hautes études. 4e section, Sciences historiques et philologiques*, 94/1 (1961), 20.

[59] Paul Édouard Passy and Daniel Jones, *The Principles of the International Phonetic Association: Being a Description of the International Phonetic Alphabet and the Manner of Using It: Illustrated by Texts in 51 Languages* (Paris, 1912).

		Lips	Lip-teeth	Point and Blade	Front	Back	Uvula	Throat
CONSONANTS	Plosive	p b		t d	c ɟ	k g	q ɢ	ʔ
	Nasal	m		n	ɲ	ŋ	ɴ	
	Lateral			l ɫ	ʎ	(ɫ)		
	Rolled			r ř			ʀ	
	Fricative	ɸ ʋ ʍ w ɥ σ ρ	f v	θ ð s z σ ρ ʃ ʒ ɹ	ç j (ɥ)	(ʍ w) x ǥ	ꭓ ʁ	h ɦ
VOWELS					Front Mixed	Back		
	Close	(u ü y)			i y ï ü	ɯ u		
		(ʊ ʏ)			ɪ ʏ	ʊ		
	Half-close	(o ö ø)			e ø ë ö	ɤ o		
					ə			
	Half-open	(ɔ ɔ̈ œ)			ɛ œ ɛ̈ ɔ̈	ʌ ɔ		
					æ ɐ			
	Open				a	ɑ		

(Sounds appearing twice on the chart have a double articulation, the secondary articulation being shown by the symbol in brackets.)

Figure 9.1 International Phonetic Alphabet, which categorizes vowels and consonants according to the voice organs they involve and the positions of the tongue when they are produced. Reprinted from Passy and Jones, *The Principles of the International Phonetic Association*, p. 10.

French philology.[60] Rousselot then moved on to study ways of analyzing the different pronunciations of French dialectical words with mechanical instruments. He served as the preparer at the Laboratory of Experimental Phonetics in the Collège de France, created in 1898 under the chair of comparative grammar, Michel Bréal (1832–1915), Meillet's predecessor. Rousselot's pioneering publications made him the most respected experimental phonetician across Europe in the early twentieth century.[61]

Experimental phonetics was done in the laboratory and relied heavily on graphical analysis, which formed a contrast to auditory training. Drawing a great deal from anatomy and mechanical technology, Rousselot studied the positions, shapes, and mutual contacts of voice organs when producing individual sounds. Figure 9.2 shows the positions of the tongue when certain vowels in Bostonian English are pronounced. The left end of the diagram shows the front teeth, the top curve depicts the palate, and the

[60] Hubert Pernot, 'L'abbé Rousselot (1846–1924)', *Revue de Phonétique*, 5 (1928), 12. For the political and cultural context of Rousselot's early dialect studies, see Haun Saussy, *The Ethnography of Rhythm: Orality and Its Technologies* (New York, 2016), 98–100; David L. Hoyt, 'Dialects of Modernization in France and Italy, 1865–1900', in David L. Hoyt and Karen Oslund (eds.), *The Study of Language and the Politics of Community in Global Context* (Lanham, MD, 2006), 85–118.

[61] Pernot, 'L'abbé Rousselot (1846–1924)', 19.

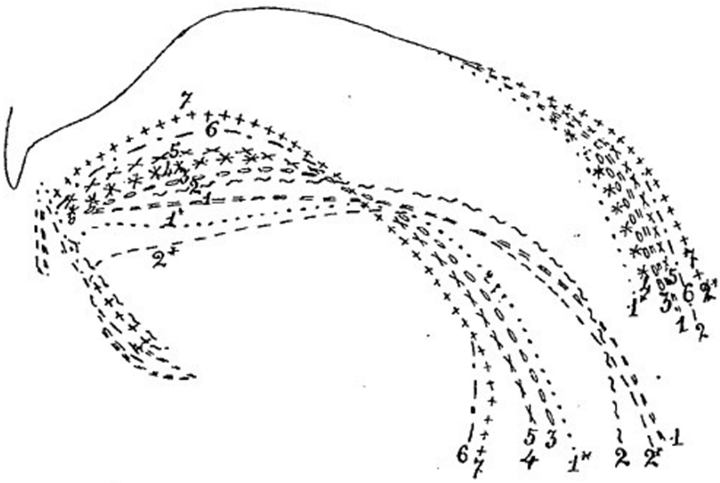

Fig. 431.

Position de la langue et du voile du palais pour les voyelles anglaises de Boston.

Série antérieure.

1. *a* (*part*), — 2. *œ̆* (*upper*), — 3. *ă* (*bat*), — 4. *ĕ* (*bet*), — 5. *é* (*bait*), — 6. *ĭ* (*bit*), — 7. *i* (*beat*).

1*. *œ* (*hurl*), — 2*. *œ̆* (*hull*).

Figure 9.2 Positions of tongue pronouncing individual vowels. Reproduced from Pierre-Jean Rousselot, *Principes de phonétique expérimentale*, i (Paris: H. Welter, 1897), 650.

lines below represent the positions of the tongues in the pronunciations of different vowels. Rousselot drew this figure based on the results that Charles Hall Grandgent (1862–1938) derived from visual observations. Later phoneticians used X-ray to achieve better results.

Figure 9.3 consists of sixteen palatograms. Palatography works by painting the palate, the roof of the mouth, with dye. The tongue takes off the dye of the area it touches when producing a particular sound. By pressing a blank piece of paper or foil against the palate, a palatogram of a particular sound is made. The palatograms in Figure 3 show the areas of the tongue-palate contacts for the spelling, or articulation, of the Parisian nasal vowels ã, õ, ẽ with two consonants, *l* in front and *g* in the rear.

Figure 9.4 compares the positions of the tongue (L in the graph, for *langue*) in the pronunciations of *b-a* and *b-i*. The position of the tongue is measured by placing on the tongue a bar whose movement is translated to

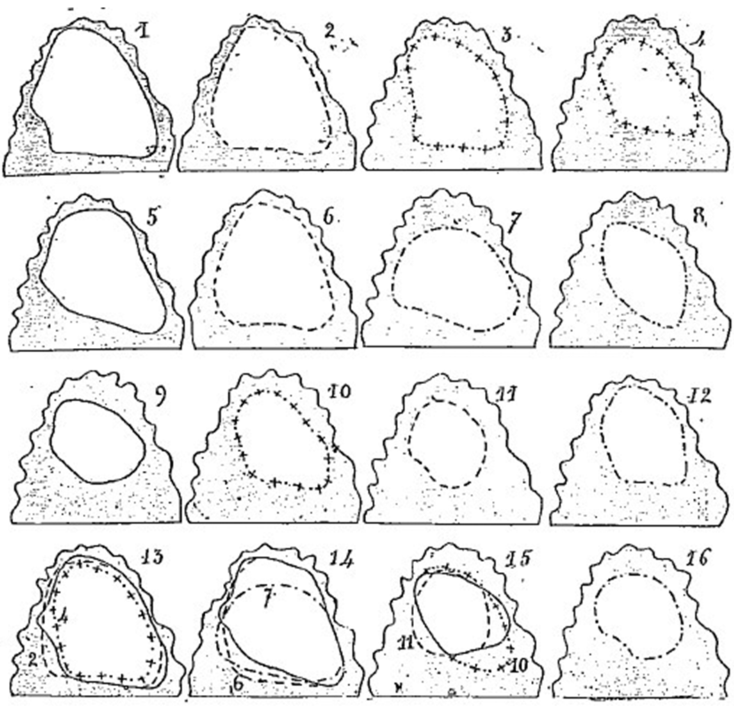

Fig. 441.

Analyse des nasales parisiennes *ã õ ẽ*. (C)

1. *lãg*, — 2. *lòg*, — 3. *lág*, — 4. *lag*.
5. *lõg*, — 6. *tòg*, — 7. *log*, — 8. *tóg*.
6. *lẽg*, — 10. *lag*, — 11. *lég*, — 12. *leg*.
13. *lãg* comparé à *lòg* (2) et *lág* (4), — 14. *lõg* comparé à *lòg* (2) et *log* (7). — 15. *lẽg* comparé à *lag* (4) et à *lég* (11). — 16. *lœ̃g*.

Figure 9.3 Palatograms comparing different articulations of vowels and consonants in Parisian French. Reproduced from Rousselot, *Principes de phonétique expérimentale*, i, 661.

a needle on the rotating drum. The chart shows that the tongue moves significantly higher when the vowel *i* follows the consonant *b* than when *a* follows *b*. The B curve traces the vibration of the breath that is transferred to another needle on the drum.

The tracing of breath depended on the kymograph (*kyma*: wave in Greek). The investigator spoke into a mouthpiece that transferred the vibration of the air through a tube (Figure 9.5). The vibration was then converted to the up-and-down motions of a needle that scratched the

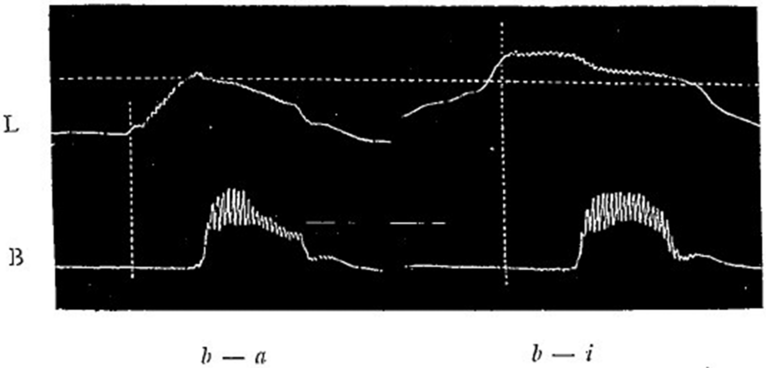

Fig. 624.

L. Langue. — B. Souffle.

La différence de hauteur de la langue pour *ba* et pour *bi* est marquée par la ligne pointillée horizontale.

Figure 9.4 A chart showing the elevations of the tongue when pronouncing different sounds. Reproduced from Rousselot, *Principes de phonétique expérimentale*, i, 941.

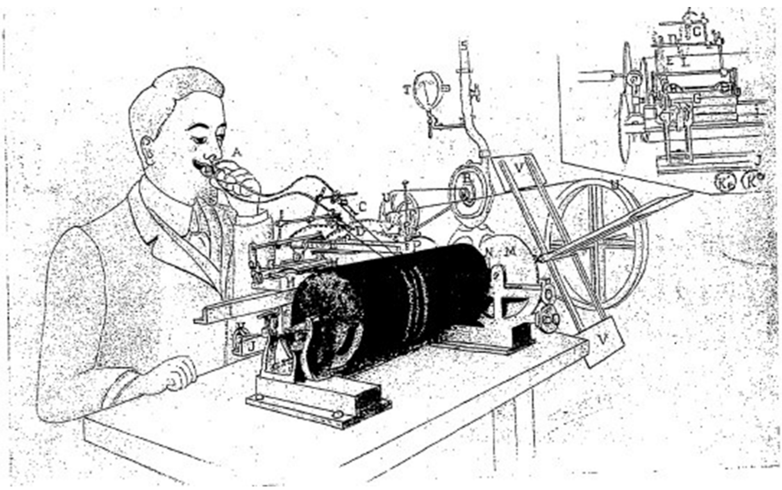

Figure 9.5 The kymograph. Reprinted from Rousselot, *Principes de phonétique expérimentale*, i, 941.

smoked paper on a rotating drum. Later models provided optional sensors attached to the nose and the throat. The air vibrations they created could likewise travel through tubes and were transferred onto the chart.

Graphics was the predominant mode of presentation in the laboratory investigations of voice. Invisible and intangible, voice can be said to be 'immaterial', if matter is, as defined by René Descartes, understood as *res extensa* (extended substance). However, it produces physical effects. It is usually perceived by the ears. In the phonetic laboratory it was registered through x-ray, palatograms, and kymographs, instruments that detected positions, contacts, and vibrations of body organs. All these effects then were translated into graphics that made sound visible, analyzable, and measurable for people with ordinary ears.[62]

Phonetics in France had a long and strong tie to dialect studies, though interest in spoken languages gradually emerged in modern and even Indo-European philology in the late nineteenth century. Meillet went on a field trip to the Caucasus, where he learned modern Armenian while studying ancient Armenian manuscripts.[63] Rousselot's experimental phonetics on French dialects in fact arose from French philology. Ferdinand Brunot (1860–1938), Jean Poirot (1873–1924), Hubert Pernot (1870–1946), and Pierre Fouché (1891–1967), the first four directors of the Institute of Phonetics at the University of Paris, were collectors and researchers of French, Finnish, and Greek dialects. Brunot even embarked in 1912 and 1913 on three recording tours of French dialects throughout the country, collecting testimonies, dialogues, folk tales, and songs in regional dialects on phonograms. This formed the core of the Archives de la Parole, a collection of sound recordings of the country that was first housed in the Institute of Phonetics at Paris.[64]

This institute combined work in dialectology, phonogram collections, and experimental phonetics. The collection of French dialects exemplified in the Archives de la Parole was an important part of the institute until it became the Musée de la Parole et du Geste (Museum of sound and motion pictures) in 1928. The institute acquired Rousselot's library and hosted a well-furnished laboratory.[65] It sponsored *Revue de phonétique*, a journal for

62 For Rousselot's graphic method, see Saussy, *The Ethnography of Rhythm*, 97–115.

63 Vendryes, 'Antoine Meillet', 7.

64 Lionel Michaux, 'The Origins of the Audiovisual Department at the BNF, Ferdinand Brunot and the Archives de la Parole', *Europeana Sounds*, 2014 <http://www.europeana-sounds.eu/sound-categories/spoken-word-recordings/the-origins-of-the-audiovisual-department-at-the-bnf-ferdinand-brunot-and-the-archives-de-la-parole> [accessed 7 August 2016].

65 Hubert Pernot, 'L'Institut de Phonetique de l'Université de Paris', *Revue de phonétique*, 4 (1928), 40–2; Pascal Cordereix, 'Les enregistrements du musée de la Parole et du

experimental phonetics that was first established and coedited by Rousselot and Pernot.

The Institute of Phonetics also gave courses in phonetics and requested research papers for the degrees it granted. During the academic year 1925–26, it offered a course of seven lessons on elements of phonetics for philology students, which fifty students took, and a course on articulations of sounds, which had thirty-six students and a number of auditors. In the first course, an hour was given to the theory of phonetics and the rest to initiating students in the methods of experimental phonetics and giving them a taste (*goût*) of personal research. In addition, twenty-nine students did practical work at the Institute of Phonetics, or at the Laboratory of Speech in the National Institution of the Deaf and Mute. To do phonetics as a field for the degree of *licence*, which one received after completing university study, or a field for the advanced degree *diplôme des études supérieures*, a student had to submit a research paper (*mémoire*). In this academic year three papers were approved for the *licence* and two for the *diplôme*. The subjects included intonation of the English phrase, French intonation in different places, palatal consonants in Lithuanian, Russian vowels, and voiceless plosives.[66]

The case of Fu Liu (1891–1934) shows how doctoral work could have been done at the Institute of Phonetics at Paris. Liu was appointed to Peking University with his literary publications in 1917. As few talents with formal training could be found to fill university positions at the beginning of modern higher education in China, Liu received his appointment with just a high school degree. Once at Peking, he was sent overseas for advanced study on a fellowship. In 1920 he arrived in Jones's department at UCL, only to be disappointed by what he considered a crude method of analyzing tone languages. Liu was then enrolled at the Sorbonne in 1921 and received training in theory and methods of experimental phonetics at the Institute of Phonetics under Poirot. He applied his training to the analysis of Chinese intonation. To show that Chinese tones were variations in pitch, he designed an experiment with the kymograph. He invited speakers of different Chinese dialects to speak to the mouthpiece of the kymograph in his tiny apartment in Paris, recording the graphs at his dinner table.[67] He then converted the lengths of sound waves into pitches (Figures 6 and 7). In 1925 he presented and defended his

Geste à l'Exposition coloniale: Entre science, propagande et commerce', *Vingtième Siècle. Revue d'histoire*, 92 (2006), 40.

[66] *Annales de l'Université de Paris* (Paris, 1926), i. 400–1.

[67] Yuen Ren Chao, 'Liu Bannong Xiansheng [Mr. Fu Liu] 1891–1934)', in *Zhao Yuanren Quanji* (Complete Works of Yuan Ren Chao) (Beijing, 2007), 901.

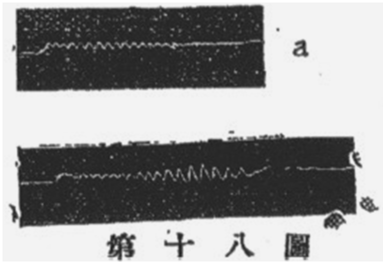

Figure 9.6 The upper graph recorded a sound wave that had a longer wavelength (thus lower in pitch) at first and changed into shorter wave lengths later. The lower graphs recorded a reverse trend. Reproduced from Fu Liu, *Sisheng shiyan lu* (Experiments on Chinese intonation). (Shanghai, 1924), 28.

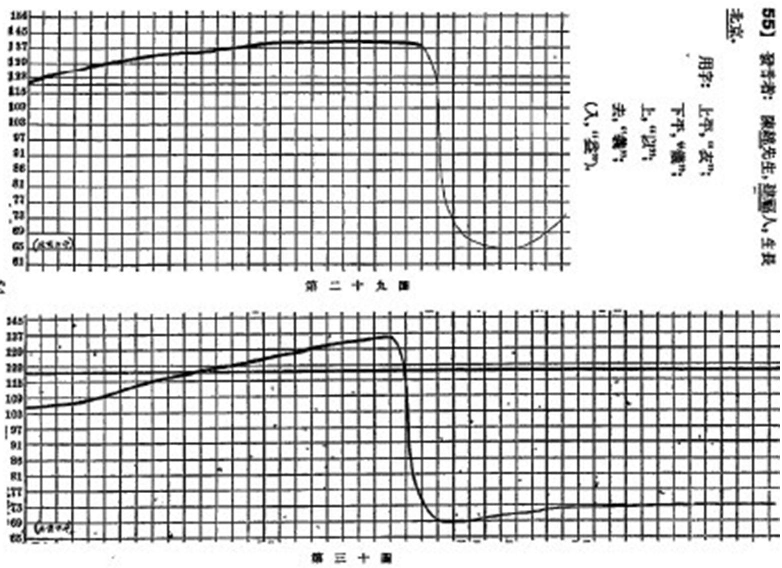

Figure 9.7 The first and second tones in mandarin Chinese converted into change in pitch. Reproduced from Fu Liu, *Sisheng shiyan lu* (Experiments on Chinese intonation). (Shanghai, 1924), 54.

experimental analysis of Chinese tones in his doctoral thesis, which was awarded the Volney Prize of the Institute of France for best work in language studies in 1925.

In France, Jeanne M. Vidon-Varney (1899–1986) and Nicolette Pernot (1903–2003) are examples of early women language scholars.

Vidon-Varney received her *licence* at Paris in 1923 and then the *Doctorat d'université*, a doctoral degree lower in prestige than the state doctorate, which did not qualify one for a French university professorship. She worked as an assistant in the Institute of Phonetics at Paris in the 1920s and early '30s and went across the Atlantic to teach at Barnard College of Columbia University in 1933. She was one of the early laboratory phoneticians in the United States, edited the phonetics section for the journal *The French Review* starting in the 1930s, and became a professor of French at Columbia in 1958. Like Vidon-Varney, Nicolette Pernot studied phonetics at Paris and then worked at the Institute of Phonetics, which her father headed from 1924 to 1930. She translated a book on modern Greek dialects and prepared phonetic transcriptions for the abovementioned *Revue de phonétique*.[68] She also produced recordings of French and their transcriptions. She went to the United States and taught at the Middlebury Summer Language School in 1932, joined Wellesley College as a lecturer in 1935, and later taught at the College of William and Mary.[69] Barnard and Wellesley were women's colleges, where early American female academics usually found positions.[70] Middlebury and William and Mary were among the coeducational institutions that began to appoint women to their faculties.

Germany

Germany was the leading country in academic studies of language around the turn of the twentieth century. The abovementioned Young Grammarians movement started at Leipzig in the 1870s. The 'reform movement' in language teaching began with Viëtor at Marburg in the next decade. Germany was also a leader in many other academic disciplines, in part thanks to its well-furnished universities and a great supply of youths who aspired to take up academic careers.

In Germany, an academic path started with the Doctor of Philosophy degree, which required taking lectures and seminars in a specialized field and completing a dissertation based on original research. Though a model

[68] Dirk Christiaan Hesseling, *Histoire de la littérature grecque moderne*, trans. N. Pernot (Paris, 1924); Nicolette Pernot, 'Transcriptions Phonétiques', *Revue de Phonétique*, 5 (1928), 147–52, 308–13, 378–412.

[69] *Annales de l'Université de Paris* (Paris, 1935), x, 100; Hippolyte Parigot, 'La vie et l'école', *Le Temps*, 24016, 18 May 1927, 5; Caroline Matulea, 'Faculty Notes', *The Romanic Review*, 26/1 (1935), 72; John E. Crews, 'Foreword', in *Out of the Corner of My Eye: Living with Macular Degeneration*, by Nicolette P. Ringgold (New York, 2007), xii; 'Nicolette P. Ringgold', *Daily Press, Williamsburg Community Hospital* (12 March 2003), 1.

[70] Margaret W. Rossiter, *Women Scientists in America: Struggles and Strategies to 1940* (Baltimore, 1982), 9–23.

for the American PhD, the German *Doctor Philosophiae* differed from the American version in that it was the first degree after secondary school, thus in some respects parallel to an American undergraduate degree. To be able to lecture in the university, the habilitation, a postdoctoral qualification, was required. There was little formal requirement for the habilitation. In general it involved either a second substantial dissertation or a series of publications based on original research and the approval of the faculty to which the candidate belonged. To compete for academic appointments, junior scholars had to show that they had complete and rigorous scholarly training, including the PhD and the habilitation. This rigor was suspended only for extraordinary reasons, such as Germany's new colonial pursuits starting in the 1880s.

Carl Meinhof (1857–1944) and Diedrich Westermann (1875–1956), two founders of *Afrikanistik* or African studies in Germany, received their academic positions in the 1900s, without PhDs or habilitations. Meinhof received some philological training in the university, though he left without a PhD. He began his work on African languages with native speakers who lived in Germany. Westermann learned African languages on a religious mission in German colonies in Africa.[71] They published transcriptions, constructed grammars, and compiled dictionaries of African languages by imitating the methods and rigor of modern and comparative philology.[72] Meinhof was first appointed, in 1902, as a professor at the Seminar for Oriental Languages (Seminar für Orientale Sprachen, founded 1887), a practical school for training officials, merchants, and missionaries to be posted in overseas colonies. Though the seminar was attached to the University of Berlin, a professorship there was not as prestigious as an ordinary professorship at the university. In 1909 Meinhof was recruited by the newly founded Colonial Institute in Hamburg, an institution that prepared for the foundation of a new university and at the time provided advance training and research for Germany's colonial enterprise. When the Colonial Institute was transformed into the University of Hamburg after World War I, Meinhof remained professor there. Westermann acquired a teacher's position (*Lehrer*) at the Seminar for Oriental Languages in 1908 thanks to Meinhof's support. After World War I, Westermann was given an extraordinary professorship of African studies at the University of

[71] Sara Pugach, *Africa in Translation: A History of Colonial Linguistics in Germany and Beyond, 1814–1945* (Ann Arbor, 2012), 71–4, 127–8.

[72] Such as Carl Meinhof, *Grundriss einer Lautlehre der Bantusprachen, nebst Anleitung zur Aufnahme von Bantusprachen* (Leipzig, 1899); Carl Meinhof, *Grundzüge einer vergleichenden Grammatik der Bantusprachen* (Berlin, 1906); Diedrich Westermann, *Wörterbuch der Ewe-Sprache* (Berlin, 1905); Diedrich Westermann, *Grammatik der Ewe-Sprache* (Berlin, 1907).

Berlin, though only after he had secured an honorary doctorate from Hamburg. He was promoted to an ordinary professor in 1925.[73]

The study of African languages was special in at least two senses. First of all, after Germany's acquisition of colonies in sub-Saharan Africa, knowledge of African nature, culture, and especially languages was most valuable to the German colonial administration and to businesses. The Seminar for Oriental Languages was created precisely to fill this need.[74] For the same reason the Colonial Institute received many resources from the German government. African languages had previously received little, if any scholarly study. Before Meinhof, the only university instructor of African studies in Germany, Hans Stumme (1864–1936) of Leipzig, worked on Arabic in northern Africa. Stumme's work was an offshoot, so to speak, of Semitic philology. To work on sub-Saharan African languages, the seminar could only recruit talent from outside academia, thus justifying the somewhat extraordinary appointments of Meinhof and Westermann.

Second, few sub-Saharan African languages had written languages and thus differed from all previous languages that philologists had placed their hands on. Meinhof had to justify his study by elaborating its significance for comparative philology in the lecture that inaugurated his professorship at the Colonial Institute in Hamburg. Like comparative philology, he suggested, the study of African languages involved collecting words and phrases, inducing grammatical rules, producing texts by transcription, and compiling a full dictionary,[75] typical tasks in philology. Moreover, the studies of African languages were valuable, Meinhof argued, as these languages were pristine, not yet polluted by writing, urbanity, and contacts with foreign languages. As living languages, they could be studied empirically, repeatedly, and comprehensively with great accuracy, advantages that historical languages cannot offer.[76] Often dismissed as having no historical depth, African languages in fact preserved very old cognate words of ancient Egyptian and Nubian and thus were helpful for the reconstruction of those languages. To discover the laws governing sound shifts, a major concern of comparative philologists, scholars had to study sounds themselves instead of symbols. 'Sounds can only be studied in living languages, not in dead ones.'[77]

[73] Archiv der Humboldt Universität zu Berlin, Personalakten, Westermann, W 252, Bd. I, 6, W 252, Bd. II/1, 1–2.

[74] The seminar's teaching was not limited to African languages. Arabic, Turkish, and Far Eastern languages were also included, as Germany was seeking a greater role in the regions where these languages were spoken.

[75] Carl Meinhof, *An Introduction to the Study of African Languages*, trans. Alice Werner (London & New York, 1915), 2–3.

[76] Ibid, 9–13. [77] Ibid, 12–13.

From early on, Meinhof placed a great emphasis on phonetics in his work on African languages. His first major work was on the phonetics, or *Lautlehre*, of Bantu (1899), a group of languages that were spoken in central and southern Africa. Shortly after his appointment at the Colonial Institute, Meinhof secured a large sum to set up a phonetics laboratory, one that made Daniel Jones jealous.[78] He hired Giulio Panconcelli-Calzia (1878–1966) to direct the laboratory under him. Calzia had studied with Rousselot in Paris for his doctorate and assisted Viëtor in Marburg, so he had the perfect pedigree in experimental and applied phonetics. In addition, before his appointment, he had published frequently in the first German journal for experimental phonetics and received the support of its editor, Hermann Gutzmann (1865–1966), a physician at the University of Berlin, specialized in speech therapy, another important field of input for experimental phonetics.[79] Westermann had no luxury of a phonetic laboratory. He, however, taught African languages as well as phonetics after he was given a chair at Berlin after World War I.[80]

The extraordinary resources of the Colonial Institute made its institutional successor, the University of Hamburg, a leader in language studies in Germany after the war. Hamburg, like its older peer institutions across Germany, had representation of modern philology (German, English, Romance, Swedish, Slavic, etc.). Its teaching and studies on Oriental philology (especially Japanese and Chinese) were stronger than those of many of its peers, thanks to the investments of the Colonial Institute in these fields. Hamburg also opened the Seminar for Comparative *Sprachwissenschaft* (language science), headed by a relatively junior Indo-European comparative philologist, Heinrich Junker (1889–1970), and set up a field of teaching in general and comparative language science. The special strength of Hamburg lay in the Seminar of African and Oceanic Languages, now expanded to include the languages of what the Germans called the 'South Sea' (*Südsee*, that is, the South Pacific), and the Institute of Phonetics (which was upgraded in 1919 and, no longer subordinate to Meinhof's seminar, was headed by Calzia as a professor). This strength is in part seen in these two programs' domination in course offerings in

[78] Collins and Mees, *The Real Professor Higgins*, 84–5.

[79] Gutzmann's journal was *Medizinisch-pädagogische Monatsschrift für die gesamte Sprachheilkunde mit Einschluss der Hygiene der Stimme in Sprache und Gesang: Internationales Centralblatt für experimentelle Phonetik* (Medical pedagogic monthly for the whole speech medicine with inclusion of hygiene of sound in language and song: International journal for experimental phonetics)

[80] See, for example, *Verzeichnis der Vorlesungen an der königlichen Friedrich-Wilhelms-Universität zu Berlin im Sommer-Semester 1924* (Berlin, 1924), 48, 54.

general and in comparative language science, which was usually the monopoly of Indo-European comparative philologists elsewhere.

A remarkable number of courses in language science, African languages, and phonetics were available at Hamburg. Meinhof's seminar offered more than ten African languages and often half a dozen Southeast Asian and Oceanic languages for beginners. In addition, a diversity of courses in the field of general and comparative language science were in the course catalogues. Meinhof regularly taught the course on general and comparative language science. There were also theoretical courses (such as 'Fundamental Problems in the Philosophy of Language', taught by the philosopher Ernst Cassirer, and 'Emergence of Inflective Languages'), and advanced studies based on empirical work ('Comparative Bantu Grammar' and 'Comparative Phonetics of Austronesian Languages'). The field also included practical training in language research ('Method of Language Research' and 'Transcription of Unwritten Languages and Dialects'). Calzia's now independent institute offered courses on the application of phonetics to language science, on ear training, and hands-on courses that trained students to do independent work in phonetics four days a week, three hours a day.[81] Calzia's assistant, the musicologist Wilhelm Heinitz (1883–1963), taught melody of language, phonetic application to music, and musicology.

Some of these courses were seminars, often listed as *Übungen* in German course catalogues. As seen in Chapters 2 and 8 of this volume, German universities trained research-minded students in seminars, immersing them in updated literature, original findings, and research writing. Most students developed their dissertations in seminars. The transcription of unwritten languages and hearing, though not formally taught in the United States, were taught in seminars at Hamburg. Thus they were seen and taught as important parts of training for language scholars.

Seven students habilitated in Meinhof's seminar between 1920 and 1940. Among them, Otto Dempwolff (1871–1938) and August Klingenheben (1886–1967) worked as Meinhof's assistants in the 1910s. Dempwolff, first trained as an MD (Berlin 1892), had spent almost twenty years in the Pacific and Africa and habilitated in Hamburg in 1920 with a thesis on Indonesian lip sounds.[82] Klingenheben started in classical, modern, and Arabic philology and worked on African languages when he assisted Meinhof in Hamburg. He defended his dissertation with the abovementioned Stumme at Leipzig in 1920 and habilitated at Hamburg in 1924

[81] See the course listings of the University of Hamburg in *Verzeichnis der Vorlesungen*, for example, Wintersemester 1924/25–Sommersemester 1927.

[82] 'Bericht der Kommission über die Habilitation des Professor Dr. med. Otto Dempwolff' (1920), Staatsarchiv Hamburg, StAH 361–6 IV 2417, 1v.

with a thesis on the sounds of Fula, a language spoken in western and central Africa. Klingenheben was appointed an extraordinary professor at Leipzig in 1928 and called to succeed Meinhof at Hamburg in 1935.[83] Klingenheben's complete academic résumé, which consisted of a PhD and a habilitation, marked the coming of age of the study of African languages in German academia.[84]

Among the few who completed their PhDs at Meinhof's seminar between 1920 and 1940, three stood out. Two were born in South Africa. Werner Willi Max Eiselen (1899–1977), son of a German missionary, and Nicolaas J. van Warmelo (1904–1989), born to a family of Dutch descent, received their PhDs under Meinhof in 1924 and 1927 with dissertations on the phonetics and classification of Bantu languages. Both of them had received their undergraduate degrees in South Africa before their study at Hamburg, seeing as it was the model institution for colonial science (even though Germany had lost its colonies after World War I). Though they had firsthand knowledge of the African languages Bantu and Sotho, they sought a scientific study of them at Hamburg and returned home to become academic leaders and important government advisers.[85] Maria von Tiling (1887–1974) was among the first generation of German women to whom the doctorate became regularly accessible.[86] She had some schooling in French, history, and German before the war and taught in Latvia. As men were drafted during the war, she was invited to help as an assistant in the Colonial Institute. At Hamburg she studied Bantu lan-

[83] 'Klingenheben, August: Ausführlicher Lebenslauf', n. d., Staatsarchiv Hamburg, StAH 361-6 IV 2472. Another assistant from the 1910s was Walther Aichele, who received his PhD in Oriental philology in 1913 and assisted Meinhof in Hamburg thereafter. Interrupted by the war, he began to study and then teach Indonesian languages at Hamburg afterward. A. Teeuw, 'In Memoriam Walther Aichele', *Oriens-Extremus*, 20 (1973), 1.

[84] Pugach made a similar point. Pugach, *Africa in Translation*, 129. Another assistant from the 1910s, Martin Heepe, left Hamburg for the State Library in Berlin in 1921, whereas Dempwolff and Klingenheben continued to teach at Hamburg.

[85] Hilke Meyer-Bahlburg and Ekkehard Wolff, *Afrikanische Sprachen in Forschung und Lehre - 75 Jahre Afrikanistik in Hamburg (1909–1984)* (Berlin & Hamburg, 1986), 211; Sara Pugach, 'Carl Meinhof and the German Influence on Nicholas van Warmelo's Ethnological and Linguistic Writing, 1927–1935', *Journal of Southern African Studies*, 30/4 (2004), 825–45.

[86] Regular university education was not accessible to women in Prussia until 1908 (a few years earlier in other German states), first because no gymnasiums (German high schools) were open to girls. Beginning in the 1890s, women were admitted to German universities as auditors and a small number of them, through successful petitions, were granted 'extraordinary' doctorates after fulfilling all the regular requirements. Ironically, foreign women students, if they had high school education acceptable to their host universities, were able to gain ordinary doctorates in Germany starting in the 1870s. See, for instance, Annette Vogt, *Elsa Neumann—Berlins erstes Fräulein Doktor* (Berlin, 1999), 10–12; Sandra L. Singer, *Adventures Abroad: North American Women at German-Speaking Universities, 1868–1915* (Westport, CT, 2003), 15.

guages and then Somali with native speakers. She received her PhD with a dissertation on transcribed texts and phonetics of Somali in 1924 and continued to teach and publish at Hamburg until she accompanied Klingenheben, her husband since 1927, to Leipzig and then back to Hamburg on his academic appointments. She gave up pursuing her own career.

The training in language studies at Hamburg played down the importance of fieldwork, even though its subjects were unwritten languages. Studying with Meinhof, Klingenheben and von Tiling both picked up their knowledge of African languages in Hamburg. Meinhof preferred the metropole to the field in Africa, as he believed that the ideal location for studying African languages was a 'sterilized' laboratory, in Sara Pugach's term, that was free from the germs, wars, and cultural backwardness in African colonies.[87] Most of Meinhof's students worked with native speakers who either had settled in Germany or were handed over by the shipping company or the port hospital.[88] These African speakers could pronounce a sound as frequently as the researcher requested and held steady their mouths, lips, or tongues in front of phonetic instruments. Indeed, Meinhof placed great value on the phonetic laboratory, believing that it helped students reproduce native pronunciations with the greatest possible accuracy.

Conclusion

This survey has focused on new developments in language studies in the 1920s and 30s at the University of Chicago, University College London, the University of Paris, and the University of Hamburg. Reflecting the shift from the study of letters to the study of sounds, language scholars employed a variety of methods for research and training, including fieldwork, auditory training, and laboratory analysis.

The study of sounds naturally valued ears. Fieldworkers in aboriginal languages often praised colleagues' good ears and complained about bad ones. Jones's department drilled its students with all kinds of natural and unnatural sounds to make sure that they could differentiate one sound from another as accurately as possible. The institutes of phonetics and language science in Paris and Hamburg likewise emphasized the training of ears.

87 Pugach, *Africa in Translation*, 117–18.
88 Giulio Panconcelli-Calzia, 'Mitteilung über das erste Arbeitsjahr', *Medizinisch-pädagogische Monatsschrift für die gesammte Sprachheilkunde*, 21 (1911), 2.

American language scholars, when doing their fieldwork, relied on their ears and transcription alone.[89] They went into the field in part because American Indian reservations, in comparison with Africa, were closer by and easier to access, and in part because the Boasian school took language as an integral part of the study of aboriginal life that could not be observed in isolation from its social and natural habitat. They did not take phonographs or kymographs with them in the 1920s and '30s, as they considered the equipment 'inferior to the human ear'.[90] Without recording devices, they picked up sounds with their ears and transcribed them with their hands, right in the field.

French and German scholars took different positions on recording or fieldwork. Brunot took recording trips across France as early as the 1910s. It was a time when French society was enthusiastic about recording technology and about the nation's collection of voices, folklore, and songs. Electricity and material supplies were closer at hand in French cities or even in the countryside than on Indian reservations. Meinhof and his Africanist colleagues accorded little value to fieldwork, preferring to work in the sterilized laboratory. This choice was reflected in the training of junior scholars at their respective institutions.

Laboratory analysis of sounds and its graphic presentation developed along with auditory methods. Experimental phoneticians analyzed sounds with mechanical instruments in the laboratory and identified them with the images of voice organs or kymographs. They used graphic presentation to compensate for or even supersede the auditory approach, as graphics were accessible to people both with and without gifted ears and available for repeated and close analysis. Graphics also promised reliability and precision.

Auditory and graphic analyses coexisted to a significant extent, though individual phoneticians might have favored one over the other. Though Jones's works, such as his first book, *Outline of English Phonetics*, included both approaches, he relied less on experimentation for his own research, leaving it rather to Stephen Jones. Likewise, although Meinhof supported the laboratory of phonetics, he let his assistant Calzia run the operations. An important reason was that experimental phoneticians also required a different gift or specialty. Instead of a good ear, Rousselot, Stephen Jones, and Calzia all had good command of anatomy, acoustics, and machinery, expertise that many colleagues in applied phonetics lacked.

[89] Bloomfield had studied Tagalog, a Philippine language, with a speaker who studied in the United States before he began working American Indian languages.

[90] Falk, *Women, Language and Linguistics*, 117.

Despite the different choices, the auditory, graphic, and fieldwork approaches signaled significant drifts away from the traditional approach to language studies by studying letters, as was previously the terrain of philology. In Britain, France, and Germany, drifts towards phonetics were clear, as these countries gave the discipline firm institutional footing—departments, institutes, and professorships—in the 1920s or earlier. Britain hosted two departments of phonetics (UCL and SOAS). France supported institutes of phonetics at Grenoble, Nancy, and Paris. Germany founded institutes of phonetics at Hamburg (1919) and Bonn (1927).[91]

After this survey, we are in a better position to answer Turner's question, namely, whether the new methods of training gave rise to a new discipline. Our observations agree with Turner's. Training methods alone did not produce a new discipline; it depended on many other factors. The prosperity of phonetics in Britain, France, and Germany first derived from the soaring need for the teaching of national and foreign languages. Then it benefited from the colonial interest in the study of African (or Asian) languages and in the teaching of European languages to colonial subjects. Phonetics also received nationalist support in the preservation of national languages (including dialects) and folk songs, and from the need for standardization of pronunciation in mass media productions like radio. New technologies, such as the phonogram, also created objects that warranted curation and analysis by phoneticians. Social, political, cultural, and technological reasons all contributed to the success of phonetics. Auditory training or phonetic experimentation alone was not sufficient to make the discipline of phonetics (or linguistics) possible, though it certainly reinforced the disciplinary identity to the junior scholars who received such training.

Women began to rise in language studies in the first half of the twentieth century, although they were constrained by the academic structure and social prejudice. As seen above, Jones employed more women in his department than men in the 1920s and '30s, thanks to his trust in women's ability. It was a different matter to project women into positions outside his department. When a spinoff department was created at the SOAS in 1927, it was Lloyd James, rather than his department senior Armstrong or Ward, who was proposed and accepted as its leader. Ward moved over to Lloyd James's department after the latter had become a professor. She received a professorship only in the 1940s. In contrast to Jones's support of women scholars in his department, Sapir is said to have not been very kind

[91] K. Kohler, 'Three Trends in Phonetics: The Development of the Discipline in Germany since the Nineteenth Century', in R. E. Asher and E. A. Henderson (eds.), *Towards a History of Phonetics* (Edinburgh, 1981), 174.

to women students and scholars.[92] In the United States, Haas waited until 1948 to receive a faculty position at Berkeley, thanks to her work on Thai. Vidon-Varney and Pernot were employed as assistants at the Institute of Phonetics at Paris in the 1920s and early '30s. Only after immigrating to the United States did they find faculty positions, teaching their mother tongue in women's or coeducational colleges. In Germany, von Tiling gave up her career for her husband's.

This chapter compares four institutions on two continents and studies scholarly migration because language studies were transcontinental, even global, during this period. Study tours within Europe continued since the earliest days of the universities, while trans-Atlantic tours accelerated in the second half of the nineteenth century. Bloomfield learned the latest language studies in Germany, reflected in his *Introduction to the Study of Language* (1914). Starting in the late nineteenth century, students arrived in Europe or the United States for undergraduate or research education from Asia, Africa, and elsewhere. Li and Liu were among the earliest Chinese examples. South African students, Eiseln and van Warmelo for example, went to Hamburg, even though they were not African aboriginals. This theme is pursued at length in the following chapters in this volume.

Academia Sinica, Taiwan

[92] Such as Reichard, Ruth Benedict, Margaret Mead, and Elsie Clews Parsons. See Falk, *Women, Language and Linguistics*, 112–15.

10

Training Researchers in Ibero-America: Early Brazilian Chemists as Case Study

Ana M. Alfonso-Goldfarb, Márcia H.M. Ferraz, and Silvia Waisse

Introduction

What do we speak about when we speak of 'Latin' America? This is a rather fuzzy concept, formulated following the independence of the former American colonies of European powers—mainly Spain, Portugal, Britain, and France—during the nineteenth century, and created a division within the Americas into North and South, Anglo and Latin, respectively. 'Latin', thus, in a wider meaning, referred to French-, Portuguese-, and Spanish-speaking America. This identity has been asserted particularly by the French and adopted by the Creole elites to define themselves.[1] The idea of an 'Ibero'-America is no less misleading, as a large part of this region fell under the dominion of Spain, while Portugal colonized Brazil after these two nations split their American possessions in 1494. The colonial policies implemented by these two European powers differed substantially, and the case of higher education is a particularly representative example.

The Spanish colonizers began establishing universities all across their American possessions soon after their arrival in the continent in 1492.[2] By contrast, the first Brazilian university opened its doors more than 400 years later, in 1920. The traditional explanation offered for the Spanish university policy derives from the notion of empire as a confederation of kingdoms, held by the Habsburgs, in contrast to the centralism later

[1] Walter D. Mignolo, *The Idea of Latin America* (Malden, MA, 2005), xv; see ch. 2 in particular.

[2] Carlos Tünnermann Bernheim, *La universidad latinoamericana ante los retos del siglo XXI* (México DF, 2003), 55; José J. Brunner, *Educación superior en América Latina: cambios y desafíos* (Mexico, 1990), 4. From Tünnermann Bernheim, see also *Historia de la universidad en América Latina: de la época colonial a la Reforma de Córdoba* (San José, Costa Rica, 1991).

Ana M. Alfonso-Goldfarb, Márcia H.M. Ferraz, and Silvia Waisse, *Training Researchers in Ibero-America: Early Brazilian Chemists as Case Study* In: *A Global History of Research Education: Disciplines, Institutions, and Nations, 1840–1950*. Edited by: Ku-ming (Kevin) Chang and Alan Rocke. *History of Universities* XXXIV/1, Oxford University Press (2021). © Oxford University Press. DOI: 10.1093/oso/9780192844774.003.0011

favored by the Bourbons. This view made Spain a notable exception among the fifteenth- and sixteenth-century colonial powers.[3] Each component of this political entity therefore had to have a university of its own. Royal or pontifical universities, or a mixture of both, began to be created in 1538 (Santo Domingo, Hispaniola). By 1812, their number had reached thirty-two, even though some were only on paper.[4] The majority of these universities, including the two most successful, those in Lima (Peru) and Mexico, followed the Salamanca pattern, according to which universities were intended to serve the state, and the academic unit was the professorial chair. Teaching was delivered in Latin and complied with the traditional style of *lectio* (reading aloud of canonical texts) and *disputatio* (presentation of objections and arguments).[5] Despite several attempts at reform, teaching remained bookish until the end of the eighteenth century.

After the Spanish colonies achieved independence, starting in the early 1800s, professional training became a privileged focus of interest for the new countries.[6] The traditional integrated university was replaced by an aggregate of professional schools meant to prepare personnel for public administration and to meet social needs, like health care and engineering.[7] As such, the universities remained a stronghold of the local elites until the early decades of the twentieth century.[8] For instance, in Chile an innovative project was devised based on the idea that the university ought to be the core of the entire educational system, whose benefits would thus naturally extend to society at large.[9] European science was to be incorporated following its adaptation to the Chilean nature and population, and to

[3] Tünnermann Bernheim, *Universidad latinoamericana*, 55. To remind briefly, the Habsburgs ruled over Spain from 1516 to 1700. While several other reasons were put forward, they do not truly account for this considerable difference, for example: to tend to the educational needs of the clergymen who accompanied conquerors; a desire to heighten the level of studies at the colonies; and education of the children of the Spanish and American-born elite to establish cultural links to the Empire and prepare personnel for colonial administration. See also Elsi Jiménez, 'Historia de la universidad en América Latina', *Revista de la Educación Superior*, 36/141 (2007), 169–78.

[4] Ibid, 59. By the time of the independence from Spain, only 25 remained; see Brunner, *Educación superior*, 17.

[5] Ibid, 57. [6] Ibid.

[7] Ibid, 66. Under such spirit, several new universities were founded, including University of Buenos Aires, Argentina (1821), University of Chile (1842), University of Uruguay (1860), National University of Asunción, Paraguay (1889) and National University of Mexico (1910). For a new historiographical movement emerging at the end of the 1990s asserting the existence of non-marginal, non-subordinated, non-precarious scientific practice in Latin America in the nineteenth century, see the special issue edited by Antonio Lafuente and Leoncio López-Ocón in the journal *Asclépio*, 50/2 (1998).

[8] In 1918, a movement for reshaping the university emerged, fueled by the fledgling middle classes, first in Córdoba (Argentina) and soon extending to the remainder of Hispanic America; see Tünnermann Bernheim, *Universidad latinoamericana*, 69.

[9] Brunner, *Educación superior*, 8.

accomplish this purpose, teaching was distributed across five schools: philosophy and humanities, mathematical and physical sciences, medicine, law and political sciences, and theology. Nevertheless, in practice it became a 'university of lawyers': 75% of the graduates from 1844 to 1879 came from the School of Law. This, indeed, was a typical phenomenon of the universities in Spanish-speaking America as a whole.[10]

The teaching of science and engineering in these countries underwent considerable development only from the 1950s onward, partly as a result of the need of the local industries to expand and replace imports from abroad. However, the entrepreneurs' expectations were to reproduce the technical specifications of the imported goods as exactly as possible.[11] As a result, teaching did not lose its emphasis on professional training. With the single exception of the exact and natural sciences in Argentina—whose government, inspired by the German academic ethos, had made research a priority—not until the period between 1960 and 1975 did the modern university take hold in Ibero-America, including new careers in the humanities and education, and in the social, exact, and natural sciences.[12]

Contrary to a commonly held view, in the present essay we shall argue that, although it is true that the modern research university only began to take root in Ibero-America from the mid-1950s onward (therefore, after the period considered in this collection), chemical studies actually developed earlier. Admittedly, the close association with attempts at boosting the local economies impeded fundamental research until the establishment of new approaches to higher education and the creation of research support agencies in the twentieth century. However, our conclusion is that the relative late arrival of universities (in comparison with Hispanic America) did not significantly slow the growth of chemical studies in Brazil.

Birth of Nations and Chemical Research in Spanish-speaking America

One of the consequences of the era of independence from Spain during the early decades of the nineteenth century was a fragmentation of vast

[10] Ibid, 9; the reason being that following the establishment of the republican system, a degree in law was the main channel for socialization and access to the political elite, in addition to ensuring the training required for a career in the government.

[11] Jorge Vivas, 'Formación universitaria en ciencias e ingeniería y el sistema científico-tecnológico en América Latina', in Jorge Graciarena et al. (eds.) *Universidad y desarrollo en América Latina y el Caribe*, (Caracas, 1984), 89–142. Until about 1950, the vast majority of universities taught law and medicine only; see Brunner, *Educación superior*, 18.

[12] Ibid, 103, 107–8.

colonial domains into a number of new countries.[13] Several categories of reasons contributed to the emergence of these new nations around several poles of attraction.[14] Long debated in the historiography, reasons range from regional rivalry and internal conflict to what many characterize as 'sovereignty dispersion'.[15] In any case, there is wide agreement that despite the countless newly drawn boundaries, much of the older colonial structures survived all across Hispanic America,[16] including the teaching and learning institutions (despite several attempts at modernization). Thus, when chemistry began to acquire its modern contours and to earn a central role elsewhere, little of this movement reached these young countries. Attempts at developing an appropriate research infrastructure, which was particularly relevant for new chemical studies, were few and usually ill fated,[17] as the following examples help illustrate.

To begin, Peru, one of the most powerful regions in the colonial era, had to overcome several obstacles before its independence could consolidate. In fact, many such hindrances persisted, and even gained new strength following emancipation.[18] These included not only border issues and conflict with its new neighbors, but also internal problems. For instance, the natural barriers represented by the high Andean mountains

[13] The most striking exception is Cuba, which proclaimed its independence only in 1899, to be immediately occupied by the United States.

[14] To remind briefly, the vast territory of Hispanic America had a complex geopolitical history. First divided into two large viceroyalties – New Spain in the north (capital: Mexico) and Peru in the south (capital: Lima)—at the end of the colonial period the latter lost a part of its territory, resulting in further two large viceroyalties, New Granada (capital: Santa Fe, present day Bogota) and Rio de la Plata (capital: Buenos Aires) and the General Captaincy of Chile (capital: Santiago). For more detail, especially after independence from Spain, see, e.g., Rafe Blaufarb, 'The Western Question: The Geopolitics of Latin American Independence', *American Historical Review*, 112 (2007), 742–63.

[15] For a more thorough and up-to-date review on so-called 'sovereignty dispersion', see Wolfgang Knöbl, 'La contingencia de la independencia y de la revolución: perspectivas teóricas y comparadas sobre América Latina', *América Latina Hoy*, 57 (2011), 15–49.

[16] A classic sociopolitical analysis is provided by John Lynch, *The Spanish American Revolutions, 1808-1826* (London, 1973). For a historiographical review reaching the present time, see Juan B. Amores, 'Nuevos enfoques y métodos en la historiografía sobre las independencias: el debate continua', *Historia y Sociedad*, 20 (2011), 13–31.

[17] On the new room for chemistry and laboratory processes in the eighteenth and nineteenth centuries, see, e.g., Ernst Homburg, 'The Rise of Analytical Chemistry and its Consequences for the Development of the German Chemical Profession (1780–1860)', *Ambix*, 46/1 (1999), 1–32; and Ursula Klein, 'The Laboratory Challenge: Some Revisions of the Standard View of Early Modern Experimentation', *Isis*, 99/4 (2008), 769–82.

[18] It is worth observing once again that along the last century of the colonial period the viceroyalty of Peru lost a large part of its territory, and with it a considerable fraction of its resources and the access to the Atlantic Ocean, in addition to being subjected to stronger control by Spain, followed by a long and difficult process of independence and border issues with its new neighbors. For more detail on the historical changes underwent by Peru, see e.g. Raul P. Barrenechea, *Historia de los límites del Perú* (Lima, 1926).

and a dense rainforest hindered the development of communication and transportation systems within the country, and the Peruvian government was left with poor access to its own territory during a large part of the nineteenth century. This and other weak points made the mapping, exploration, study, and exploitation of natural resources substantially difficult, with the corresponding impact on the creation of teaching and research institutions.[19]

Nevertheless, chemical innovations, including Lavoisier's new chemistry, awakened much interest among the Peruvian scholars starting in the late 1700s, i.e. still during the colonial period. This is evidenced by the local publication of the *Méthode de nomenclature chimique* soon after its original French edition. Countless brochures, articles, reports, and even books and dictionaries devoted to the principles of the new chemistry began to appear soon after independence from Spain in 1821.[20] In addition, whenever financial conditions were favorable, the government sought to promote national and foreign expeditions. With very few exceptions, these travelers behaved more as explorers than as scientists, possibly as an outcome of a rather pragmatic view seemingly adopted by the local oligarchy since the end of the colonial period. The first mining and civil engineering school was founded in the last quarter of the nineteenth century. Though its graduates proactively engaged in constructing roads and exploring mineral resources, the few fine works on Peruvian natural history and archeology did not awaken the same degree of interest. Indeed, many of these works were published too late and/or incompletely, while their diffusion and continuity demanded specialized laboratories and equipment that were then unavailable in Peru.[21] Therefore, chemical studies remained restricted to engineering, medical, and pharmacy schools, which focused on professional training and provided few resources, room, or staff for research. In addition, most such schools were located in Lima, the capital, where all attempts to reform the traditional university curriculum—much respected in colonial times—suffered serious setbacks or were short-lived.[22]

In Peru, chairs in chemistry gained enough momentum to form a school of chemistry in the university during the 1940s. Around the same

[19] For more detail on the troubles Peru had to overcome, see Carlos Contreras and Marcos Cueto, 'Caminos, ciencia y Estado en el Perú, 1850-1930', *História, Ciências, Saúde—Manguinhos* 15/3 (2008), 635–55.

[20] On these and other publications related with the new chemistry, see Juan D. Guevara, *Historia de la quimica en el Perú* (Lima, 1993), 71–113, 164–174.

[21] Contreras and Cueto, 'Caminos, ciencia', 642–4.

[22] On the creation (and setbacks) of higher education schools in independent Peru and the establishment of chemistry as ancillary chair, see Guevara, *Historia de la química*, 212–50; on the concentration of higher education schools in Lima and some attempts at reform, see Ibid, 649–50.

time, the Chemical Society of Peru and the Superior Institute of Chemistry at San Marcos National University were also created. Official support for research was first secured following a major reform in the 1960s.[23]

The situation was similar, although with some peculiarities, in other young Andean countries. For instance, in Chile—a very wealthy area under the rule of the viceroyalty of Peru for a large part of its colonial history—chemistry succeeded in achieving autonomy from medicine by the middle of the twentieth century, though still joined to pharmacy.[24] Another relevant example is that of the viceroyalty of New Granada, the birthplace of one of the earliest and strongest independence movements in Hispanic America, and from which Colombia and Venezuela emerged. Like Chile, these territories were rich in natural and agricultural resources. But they had unexplored areas, too, and poor communication systems. Its situation resembled that of Peru, again complicated by instability and internal conflict for a large part of the nineteenth century.[25] Within this context, sciences such as chemistry remained taught as auxiliary to medicine and engineering, while scarce resources were afforded to specialized studies or laboratories fit for research.

In Colombia, chemistry severed its ties to medicine only in the 1930s. For this development—set off by the creation of the National Chemical Laboratory—governmental support was crucial. Various isolated chemical chairs were united in one single school at the National University, which produced the first graduates in the 1940s. However, it seems that in its beginning this school had very simple laboratories intended for teaching purposes only, since the government's interest was exclusively in training chemists for the emerging Colombian industry. As a result, advanced research took off only in the second half of the century.[26] In Venezuela, the first superior schools of chemistry were created in the 1940s, once again to train professionals to meet government and industry needs, e.g. petroleum development. The same reasons account for the foundation of the first

[23] Guevara, *Historia de la química*, 270–95, 304–47.

[24] Eduardo Guzmán Riberos, *Historia de una profesión: Colegio Químico Farmacéutico y Bioquímico de Chile A.G. 60 años, 1942–2002* (Santiago, Chille, 2003), 59–60.

[25] Although these independence movements were among the earliest in the Americas, consolidation was particularly delayed and bloody; in addition, emancipation was followed by periods of serious instability. For more detail, see, e.g., Clement Thibaud, 'En búsqueda de un punto fijo para la república: el cesarismo liberal (Venezuela-Colombia, 1810–1830)', *Revista de Indias*, 62/225 (2002), 463–92. On expeditions during the period of independence, see e.g., Álvaro Villegas Vélez, 'Paisajes, experiencias e historias en las dos primeras expediciones de la Comisión Corográfica', *Historia y Sociedad*, 20 (2011), 91–112.

[26] Rogino Martínez-Chavanz, German Cubillos and Flor M. Poveda, *Historia social de la ciencia en Colombia*, vi: Fisica y quimica (Bogotá, 1993), 189–90; Diana Obregón, 'Trade and the Natural Sciences in the United State of Colombia', in P. Petitjean, C. Jami and A. M. Moulin (eds.), *Science and Empire* (Dordrecht, 1992), 147–52.

School of Pharmacy and Chemistry at Central University of Venezuela about this time. Also, in this case institutions devoted to specialized research began to appear in the second half of the century.[27]

The picture painted up to this point is completed by a group of young Hispanic American countries born out of the viceroyalties of New Spain and Rio de la Plata. Many such countries were small and achieved their independence later compared to the larger ones. They therefore had to overcome additional hindrances and took longer to establish scientific programs and create research institutions.[28] It is worth noting that these countries were the result of the aforementioned 'sovereignty dispersion'. They spared no efforts to avoid being absorbed into the two larger poles of attraction. We allude here to Argentina and Mexico, which in a succession of internal wars and agreements following independence saw a number of new and small countries appear on their former borders. In any case, these two larger countries were precisely the ones in the best condition to maintain or create scientific institutions, as we discuss next.

Chemical Research in Argentina and Mexico

Any approach to the development of science in Hispanic America needs to consider the violent political upheavals that took place in this region following its independence from Spain. Periods of civil war alternated with dictatorships and attempts at 'national reorganization', which usually comprised well-defined, albeit seldom successful, social, economic, and cultural reform programs.

This phenomenon is, for instance, illustrated by two early attempts at establishing teaching laboratories for chemistry in Argentina. Once the wars of independence were over, a period of relative stability settled in. The government consisted of a liberal, enlightened, and European-minded elite, one of whose first actions was to create the University of Buenos Aires (1821) to bring the city closer to the large and modern European

[27] Ivan de la Vega, José L. Paz, Jorge Mostany, Domingos Vargas and Jaime Requena, 'Sociología de la ciencia: la investigación química en Venezuela. Retrospectiva y perspectivas', *Espacio Abierto* 21/1 (2012), 119–44, on 120–2; Reinaldo Rojas, 'Historia de la universidad en Venezuela', *Historia de la Educación Latinoamericana*, 7 (2005), 75–100.

[28] In some cases, like the one of Uruguay, new schools including facilities for chemical studies were established. However, as the standard pattern goes, research only gained momentum late in the twentieth century; see Bernardo Borkenztain, Amilcar Davyt, Fernando Ferreira and Patrick Moyna, 'Giovanni Battista Marini Bettolo: su incidencia en el desarrollo de la química en Uruguay', *História, Ciências, Saúde—Manguinhos*, 12/2 (2005), 535–46, on 537–38.

urban centers.[29] This university was organized on the basis of departments. One of them was the Department of Preparatory Studies, in which natural sciences, including chemistry, were taught.[30] Although a state-of-the-art teaching laboratory of chemistry was established, following the model developed by the French chemist Louis J. Thénard (1777–1857), it never fulfilled its goals, and in fact did not survive long.[31] The entire university system entered a period of decline under the dictatorship of Juan Manuel de Rosas (1829–32, 1835–52).

Consistent with the pattern in Spanish-speaking America, this dictatorship was followed by a process of national reorganization. In this process, by the 1860s the economic system of Argentina had undergone a major transformation. It was integrated into international markets as an agricultural and livestock producer, and imported manufactured goods. This resulted in dramatic social and demographic changes. Within this context, particular relevance was attributed to chemistry for its close relationship to industry, production, and health.[32] Several institutions were created for public health, food production, trade, and agriculture in the 1880s, including government-run chemical bureaus and laboratories.

The new dean of University of Buenos Aires, appointed in 1861, was strongly persuaded that science afforded the path to train the professionals needed for the economic and industrial development of the country, as well as to develop and spread the values of a democratic republican society. A new Department of Exact Sciences was thus created (1865) with the explicit purpose of establishing the teaching of science and training engineers.[33] Within this context, a young Spaniard with a doctorate in physical and mathematical sciences and a career in pharmacy, Manuel Puiggari (1827–1899), was appointed to the chair of chemistry.[34] Puiggari established a teaching laboratory on the model of that of Justus von Liebig

[29] Gabriel Matharan, 'Los inicios de la enseñanza experimental de la química: el caso del Laboratorio de Química de la Universidad de Buenos Aires (1823–1865)', *Saber y Tiempo* 1/1 (2015), 96–117, on 99–101.

[30] Up to that moment, chemistry was only taught as a part of the training of doctors and pharmacists; see Daniel Coria, 'La química en Argentina: un esbozo de 200 años de historia', *Invenio*, 19/37 (2016), 7–10.

[31] Matharan, 'Inicios de la enseñanza', 102–6; Gabriel Matharan, 'La emergencia y la dinámica de la investigación química en la Argentina (1896–1942)', in *13º Seminário Nacional de História da Ciência e da Tecnologia. Anais*. São Paulo, September 3–6, 2012, on 3. Available at:
http://www.13snhct.sbhc.org.br/resources/anais/10/1345002400_ARQUIVO_GabrielMatharanTrabajo.pdf

[32] Matharan, 'Emergencia y dinámica', 6.

[33] Along the 1880s, the government established laboratories for chemical studies and research, such as the municipal chemistry bureau of National Institute of Hygiene, and laboratories at the National Sanitation Service; see Ibid, 6.

[34] Matharan, 'Inicios de la enseñanza', 107–11.

(1803–1873), i.e. where students were expected to learn by performing 'chemical manipulations'.[35] Yet, chemistry remained tied to medicine and pharmacy through a link that only began to dissolve at the end of the 1890s, when the first university career in chemistry, a doctoral course, was established at the University of Buenos Aires School of Exact, Physical, and Natural Sciences (1896).[36] As we shall see, this association of chemistry with pharmacy was also present in Mexico.

The focus of this doctoral course in Argentina was not chemistry as such, but its possible applications. It aimed at training professionals for the technico-bureaucratic needs of the government. Thus, the practical side of the course was conducted at the aforementioned government-run laboratories, which eventually hired the graduates of this doctoral course. Interest increased gradually, as the number of graduates grew from 3 (1897–1902) to 217 (1932–1941).[37] Starting around 1910, two trends began to take shape and remain to this day: teaching that was centered on the training of professionals for industry, and the education of university professors, investigators, and laboratory experts.[38] Research began to gain momentum when chemists, congregated in the Argentinian Chemical Society (created in 1912 and renamed the Argentinian Chemical Association in 1920) succeeded in persuading the government, universities, and the industry of their relevance. The establishment of the earliest research institutes and incipient professionalization of research became available.[39] The creation of these institutes led to the emergence of research as a profession and to the development of research groups. Yet, positions of full-time professors and professional investigators were established only at the turn of the 1950s, with the creation/re-foundation of institutions such as the National Scientific and Technical Research Council (CONICET) and the modernization of the universities.[40]

Mexico has had a long tradition of chemical research starting from the colonial period. It first focused on mining and metallurgy, then also on the native flora and fauna. Nevertheless, specifically chemical laboratories

[35] Ibid, 107–11.

[36] To be sure, Puiggari strongly associated with pharmacists and the teaching of pharmacy and his tenure was characterized by efforts to detach this profession from the control and supervision of doctors; see Coria, 'La química en Argentina', 8.

[37] Matharan, 'Emergencia y dinámica', 7; 'Constitución de la química', 68.

[38] Coria, 'Química en Argentina', 8; Matharan, 'Constitución de la química', 70.

[39] Matharan, 'Constitución de la química', 70. The earliest research-only institutions were Institute of Chemical Research, National University of La Plata (1926); Institute of Microchemical Research, National University of the Littoral (1936); and Institute of Scientific and Technological Research, National University of the Littoral (1929); see Matharan, 'Emergencia y dinámica', 11–12.

[40] Matharan, 'Constitución de la química', 71.

began to appear only at the turn of the twentieth century.[41] An example was the Departments of Analytical and Industrial Chemistry of the National Medical Institute (opened in 1904). These laboratories, designed for manufacturing industrial chemicals and pharmaceuticals from native plants and products, also served to train pharmacists. Some of their trainees later became professors at the School of Chemistry at the National University of Mexico.[42]

Following a long period of civil war, industrialization and economic reactivation ensued in the early decades of the twentieth century. The new constitutional governments were persuaded that professional education, particularly within the university setting, ought to be fully aligned to the problems affecting the population and to boost the Mexican economy. This development-centered approach gave a strong impulse to careers in applied science and industry. This was the context for the creation of the National School of Chemical Industries in 1916, the first formal school for chemical teaching in the country.[43] This school, incorporated the following year into the National University as the School of Chemical Sciences, sought to train chemical technicians, industrial investigators, chemical engineers, and chemists, and particularly to prepare youths for the

[41] Royal Mining Body of New Spain (1792) and Royal Mining Seminary; 19th century: chemical laboratories at National School of Medicine and National School of Agriculture, mainly devoted to teaching; chemical laboratory at the Customs Administration, targeting control of the quality of food, beverages and other products; chemical laboratory at the Superior Health Council, for analysis of food, beverages and medicines, among others. See Andoni Garritz Ruiz, 'Breve historia de la educación química en México', *Boletín de la Sociedade Química Mexicana*, 1/2 (2007), 3–24; Liliana Schifter and Patricia Aceves, 'The Development of Industrial Chemistry at the National Medical Institute (1904–1915), The Study of Mexican Medicinal Plants' in Ana M. Alfonso-Goldfarb et al. (eds.), *Crossing Oceans: Exchange of Products, Instruments and Procedures in the History of Chemistry and Related Sciences* (Campinas, 2015), 285–98.

[42] Schifter and Aceves, 'Development of Industrial Chemistry', 288, 295–6. There are instances of chemists who sought more specialized training in Europe, as e.g., V. Ortigosa, who spent some time at von Liebig's laboratory in Giessen in 1842; however, upon returning to Mexico, he met a total lack of infrastructure to continue his work of research; see Garritz Ruiz, 'Breve historia', 9.

[43] Until this moment, the few academically trained chemists had their professional education in European universities; see Felipe L. Olivares, 'Pioneros de la investigación científica de la UNAM', *Educación Química*, 17/3 (2006), 335–42. On this subject, see Rogelio Godímez Resendiz and Patricia Aceves Pastrana, 'Los primeros químicos y el surgimiento de la industria farmacéutica en México (1900–1940)' in A.M. Alfonso-Goldfarb et al. (eds.), *Simão Mathias—Cem Anos: Química e História da Química no Início do Século XXI* (São Paulo, 2010), 88–106; and Patricia Aceves and Sandra Martínez, 'Los farmacéuticos y los químicos mexicanos en la búsqueda de su identidad en los inicios del siglo XX', in J.A. Chamizo (ed.), *Historia y filosofía de la química: aportes para la enseñaza* (México DF, 2010), 114–41, on 125 et seq. Between 1865 and 1870, the Literary Institute (later Scientific and Literary Institute) included a chair of organic and inorganic chemistry; see Garritz Ruiz, 'Breve historia', 10.

exploration and exploitation of Mexico's natural resources.[44] However, due to budget restraints, this school never enjoyed the infrastructure required for experimental training, which instead was available in industrial laboratories.[45] Though grants for the best students to pursue their studies in Europe, Germany in particular, were available, upon these students' return to the country they had to contend with the lack of research infrastructure.[46] Nevertheless, the school's graduates became the professional manpower in schools, laboratories, and the incipient chemical-pharmaceutical industry.[47]

Starting in 1934, the National University of Mexico underwent a thorough reform, leading, among other results, to the creation of a doctoral course in the sciences. The explicit goal of the course was to train researchers in subjects of practical and industrial interests for the economic development of the country. This new orientation resulted in the creation of two learning programs, one for professional training and the other devoted to formal graduate education (the Graduate School). The Chemistry Department at the School of Philosophy and Literature was incorporated into the Program of Advanced Studies, which was entitled to grant doctoral degrees.[48]

The teaching profile at the chemical school began to change following the appointment of Fernando Orozco (1899–1978) as its director in 1935. Having graduated in industrial chemistry at the School of Chemical Sciences and then earning a doctorate in chemistry in Germany, he sought to boost chemical research upon his return to Mexico. For that purpose he first transformed the older workshops into proper laboratories for scientific education, updated the teaching curriculum, and established the Chemistry Institute—with help from the Rockefeller Institute and the Bank of Mexico—as a locus for fundamental research and the training of researchers.[49] Although material resources were scarce, the Institute activities flourished through partnerships with industry.[50] As part of the new program, the best students of the School of Chemical Sciences were

[44] Godímez Rezendiz and Aceves Pastrana, 'Primeros químicos', 90–1. Following the inclusion of pharmacists, in 1919 the institution was renamed School of Chemistry and Pharmacy.

[45] Ibid, 91; Aceves and Martínez, 'Farmacéuticos', 130.

[46] Garritz Ruiz, 'Breve historia', 12–13.

[47] Godímez Rezendiz and Aceves Pastrana, 'Primeros químicos', 91.

[48] Olivares, 'Pioneros', 336. To remind briefly, in the nineteenth century, especially in Germany, the traditional faculty of arts became the faculty of philosophy, which included teaching of sciences; for more detail see, e.g., Charles E. McClelland, *State, Society and University in Germany, 1700–1914* (Cambridge, 1980); and Kathryn M. Olesko (ed.), *Science in Germany: The Intersection of Institutional and Intellectual Ideas*, *Osiris*, 5/1 (1989).

[49] Ibid, 337.

[50] Ibid, 340.

invited to perform their dissertation research at the Institute. A system of grants to study abroad was established, whereby several candidates spent periods in England, the United States, or France.[51] Starting in 1941, the Graduate School offered a doctoral program in chemistry, which was coordinated by the Chemistry Institute, and the young doctors were consequently invited to join the group of researchers at the Chemistry Institute.[52] Professionalization of research was sanctioned when the position of full-time investigator was established in 1954.[53]

To summarize, in Argentina and Mexico, as well as in other countries in Hispanic America, the fact that universities were created early as part of the Spanish colonization policy does not seem to have contributed to the development of research traditions or communities for chemistry. Following independence, the traditionally integrated university was fragmented into professional schools intended to boost the economic development of the young countries, and were accessible mainly to the elite. Chemistry, first taught as an auxiliary discipline to mining, engineering, or medical students, gradually came to be seen as particularly useful for agriculture and local industries, though it hardly lost its close ties to pharmacy, e.g. through the manufacture of drugs, until it became an independent field of research at the turn of the twentieth century.

A Country Without Universities: No Institutional Locus for Chemistry in Brazil?

Brazil, the largest country in Ibero-America, had a substantially different geopolitical history. To begin with, the Portuguese Crown's policies for exploration, exploitation, and education included a stubborn refusal to establish formal universities for more than 400 years, from the early period of colonization, through those of royal and imperial rule and republican governments, to the age of Positivism in the last decades of the 1800s.

The Portuguese policy for Brazil was dramatically different from that applied by Spain in its American colonies, particularly in regard to actions likely to promote the development of its 'new' territory. Indeed, only elementary education was allowed in the Portuguese colony until the beginning of the nineteenth century, especially following the expulsion of the Jesuits in 1759. As part of the organized efforts to strengthen the colony's dependence, creating higher education institutions was strictly prohibited. Anyone desiring advanced learning had to seek it in Europe,

[51] Ibid, 339. [52] Ibid. [53] Ibid, 340.

Portugal in particular.[54] Even books were scarce: those that succeeded in reaching Brazil were subjected to heavy censorship, and printing presses were banned. Initiatives to explore native resources were all but irrelevant until the end of the eighteenth century. In addition, the results could be informed to the Portuguese government alone, which kept these discoveries secluded as state secrets.

This sorry state of affairs, in comparison with other American countries, began to change when the Portuguese Crown moved to Rio de Janeiro in 1808, facing the imminent invasion of Portugal by Napoleon. Brazil thereby became the administrative seat of the kingdom, and the Portuguese sought to replicate some of their traditional institutions there. For instance, on his way to Rio de Janeiro, Prince Regent João (future King D. João VI) stopped in Salvador, Bahia, where he decided to establish a school of surgery.[55] The conditions in the colony long precluded the creation of a true medical school, therefore, the earliest initiatives for medical teaching in Rio de Janeiro consisted of a simple anatomy chair in 1808, followed by the few others needed to train elementary qualified health care providers, especially surgeons.[56] Teaching in engineering began soon after, in 1810, and was somewhat more organized in terms of guidelines.[57] Together with these first schools, a publishing house opened to print governmental documents along with some books, usually translations, needed by the students of these new schools.

In 1822, the colony proclaimed its independence from Portugal, and consequently became the Empire of Brazil, headed by Emperor D. Pedro I, a son of King D. João VI. Some changes in education ensued, such as improved organization of the medical and engineering courses, and the creation in 1827 of two courses on 'juridical and social sciences', one in São

[54] Ana M. Alfonso-Goldfarb, Márcia H.M. Ferraz and Maria H.R. Beltran, 'Substitutos do "Novo" Mundo para as Antigas Plantas Raras: Um Estudo de Caso dos Bálsamos', *Química Nova*, 33/7 (2010), 1620–26; Daniel Guerrini, Renato de Oliveira and Luciano Fedozzi, 'A Formação da Universidade de Pesquisa no Brasil', in *Seminário Internacional de Educação Superior 2014, Anais Eletrônicos*, available at: http://uniso.br/publicacoes/anais_eletronicos/2014/5_es_memoria/01.pdf, cited 24 July 2017; Maria de L. de A. Fávero, 'As Universidades no Brasil: Das Origens à Reforma Universitária de 1948', *Educar*, 28 (2006), 17–36, on 20. The only institutions for higher education in Brazil were Jesuit colleges; see Arnaldo Barreto and Carlos A.L. Filgueiras, 'Origens da Universidade Brasileira', *Química Nova*, 30/7 (2007), 1780–90.

[55] Ruling from February 18th, 1808, *Collecção das Leis do Brasil, 1808*, part 2 (Rio de Janeiro, 1891), 2.

[56] Márcia H.M. Ferraz, *As Ciências em Portugal e no Brasil (1772–1822), O Texto Conflituoso da Química* (São Paulo, 1997), 191–92.

[57] Ferraz, *Ciências em Portugal*, 209; Decree from July 6th, 1810, *Collecção das Leis do Brasil, 1810*, part 1 (Rio de Janeiro, 1891), 118.

Paulo and the other in Olinda.[58] Further modifications were introduced in the nineteenth century, including the splitting of the engineering course into the Military School and the Central School, which was renamed the Polytechnic School in 1874, as the result of a considerable reform.[59] This Polytechnic School, the medical school, and a few other schools created along the last quarter of the nineteenth century, along with private laboratories, engaged in studies on minerals and other native resources.

Of particular interest for our purpose here are a 'Chair of Chemistry' established in 1817 in Bahia (though it is not known whether it ever functioned as designed),[60] and a 'Practical Chemical Laboratory' created in Rio de Janeiro in 1812 to perform chemical analyses,[61] with emphasis on substances for use in the crafts and trade.[62] The Practical Chemical Laboratory lasted about seven years and is believed to have also developed processes for native products.[63] In addition to these official facilities, a private chemical laboratory was established by Antônio Araújo de Azevedo (1754–1817). This laboratory functioned from 1808 to 1819, when it was incorporated by the state and closed soon afterwards. In addition to analyses of natural products, this laboratory also served to prepare medicines for the army and to teach chemistry lessons, mainly to medical students.[64]

[58] Law from August 11th, 1827, *Collecção das leis do Brasil, 1827* (Rio de Janeiro, 1878), i. 5.

[59] Ana M. Alfonso-Goldfarb and Marcia H.M. Ferraz, 'Mining School of Ouro Preto: An Attempt to Establish Metallurgy in Brazil', *Quipu,* 12/1 (1999), 25–37, on 29.

[60] Ferraz, *Ciências em Portugal*, 195; Ana M. Alfonso-Goldfarb and Marcia H.M. Ferraz, 'Reflexões sobre uma História Adiada: Trabalhos e Estudos Químicos e Pré-Químicos Brasileiros', *Quipu* 5 (1988), 3–12. According to some sources, this chair was inaugurated in 1833, see Kedima F. Oliveira Matos, 'A Química na Bahia: da Faculdade de Medicina à Faculdade de Filosofia, Ciências e Letras (1889–1950)' (Master's thesis, Pontifical Catholic University of São Paulo, 2006), 9.

[61] Ferraz, *Ciências em Portugal*, 212 et seq.; Simon Schwartzmann, 'Introdução', in Simon Schwartzmann (ed.), *Universidades e Instituições Científicas no Brasil* (Brasilia, 1982), 7–16, on 9; Heinrich Rheinboldt, 'A Química no Brasil', in Fernando de Azevedo (ed.), *As Ciências no Brasil* (São Paulo, 1955), ii. 9–92, on 22–6.

[62] Rheinboldt, 'Química no Brasil', 22–5. However, the laboratory activities were soon channeled toward work without any scientific value whatsoever, namely, selling of medicines.

[63] Activities included analysis of brasilwood and sulfur mineral waters, as well as preparation of opium from poppy; see dos Nadja P. Santos, 'Laboratório Químico-Prático do Rio de Janeiro: A Primeira Tentativa de Difusão da Química no Brasil (1812–1819)', *Quimica Nova*, 27/2 (2004), 342–8, esp. on 346.

[64] Ferraz, *Ciências em Portugal*, 197–9; Santos, 'Laboratório Químico-Prático', 347; Nadja P. dos Santos, 'Os Primeiros Laboratórios Químicos do Rio de Janeiro' in *XI Encontro Regional de História, ANPUH-RJ, 2004*. Rio de Janeiro: UERJ/ANPUH/Arquivo Público do Rio de Janeiro, 49–50 (full text available at: http://www.memoriasdaquimica.ccs.ufrj.br/txt/npds.pdf).

More relevant and long lasting was the chemistry laboratory established at the National Museum in 1824, devoted to chemical analyses of natural resources such as minerals, coal, and pau-brasil (*Paubrasilia echinata* Lam., brazilwood). Initially run by chemists who had had training in France,[65] the appointment of the German naturalist and pharmacist Theodor Peckolt (1822–1912) in 1874 raised expectations. However, whereas Peckolt did restructure and renovate the laboratory, his tenure was too short to have lasting impact. More interested in the Brazilian medicinal plants, he established a laboratory in his own chemist's shop, where he conducted studies on about 6,000 species, many of which were published in Brazil and abroad or presented in national and universal exhibitions. Peckolt thus contributed to the development of phytochemistry, one of the most relevant fields of chemical research in Brazil. However, he did not devote any attention to the training of future researchers.[66]

Here we have the first sign of a pattern that, as we shall see, would repeat time and again: foreign chemists were hired to teach and/or establish laboratories, they performed their research and/or trained students, but their tenure was too short, or their institutions were closed after their death or as the result of political upheavals. This was the case, for instance, of Claude H. Gorceix (1852–1919), who was brought from France by Emperor D. Pedro II to establish and direct the first mining school for the studies of minerals. The conditions seemed ideal: Brazil is rich in minerals, and Minas Gerais, the province where the school was located, remains to this day one of the richest in minerals, which at that time demanded urgent studies. For this purpose, Gorceix formulated a program that included specialized training for engineers and scientific studies of Brazilian minerals in laboratories furnished with modern equipment. Such goals were accomplished. But soon they had to be modified, because the students did not have the preparation necessary to follow the teaching, and the few who managed to graduate had to compete with specialists brought to the country by foreign mining companies.[67] In order not to lose all the time and money invested in this school, a course on civil engineering was established, while Gorceix was compelled to continue his research with a single assistant.[68]

[65] Rheinboldt, 'Química no Brasil', 26–32.

[66] Nadja P. dos Santos, Angelo C. Pinto and Ricardo B. de Alencastro, 'Theodoro Peckolt: Naturalista e Farmacêutico do Brasil Imperial', *Quimica Nova*, 21/5 (1998), 660–70; Simão Mathias, 'Cem Anos de Química no Brasil', *Revista de História*, 63 (1975), 5–69, on 6–7.

[67] Alfonso-Goldfarb and Ferraz, 'Mining School', 37–8.

[68] Ibid, 37–8; Mathias, 'Cem Anos', 15.

A similar story occurred in Rio de Janeiro, the Empire's capital. As was mentioned above, in 1874 the Polytechnic School was created as an offshoot of the older Royal Military Academy. The curriculum demanded that students first attend a common preparatory course, including chemistry, before entering the professional schools. However, appropriate teachers were lacking.[69] In 1884 Wilhelm Michler (1846–1887), a professor at the Polytechnic School of Zurich, was appointed to the chemistry chair. He established a well-equipped research laboratory—first with his own resources, reimbursed only much later and with considerable difficulty. In this laboratory, with room for 30 students, he conducted original chemical studies of Brazilian plants. Although he trained some Brazilian disciples, the laboratory did not survive after his death.[70]

In a few cases, specialists brought from abroad succeeded in making a difference in chemical research and education. One example is the Imperial Agronomic Station of Campinas, founded in 1887 in the interior of the province of São Paulo for the study of tropical crops in the area, one that was very fertile and home to large plantations. The appointed director was the Austrian chemist Franz W. Dafert (1863–1933), who had earned his doctoral degree from the University of Giessen.[71] Soon Dafert established laboratories and stoves, and collected all the equipment needed for research to bear expected fruit. Research was to be conducted in the German style. He gathered a highly qualified staff rather quickly, including Brazilian and foreign experts. All were engaged in original research based on the local conditions, not always with an eye on immediate practical applications. During the ten years of Dafert's tenure, research at the Station attained a stunningly high level. However, despite several practical problems that he solved related to pests and epidemics, Dafert's work was a target of continued criticism by those who expected immediate results.[72] After his departure in 1897, the new director enacted a research policy centered on profitable applications to agriculture. Dafert's guidelines were reestablished

[69] Rheinboldt, 'Química no Brasil', 54 et seq.

[70] Mathias, 'Cem Anos', 12–4; Nadja P. dos Santos, Angelo C. Pinto and Ricardo B. de Alencastro, 'Wilhelm Michler, uma Aventura Científica nos Trópicos', *Quimica Nova*, 23/2 (2000), 418–26, esp. on 422–4.

[71] Tamás J.M.K. Szmrecsányi, 'Origens da Liderança Científica e Tecnológica Paulista no Século XX', *Revista Gestão & Conexões*, 2/2 (2013), 181–206, on 189; Pedro Ramos and Fabrício J. Piacente, 'O Instituto Agronômico de Campinas: Sua Criação, Importância e um Pouco de sua História', *Revista Brasileira de Inovação*, 15/2 (2016), 365–92. The Agriculture Ministry Report for 1888 mentions the emphasis on the chemical work conducted by Dafert at the Station; see Brazil, *Relatorio apresentado à Assembleia Geral, pelo Ministro e Secretario Interino dos Negocios da Agricultura, Commercio e Obras Públicas* (Rio de Janeiro, 1889), 73.

[72] São Paulo state, *Relatório Anual do Instituto Agronômico do Estado de São Paulo em Campinas* (1892), [. . .] pelo Director Dr. F. W. Dafert (São Paulo, 1893).

in 1924, when Teodureto de Camargo, a Brazilian, was appointed director. Original studies were again conducted in large scale. According to some scholars, the success of the Station was largely due to the fact that in its earliest years Brazil had become a republic, and the institution was transferred to the state government.[73]

One of the characteristics of the First Brazilian Republic, proclaimed in 1889, was its decentralizing nature. The individual states had the authority to establish teaching and research institutions considerably independent of the federal government.[74] Most of these new institutions were created with the explicit purpose of solving immediate problems related to agriculture—control of pests, workers' health, and the ubiquitous epidemics that periodically broke out across the country.[75] Most of these research institutes had no links whatsoever to higher education institutions, while some of them established courses for training researchers. For example, the Manguinhos Institute in Rio de Janeiro trained a full generation of investigators who later furnished staff to the main research institutions in other states.[76]

In any case, a spurt of industrialization, triggered by World War I, led the Brazilian government and scholars to adopt an overtly favorable position for scientific development, especially for its practical application and, significantly, with a focus on chemistry. An article written in 1917 by José de Freitas Machado, a professor at the Superior School of Agriculture and Veterinary Medicine of Rio de Janeiro, achieved wide circulation. Entitled 'Let's Make Chemists', it demanded the creation of schools and centers for chemical studies following the Parisian model.[77] It was thus no coincidence that the following year the Chemical Institute of Rio de

[73] Mathias, 'Cem Anos', 15; Szmrecsányi, 'Origens da Liderança', 188–9; Ramos and Piacente, 'Instituto Agronômico', 36–71; Rosely A. de Vargas, 'A Produção Científica Brasileira em Ciências Agrárias Indexada na Web of Science: Características e Redes de Colaboração (2000–2011)' (Master's thesis, Federal University of Rio Grande do Sul, 2014), 32.

[74] Helena Sampaio, 'Evolução do Ensino Superior Brasileiro, 1808–1990', *Documento de Trabalho*, 8/91 (São Paulo, 1991), 7.

[75] Bacteriological Institute (1892) for manufacture of vaccines and medicines and performance of microbiological tests; Butantan Institute (1889) following an outbreak of plague, as a laboratory for production of sera and vaccines; Vaccinogenic Institute (1892); Biological Institute (1928); Forest Institute (1896); Experimental Station of Campinas (later Agronomic Institute of Campinas, 1887). In Rio de Janeiro, Serotherapy Institute of Manguinhos was created in 1899 as a center for combat of environmental diseases to later on become the prestigious Oswaldo Cruz Institute, present-day Oswaldo Cruz Foundation; Guerrini et al., 'Formação da universidade', 6; Sampaio, 'Evolução do Ensino', 7–8.

[76] Schwartzman, 'Introdução', 10.

[77] Mathias, 'Cem Anos', 17; Nadja P. dos Santos, Angelo C. Pinto and Ricardo B. de Alencastro, 'Façamos Químicos: A "Certidão de Nascimento" dos Cursos de Química de Nível Superior no Brasil', *Quimica Nova*, 29/3 (2006), 621–6.

Janeiro was founded. Its chair for more than twenty years was Mário Saraiva, a physician from Bahia who was considered to be an expert in chemical research. The Institute specialized in Brazilian natural products. Transferred in 1934 to the National Department of Plant Production, it became the Institute of Agricultural Chemistry, enjoying national and international fame. More than 200 papers on natural products and agricultural production ensued, almost all of them published in highly reputable journals.[78]

In addition, starting in 1919, several independent courses on industrial chemistry were appended to previously existing technical schools. Many of these courses eventually became the present-day programs in chemical engineering, which gradually introduced research programs in the 1920s and 1930s.[79] For instance, a 'Course of Industrial Chemistry' was established in 1926 at the Polytechnic School of São Paulo (founded in 1918) side by side with a five-year university-level 'Chemical Engineering Course' that resulted from the merging of the courses for 'chemists' and 'industrial engineers'. Both the courses of industrial chemistry and of chemical engineering were meant to feed trained manpower to the chemical industry that was undergoing overt expansion.[80]

Decentralization favored the establishment of institutions not only in São Paulo, but also all across the country. Following the implementation of these new establishments, foreign chemists were then hired to establish laboratories and training courses, but all of them were ephemeral. This is, for instance, the case with the School of Industrial Chemistry of Pará, in which the former chemist assayer at Université de Nancy, Paul Le Cointe (1870–1956) performed studies on Amazonian flora together with other French colleagues from 1921 until the school's closure in 1930.[81] Chemistry courses were launched in 1921 at the School of Engineering of Porto Alegre, Rio Grande do Sul, taught by German professors, before closing in 1930.[82] Likewise, chemistry courses were available at the School of Engineering of Belo Horizonte, Minas Gerais, taught by German

[78] Mathias, 'Cem Anos', 17; unfortunately, the central government closed this prestigious and highly productive institution in 1962, with no explanation whatsoever and despite the protests of the entire Brazilian scientific community.

[79] Mathias, 'Cem Anos', 18–19.

[80] Rheinboldt, 'Química no Brasil', 68.

[81] Mathias, 'Cem Anos', 18 et seq. This was a four-year course, comprising a minimum of 20 hours/week of practical work in laboratories or seminars, and that delivered a 'chemist diploma' following the conclusion of a dissertation; Rheinboldt, 'Química no Brasil', 3–4.

[82] Rheinboldt, 'Química no Brasil', 71.

professors from 1921 to 1931.[83] Altogether these courses trained about 300 graduates, half of whom entered the profession.[84]

New University Space for Chemical Research

While several higher education institutions in Brazil had been given the name of 'university', one of the first that truly deserved it was the University of Rio de Janeiro (URJ), established by a presidential decree in 1920. It resulted from the union of three professional schools—polytechnic, medicine and law—though without any connecting links between them.[85] In any case, this development promoted serious discussions in the 1920s on the role of universities, especially within the Brazilian Academy of Sciences and the Brazilian Academy of Education, which strongly advocated the value of 'pure science' that had no immediate useful application.[86] This trend developed against an older Positivistic tradition particular to Brazil, according to which professional and technical training was to be preferred over the university style of education, considered to be exclusively accessible to the elite.[87]

This wave of optimism notwithstanding, the decade closed in 1930 with a political coup that enthroned Getúlio Vargas (1882–1954) as president. Vargas enacted radically centralizing and interventionist policies with direct impact on education. A Statute of the Brazilian Universities was passed in 1933, including a reform of URJ, which against the expectations of the intellectual elite remained a professional school without any room

[83] Ibid, 72. This pattern would have a remarkable long life: in 1941 the German chemist Fritz Feigl (1891–1971) was hired to run a—very modest—chemical laboratory in Rio de Janeiro, where he performed considerable work with Brazilian colleagues. However, the laboratory, which was never incorporated into any higher education institution, was closed when he died. Since Feigl never had a chance to create a school of researchers, he was not able to establish facilities for high-level chemical research. The same was the fate of Hans Zocher (1893–1969) who arrived in Rio de Janeiro in 1946; see the anonymous 'À Memória do Professor Hans Zocher', *Anais da Associação Brasileira de Química*, 30/3&4 (1979), 7–10.

[84] Rheinboldt, 'Química no Brasil', 74.

[85] Fávero, 'Universidades no Brasil', 22. In 1927, a second university was created in Minas Gerais, also out of the merging of professional schools (engineering, medicine, dentistry and pharmacy).

[86] Ibid, 3; Antonio Paim, 'Por uma Universidade no Rio de Janeiro', in Simon Schwartzman (ed.), *Universidades e Instituições Científicas no Brasil* (Brasilia, 1982), 17–96, on 29–30; Eunice R. Durham, 'As Universidades Públicas e a Pesquisa no Brasil', *Documento de Trabalho*, 9/98 (São Paulo: Núcleo de Pesquisas sobre Ensino Superior/USP, 1998); Simon Schwartzman, *Um Espaço para a Ciência: A Formação da Comunidade Científica no Brasil*. 2nd ed. (Brasilia, 2001), v. 5–6; Sampaio, 'Evolução do Ensino', 8.

[87] Ana M. Alfonso-Goldfarb and Márcia H.M. Ferraz, 'Raízes Históricas da Difícil Equação da Institucionalização da Ciência no Brasil', *São Paulo em Perspectiva*, 16/3 (2002), 3–14, on 9.

for scientific research.[88] Yet the decree also preserved room for state universities, granting them full freedom from federal supervision, which in the last instance afforded the path through which research could be finally institutionalized.[89] Naturally, this could not occur in Rio de Janeiro, the capital and seat of the central government. The radical shift took place in São Paulo.[90]

The state of São Paulo had rebelled against Vargas in 1932 with the ambition of reestablishing a constitutional government, only to be quickly defeated. The appointed federal intervenor had close ties to the liberal and intellectual Paulista elite, who strongly supported the creation of a research university more akin to the European standards of higher education.[91] As a result, the University of São Paulo (USP) was created through a state decree in 1934.[92] From its very inception, the basic design of USP was substantially different from any other university projects in Brazil. Although the preexisting professional schools were integrated into the new institution,[93] the core of the new institution was the School of Philosophy, Science and Literature (Faculdade de Filosofia, Ciências e Letras—FFCL), the equivalent of the German philosophical faculty, originally intended to be of mandatory attendance for all students before their admission into the professional schools.[94] The university statutes introduced an academic

[88] Talamira T.R. Brito and Ana M. de O. Cunha, 'Revisitando a História da Universidade no Brasil: Política de Criação, Autonomia e Docência', *Aprender*, 7/2 (2009), 43–63, on 51–2; Fávero, 'Universidades no Brasil', 24; Paim, 'Por uma Universidade', 18, 57; Schwartzman, 'Introdução', 10; Sampaio, 'Evolução do Ensino', 10–11.

[89] Paim, 'Por uma Universidade', 57.

[90] Schwartzman, 'Introdução', 10. To be true, also a new university conceived of as a locus for free activity and non-utilitarian culture was established in Rio de Janeiro (University of the Federal District) however, it was closed after just four years; Fávero, 'Universidades no Brasil', 25–6.

[91] Paim, 'Por uma Universidade', 69. Application of the model varied according to the professors called to develop new scientific areas, to wit, the French model mainly in the humanities, the German in chemistry, and the Italian in physics and mathematics.

[92] Diogo da S. Roiz, 'Entre Memórias e Histórias da Universidade de São Paulo: Histórias em Construção', *HISTEDBR*, 21 (2006), 52–64, on 53. Creation of USP resulted from a convergence of reasons, including: the will of the federal government to appease powerful São Paulo after crushing the 1932 revolt; symbol of power for the state of São Paulo; and attempt of the Paulista elite to return to the political foreground, however, no longer through military, but through intellectual power; see Alexandre M. de M.P. Ferreira, 'A Criação da FFCL da USP: Um Estudo sobre o Início da Formação de Pesquisadores e Professores de Matemática e Física em São Paulo' (PhD dissertation, Pontifical Catholic University of São Paulo, 2009), 60 et seq.; Sampaio, 'Evolução do Ensino', 11–12; Schwartzmann, *Espaço para a Ciência*, v. 21–2.

[93] Schools of law, polytechnic, agronomy, medicine, and veterinary medicine; also the Institute of Education was incorporated into USP; see Brito and Cunha, 'Revisitando', 53.

[94] Which desire, however, never came to fruition; see Paschoal Senise, *Origem do Instituto de Química da Universidade de São Paulo: Reminiscências e Comentários* (São Paulo, 2006), 14; Brito and Cunha, 'Revisitando', 53; Ferreira, 'Criação da FFCL', 77 et seq; Roiz, 'Entre

doctoral program for the very first time in the history of Brazil. The doctoral degree could be granted after students completed a previous licentiate degree requiring three years of studies, two additional years of internship in seminars and laboratories, and the defense of a dissertation resulting from original research or substantial cultural work.[95] To fulfill these goals, USP had to have research laboratories, experimentation fields, equipment for biological, biogeographical, geological, and mineralogical research, general and specialized libraries, an office for national and international exchange, a university press, meeting halls, movie and records collections, a radio station, and an outreach office.[96] Per the statutes, the position of full-time professor was established, and all the professors were required to perform, promote, and supervise research projects, as well as organize and participate in courses and conferences.[97]

The underlying objectives of this plan were to create research schools, train researchers, and prepare professors with close contacts within the international scientific community.[98] The founders of USP believed that these goals could only be accomplished by hiring European professors from abroad for FFCL, the university's base for research. These professors were recruited from France, Germany, and Italy.[99] As concerns chemistry, our focus of interest here, the Department of Chemistry, FFCL/USP, was the first institution explicitly established to educate scientifically trained chemists who would lay the groundwork for a genuine center of research and innovation.[100] Throughout its thirty-five years of existence (1935–1970) before becoming the Institute of Chemistry, as we discuss below, the Chemistry Department staff trained around forty doctoral students and published well over 300 articles reporting on original research, almost all of them in international journals.[101]

The first chair of the Chemistry Department was the German chemist Heinrich Rheinboldt (1891–1955). Rheinboldt studied general chemistry and geology at the Technische Hoschschule of Karlsruhe and the University of Strassburg (Strasbourg), and earned a doctoral degree in 1918 under the

Memórias', 52, 54; Schwartzman, *Espaço para a Ciência*, v. 22; Sampaio, 'Evolução do Ensino', 13. Actually, the idea of the School of Philosophy had been considered in the 1933 reform, but was not actualized in the Carioca universities; see Schwartzmann, *Espaço para a Ciência*, 5, 24; Sampaio, 'Evolução do Ensino', 11–12.

95 State decree 6283/34, art. 10 and 12. The Law School had established a doctoral program in 1931; the one alluded here was the first doctoral program in sciences in Brazil.

96 Ibid, 28.

97 Ibid, 39.

98 Fávero, 'Universidades do Brasil', 27–8; Roiz, 'Entre Memórias', 4.

99 Brito and Cunha, 'Revisitando', 54; Ferreira, 'Criação da FFCL', 77 et seq; Schwartzman, *Espaço para a Ciência*, 5, 22.

100 Rheinboldt, 'Química no Brasil', 79.

101 Mathias, 'Cem Anos', 29.

supervision of Paul Pfeiffer, a student of Nobelist Alfred Werner.[102] After a period serving as a teaching and research assistant at chemistry institutes in Strasbourg and Karlsruhe, Rheinboldt moved with Pfeiffer to Bonn in 1922, where he obtained his habilitation in 1924, was made extraordinary professor in 1928, and two years later was charged with teaching analytical and inorganic chemistry. By 1934 he had supervised thirty-five doctoral dissertations.[103] Distressed by the rise of the Nazis, he accepted the position in Brazil, where he arrived in July 1934.[104] Upon Rheinboldt's request, USP hired from Europe Heinrich Hauptmann (1905–1960) as his assistant. After leaving the University of Göttingen to escape Nazi persecution, Hauptmann had been appointed professor at the École de Chemie in Geneva, and arrived in Brazil in February 1935.[105]

The reasons for the earliest students to enroll in the new chemistry course at USP were diverse and curious. Since his youth, Simão Mathias (1908–1991), the first student ever to earn a doctoral degree in science from USP (1942), dreamed of devoting himself to fundamental research in science—mathematics in particular.[106] Since there were no conditions for such endeavors in Brazil, he contented himself with what he believed

[102] Alfred Werner (1866–1915) established the grounds of modern coordination chemistry, earning the Nobel Prize in Chemistry in 1913. His most successful student and then assistant was Pfeiffer (1875–1951) known for the 'Pfeiffer effect', namely, the fact that optically active compounds influence the optical rotation of a racemic mixture of another compound.

[103] Biographical sketch in Fernando de Azevedo (ed.), *As Ciências no Brasil* (São Paulo, 1955), ii. 10. In addition, Rheinboldt was foreign editor of *Journal of Chemical Education* and *Chymia*; see also Ralph E. Oesper, 'Heinrich Rheinboldt', *Journal of Chemical Education*, 27 (1950), 296; and Simão Mathias, 'O Departamento de Química da Faculdade de Filosofia, Ciências e Letras: Primeiros Anos', *Química Nova*, 7/4 (1984), 191–7, on 191–2. A considerable part of the data in this section was taken from interviews given by the actors themselves, within a project conducted at Center Simão Mathias of Studies on History of Science (CESIMA), based on the concepts and methods of oral history; on this see Ana M. Alfonso-Goldfarb, Márcia H.M. Ferraz, Maria H.R. Beltran and Andrea P. dos Santos, ed., *Simão Mathias—Cem Anos: Química e História da Química no Início do Século XXI* (São Paulo, 2010); Andrea dos S.O. Kamensky, 'Construction of Documents and Memories of the Brazilian Chemical Community: Intellectual Influences, Beliefs and Achievements', in Ana M. Alfonso-Goldfarb et al (eds.), *Crossing Oceans*, 229–48; and Ana M. Alfonso-Goldfarb, Márcia H.M. Ferraz and Silvia Waisse, 'The Role of Oral History in the History of 20th Century Chemistry', in Isabel Malaquias and Peter J. T. Morris (eds.), *Perspectives on Chemical Biography in the 21st Century* (Newcastle upon Tyne, 2019), 61–9.

[104] Ernesto Giesbrecht, 'Ernesto Giesbrecht: O Desenvolvimento do Ensino de Química (interview)', *Estudos Avançados*, 8/22 (1994), 115–22, on 116.

[105] Senise, *Origem do Instituto*, 20; Mathias, 'Cem Anos', 21–6; Mathias, 'Departamento de Química', 195–6.

[106] A touching report of the ceremony in which Mathias was awarded USP first doctoral degree, rousing the applause of the full auditorium, was then made by freshman Antônio Candido, who later on became one of main Brazilian literary critics; see Antonio Candido, Aziz Ab Saber, Carlos G. Mota, Helena Hirata, José E. Mindlin, Maria L. Queiroz, Paulo S. Pinheiro and Pedro Moraes, 'O Ímã que Anima Amigos', in J.L. Goldfarb and

was closest, namely engineering, and then—for unclear reasons—also dentistry. He had already developed a sound career as a dentist when he first learned about the creation of USP. Not without sacrifice, he decided to bet everything to see his dream come true. He became one of the members of the very first class of the USP chemistry course. This decision was much criticized, but time eventually proved it was the best choice he could have made.[107] Another case was Paschoal Senise (1917–2011), then seventeen, who was troubled by professional indecision: while in truth he desired to enter medical school, he feared its rigorous entrance examination.[108] As he told the story, one day he read in a newspaper about the recent creation of USP and FFCL, as well as about the arrival of famous European professors. While he did not have a clear idea of what the job description of a chemist actually was,[109] he finally decided to apply, because 'sound chemical grounds would help me prepare for medical school'.[110] Many others enrolled in the chemistry course based on misguided ideas: some believed the Department was a center of advanced studies, and therefore soon dropped out upon learning it was a full-time undergraduate course with a heavy load of lectures and required credits in experimental work. The course opened in 1935 with forty seats for students, but only about a dozen stayed. Most of them were university professors,

L.F. Colombini (eds.), *O Ímã que Tudo Anima: Homenagem a Simão Mathias*, (São Paulo, 1989), 69–74, on 69–70.

[107] As discussed below, Mathias developed a sound and successful career in chemistry, playing a key role in the future transformations of this field in Brazil and other developments undergone by USP and the university system in the country. Mathias, Emeritus Professor, USP, was the first president of the Brazilian Chemical Association and of the Brazilian Society of History of Science, in addition to secretary of the Brazilian Society for Advancement of Science. For more detail on Mathias' life and work, see the various chapters in *O Ímã que Tudo Anima: Homenagem a Simão Mathias* (see the previous note), esp. the ones written by chemists, Alberto L.R. Barros, Crodowaldo Pavan, Eduardo Peixoto, Ernesto Giesbrecht, José A. Vanin, Luiz C. de Menezes, Paschoal Senise and Renato Cecchini, 'O Ímã que Anima Cientistas e Químicos', 19–68, personal friends, and Candido et al., 69–74.

[108] Senise developed instrumental methods for chemical analysis and played a key role in the development of graduate education in Brazil. He chaired Institute of Chemistry, USP, from 1970 to 1974 and from 1978 to 1982. In 1987 he was appointed Emeritus Professor at USP. Further detail of his career is given later in this article.

[109] Until the opening of the chemistry course, FFCL/USP, chemistry was taught at secondary schools by self-taught pharmacists, physicians, and engineers. As mentioned above, at the higher education level chemistry was taught exclusively as an applied, industrial science; the first chair of chemistry as fundamental science in Brazil was the one at FFCL/USP; Giesbrecht, 'Ernesto Giesbrecht', 116; Senise, *Origem do Instituto*, 16; Mathias, 'Cem Anos', 20–1.

[110] Paschoal Senise, 'Entrevista com Prof. Paschoal Senise (interview)', in A. M. Alfonso-Goldfarb et al. (eds.), *Simão Mathias—Cem Anos: Química e História da Química no Início do Século XXI* (São Paulo, 2010), 140–69, on 140.

joined by four students who were the first to finally graduate: Mathias, Senise, Luciano Barzaghi, and a woman, Jandira França.[111]

The learning style chosen by Rheinboldt was the traditional one for German universities.[112] While there is extensive scholarship on the rise of the so-called 'German model',[113] one might characterize it following Alan Rocke as including a neohumanist, idealist philosophy with its creed of pure science, an empiricist/objectivist laboratory/seminar pedagogy, an appeal to practice, group research tied to advanced education, and the research mandate.[114] Indeed, all the experimental classes were taught in the laboratory, and theoretical subjects were systematically illustrated with experimental demonstrations.[115] From the very beginning of their training, the students received samples for analysis in increasing order of complexity. The results were discussed in weekly colloquia, intended for the students to draw correlations among observed facts.[116] This experience prepared them for original research, albeit with a narrower scope.

Soundly grounded on the principles of self-cultivation and broad-based education, Rheinboldt expected to foster the development of a laboratory culture among his students.[117] His motto was 'to do everything with one's own hands', and consistent with this creed, the students were even required to prepare and clean all the equipment they used. Hauptmann monitored

111 Senise, *Origem do Instituto*, 20; Mathias, 'Departamento de Química', 192; University of São Paulo, *Anuário da Faculdade de Filosofia, Ciências e Letras da Universidade de São Paulo (1934–1935)* (São Paulo, 1937), 29; Barros et al., 'Ímã que Anima', 39.

112 Giesbrecht, 'Ernesto Giesbrecht', 116; Mathias, 'Cem Anos', 21.

113 To mention just a few examples: McClelland, *State, Society and University*; Olesko (ed.), *Science in Germany*; Silvia Waisse, *The Science of Living Matter and the Autonomy of Life: Vitalism, Antivitalism and Neovitalism in the German Long Nineteenth Century* (Saarbrücken, 2010).

114 See chapter 3 in this volume, 'The Rise of Academic Laboratory Science: Chemistry and the 'German Model' in the Nineteenth Century'. Rocke further observes that the 'German model' was variously interpreted and modified as per national context; therefore, here we contribute to the understanding of this process of import in the Brazilian case.

115 Giesbrecht, 'Ernesto Giesbrecht', 116; Mathias, 'Cem Anos', 21–2; Senise, *Origem do Instituto*, 25–7; Senise, 'Entrevista', 145.

116 Senise, *Origem do Instituto,* 27.

117 This ethos is reflected in a biographical anecdote. Ricardo Ferreira developed an interest in chemistry while attending secondary school. However, in Recife, Pernambuco, Northeastern Brazil, chemistry was merely taught as a side course in the Agronomics School. Upon the advice of a professor, he travelled to São Paulo and enrolled in the chemistry course, FFCL/USP, but found it 'excessively practical'… to the point he was failed twice and finally dropped out; see Ricardo Ferreira, 'Entrevista', in A.M. Alfonso-Goldfarb et al. (eds.), In *Simão Mathias—Cem Anos: Química e História da Química no Início do Século XXI* (São Paulo, 2010), 170–9, on 173. Ricardo de Carvalho Ferreira (1928–2013) eventually became a theoretical chemist; in addition to having been invited to teach at prestigious universities abroad, he became Emeritus Professor, Federal University of Pernambuco, president of the Brazilian Chemical Society, and honor president of the Brazilian Society for the Advancement of Science.

the students' assignments following guidelines specifically formulated by Rheinboldt for this purpose. The overall goal of this program was not to produce skilled assayers, but to train the students in the practice of observation, a skill indispensable to succeed in 'understanding the phenomena and learn[ing] how to think in a chemical manner'.[118] Though without fixed schedules, the program followed Liebig's 'all-day practicum' model.[119] Though assignments were individual, and though the students were evaluated individually by completed tasks, they spent much time together at the laboratory. This promoted comradeship among them and their teachers, which awakened an early sense of professional identity. Indeed, many of these students decided to develop professional careers as chemical researchers, and appreciated the experimental approach as a learning method.[120] This entirely agreed with the laboratory culture that permeated and gave its original and unitary character to the entire FFCL, since the rationale underlying its creation was to privilege creativity through an emphasis on research leading to innovative learning techniques.

Initially, the Chemistry Department was relegated to an annex in the School of Medicine, built with the financial help of the Rockefeller Foundation.[121] Soon the space proved to be insufficient, while the medical students complained against the 'invasion of the philosophers'.[122] As a result, in 1939 the Chemistry Department moved to a different campus together with the other schools of natural sciences. In addition to the opportunity to attend classes in other schools—those of physics, mathematics, and natural history—this move to a new campus favored socializing among students and professors, which gave rise to what became a legendary 'Glette spirit', after the name of the street where the campus was located.[123]

The original undergraduate curriculum extended over three years, at the end of which graduates earned a licentiate degree. Subjects included general and inorganic chemistry (taught in alternating annual courses), physical chemistry and biochemistry (also annually taught in alternation), analytical chemistry, mathematics, physics, and mineralogy. History of

[118] Senise, *Origem do Instituto*, 25–7.

[119] See Chapter 3 in this volume.

[120] Ibid, 65–6; Senise, 'Entrevista', 141, 146; Giesbrecht, 'Ernesto Giesbrecht', 117, 120.

[121] There are countless studies on the activities of the Rockefeller Foundation in Brazil; for the case of University of São Paulo, see, e.g., Maria G.S.M.C. Marinho, *Norte-americanos no Brasil: Uma História da Fundação Rockefeller na Universidade de São Paulo* (1932–1954) (Campinas, 2011).

[122] This was no rhetorical figure: in one of their protests, the medical students actually set to fire the construction site of the chemical annex; Mathias, 'Departamento de Química', 193–4.

[123] Senise, 'Origem do Instituto', 24, 31–3, 39; Senise, 'Entrevista', 144–5, 147; Mathias, 'Departamento de Química', 194–5; Giesbrecht, 'Ernesto Giesbrecht', 120.

chemistry was taught in each individual subject.[124] Rheinboldt was aware that a three-year undergraduate course was evidently insufficient to meet the expectations of the students who hoped to develop a career as 'scientific chemists.' Upon the spontaneous request of Mathias, Senise, Barzaghi, and França, a fourth year was added, devoted to chemistry of higher order compounds (present-day coordination chemistry), biochemistry, and additional laboratory work. The four-year course was officially sanctioned through a decree by the federal government from 1946, which also introduced preparative chemistry and industrial chemistry. Instrumental analysis was added in 1952.[125]

For further advancement, all the earliest graduates entered the doctoral program, which, as was mentioned above, required two additional years of courses and seminars and the defense of a dissertation based on original research.[126] A fundamental aspect of the organization of USP was the full autonomy granted to the department chairs. As a relevant example, Rheinboldt chose to apply the German standards of education to the chemistry doctorate, which correspondingly granted the degree of Doctor of Science (Dr. sc.).[127] In contrast, the French and Italian models were preferred for the humanities and for physics, respectively.[128] This situation began to change only after World War II, when North American patterns of graduate education were gradually implemented.

After earning their degrees, the new doctors were advised by Rheinboldt and Hauptmann to spend time as postdoctoral fellows abroad.[129] Indeed, international networking was a crucial component of Rheinboldt's program. In 1949, Hauptmann went to the University of California Berkeley and Harvard. In the 1950s all the doctors travelled abroad,

[124] Brazil, *Decreto nº 39, de 3 de Setembro de 1934*. Available at: http://www2.camara.leg.br/legin/fed/decret/1930–1939/decreto-39-3-setembro-1934-515616-norma-pe.html; Senise, *Origem do Instituto*, 23. Following a reform of the university system established by the federal government in 1939, the curriculum was redefined as follows: 1st year—Complements of Mathematics, General and Experimental Physics, General and Inorganic Chemistry, Qualitative Analytical Chemistry; 2nd year—Physical Chemistry, Organic Chemistry, Quantitative Analytical Chemistry; 3rd year—Superior Chemistry, Biological Chemistry and Mineralogy; Senise, *Origem do Instituto*, 43.

[125] Senise, *Origem do Instituto*, 27–8; 44–5; Mathias, 'Departamento de Química', 193; University of São Paulo, *Anuário da Faculdade de Filosofia, Ciências e Letras da Universidade de São Paulo (1936)* (São Paulo, 1937), on 239.

[126] Senise, *Origem do Instituto*, 36–7.

[127] As emphatically stressed by Simão Mathias in an interview he gave in 1977, see 'Entrevista (1977)', interview given to Simon Schwartzmann, Ricardo G.F. Pinto and Nadja C.X. Souza (Rio de Janeiro, 1985), 31. Transcripts available at Historical Archives, Center of Logic, Epistemology and History of Science, State University of Campinas (UNICAMP).

[128] Mathias, 'Entrevista', 34–5.

[129] Mathias, 'Cem Anos', 26.

especially to the United States, mainly funded by the Rockefeller Foundation.[130] A pattern subsequently developed: following their return to Brazil, these scientists were appointed to university positions, where they continued their research with the help of students, thus contributing to the training of the following generations of chemists.

The material conditions necessary to launch a formal research program were met after the move to the Glette campus. For this purpose, the earliest doctors were appointed as assistants—Matthias and Senise to Rheinboldt, and França to Hauptmann. Barzaghi was hired by the Institute of Technological Research (IPT), USP.[131] The latter appointment shows the high degree of recognition chemistry had already achieved as a fundamental science. While most professors at the Polytechnic School viewed the FFCL with misgivings, the IPT director clearly understood the significance of fundamental research, and sought to develop closer contacts with Rheinboldt and Hauptmann by requesting a researcher trained by them to work at IPT.[132]

At the Glette campus, the Chemistry Department was allocated a three-floor building, which included a lecture hall of sixty seats, three teaching laboratories, research laboratories, a library, and a chemical museum. The facilities were expanded in 1944/45 through the addition of one further teaching laboratory, two new research laboratories, a workshop to manufacture glassware, and a laboratory for microanalysis. The teaching style remained the same, i.e. laboratory-based, but now with the active participation of the new doctors as assistants.[133]

The position of assistant was crucial for the new teaching style implemented at USP, and at FFCL in particular. Per the university statutes, the organizational unit was the autonomous and privileged professorial chair, a tenured position that ended with its occupant's death or retirement. As a consequence, there was little upward mobility. The assistant was a formal position circumscribed by rigid set of rules. There could be up to three assistants per chair, with a hierarchical order—first, second, and

[130] Senise, *Origem do Instituto*, 51–2. Also, other North-American institutions funded not only training seasons, but also the purchase of laboratory equipment; see Barros et al., 'Ímã que Anima', 40. As mentioned above, the so-called 'North American model' of higher education became influential in Brazil after World War II, yet USP had initiated contacts with the Rockefeller Foundation quite earlier, especially for the development of exact and biological sciences, see Marinho, *Norteamericanos no Brasil*.

[131] Giesbrecht, 'Ernesto Giesbrecht', 117; Senise, 'Entrevista', 148; Senise, *Origem do Instituto*, 37.

[132] Senise, *Origem do Instituto*, 150.

[133] Ibid, 38; Mathias, 'Departamento de Química', 194–5; University of São Paulo, *Anuário da Faculdade de Filosofia, Ciências e Letras da Universidade de São Paulo (1939–1949)*, (São Paulo, 1953), ii, 62.

third assistant. All of them were chosen by the chair professor. Later, two additional teaching assistants were granted to each chair. As in the case of the head professors, new appointments could only be made when a position became vacant. The assistantship was at first a part-time position. Following the creation of CNPq (National Research Council, present-day National Council of Scientific and Technological Development) in 1951, the assistants' income was complemented by grants to make up for a full-time salary.[134]

Material and financial resources posed chronic problems all along the first fifteen years of existence of the Chemistry Department, until the creations of CNPq and other funding agencies, such as the Brazilian Federal Agency for Support and Evaluation of Graduate Education (CAPES) and the 'FAPs' (research support foundations of individual states, FAPESP in the case of São Paulo). In the 1940s and part of the 1950s, the only resources—besides the ones coming from the USP—were sporadic donations and the Rockefeller Foundation grants for postdoctoral visits abroad and purchases of laboratory equipment.[135]

To paint a more concrete picture of the training of the early Brazilian chemists and the actual unfolding of the new learning style for science in Brazil, we next briefly describe two illustrative cases, those of Mathias (introduced above), and Giuseppe Cilento (1923–1994). Each of these two scientists established new fields of chemical research in Brazil, physical chemistry and photo-biochemistry, respectively.[136] Mathias was not only a member of the very first class of chemists trained at USP, but was also the first student ever to earn a doctorate in science in Brazil. He travelled abroad for further specialization, and was hired as a chair professor, besides having played a fundamental role in the institutionalization of chemistry in Brazil.[137] Cilento was part of the following generation, though still trained in the 1940s. Just as Mathias, he had crucial participation in the institutionalization of chemistry, particularly in relation to the creation of the Chemistry Institute at the State University of Campinas (UNICAMP) in the 1960s.[138]

[134] Senise, *Origen do Instituto*, 46.

[135] Ibid, 50–1.

[136] Mathias, 'Entrevista (1977)', 23–4.

[137] Originally, the number of chairs was two (General and Inorganic Chemistry/Analytical Chemistry, and Organic and Biological Chemistry), for which Rheinboldt and Hauptmann were appointed. A third chair (Physical Chemistry and Superior Chemistry) was created in 1945, for which Mathias was appointed; see Senise, *Origem do Instituto*, 44; Mathias, 'Entrevista' (1977), 29–30.

[138] Cilento's personal papers were carefully collected and conserved by his students, who donated them to CESIMA, our research center. This was the basis for a broad-scoped research project, also including oral history research and involving postdoctoral and doctoral students; see note #103 supra, and Andreia M. de Medeiros, 'As Contribuições de

An early concern of Rheinboldt was that neither he nor Hauptmann had a sound training in physical chemistry. Yet this was precisely the field Mathias preferred, given his early interest in mathematics. Aware of this proclivity, Rheinboldt suggested a physical-chemical subject for Mathias' dissertation, which he completed in 1942 with the title 'On Bivalent Mercaptans and Sulfide Dimercaptans'.[139] A short while earlier, the Rockefeller Foundation had sent a representative to Brazil to identify still unestablished fields with high potential for development. This was the context in which Mathias was selected for a postdoctoral fellowship at the prestigious department of physical chemistry at the University of Wisconsin, from 1942 to 1944.[140]

For many decades, from 1919 to 1952, the chair of the Chemistry Department at the University of Wisconsin–Madison was J. Howard Matthews (1880–1970). A physical chemist, Matthews had received his early training from Louis A. Kahlenberg (1870–1941), a former student of Wilhelm Ostwald (1853–1932) at Leipzig, who is considered one of the founders of modern physical chemistry. Matthews specialized in the correlations between electrical conductivity and chemical activity. In addition, he established the physical chemical laboratory course, which became standard throughout the United States, and together with Farrington Daniels and John Warren Williams wrote *Experimental Physical Chemistry* (first published in 1929, thereafter in seven more editions up to 1970), the bestseller among chemical laboratory textbooks up to the 1970s.[141] Mathias had strong interactions with these and other

Giuseppe Cilento para o Desenvolvimento da Fotobioquímica na Ausência de Luz' (PhD dissertation, Pontifical Catholic University of São Paulo, 2017), 139; Simão Mathias and Heinrich Rheinboldt, 'Sobre Mercaptanas Bivalentes e Sulfetodimercaptanas' (PhD dissertation, University of São Paulo, 1942).

139 Mathias and Rheinboldt, 'Mercaptanas Bivalentes'.

140 Senise, *Origem do Instituto*, 37, 41–2; Mathias, 'Entrevista (1977)', 6–7, 33; Mathias, 'Entrevista (1982)'.

141 For more detail of chemistry at Wisconsin and the role of Matthews, see Aaron J. Ihde, *Chemistry, as Viewed from Bascom's Hill: A History of the Chemical Department at the University of Wisconsin in Madison* (Madison, 1990). For the leading role of North American chemists in physical chemistry, see John W. Servos, 'History of Chemistry', *Osiris*, 1/1 (1985), 132–46, on 139. In chemistry, and science as a whole, the modern American research university was a product of the import and modification of the German model starting at the end of the nineteenth century; see Rocke's chapter in this volume; and Alan Rocke, 'Origins and Spread of the "Giessen Model" in University Science', *Ambix*, 50/1 (2003), 90–115. On the rise of the American research university, see e.g. Roger L. Geiger, *To Advance Knowledge: The Growth of American Research Universities, 1900–1940* (Oxford, 1986); for the role of chemists, see e.g., Owen Hannaway, 'The German Model of Chemical Education in America: Ira Remsen at Johns Hopkins (1876–1913)', *Ambix*, 23/3 (1976), 145–64; Bruce V. Lewenstein, '"To Improve Our Knowledge in Nature and Arts": A History of Chemical Education in the United States', *Journal of Chemical Education*, 66/1 (1989),

investigators, and also visited several research centers across the United States, which afforded him, for instance, the occasion to establish contact with Linus Pauling. As a result, at the end of this period Mathias had a very clear idea of the path that would lead him to sound research in physical chemistry, as well as its relationship with other fields of science.[142]

After his return to Brazil, Matthias devoted himself to teaching and research on physical chemistry, following the style learned in Wisconsin, to eventually earn a tenured position in 1946. For this purpose, he constructed a laboratory with his own hands that included a mechanical workshop, the very first of such for physical chemistry in Brazil, and trained a glassware technician.[143] Mathias specialized in the determination of the dipole moment, which at that time could only be achieved through direct measurement, as there was no ready-made, commercially available equipment for this purpose.[144] To continue his work, Mathias had to build by himself a condenser with parallel or coaxial metallic plates, which were immersed into the material to be tested, and the condenser's capacity was then measured. The results were used to calculate the values of the dielectric constant and the dipole moment of the tested material.[145]

Mathias' international experience did not end in Wisconsin. Later he also visited Kazimierz Fajans at the University of Michigan, funded by the Guggenheim Foundation, which also funded a trip to France. Upon his return to Brazil, he conducted work together with his students and succeeded in finding experimental proof for quanticle theory values that Fajans had obtained through exclusively theoretical estimations.[146] Soon Mathias became the leading authority in physical chemistry in Brazil, and

37–44; and D. S. Tarbell, Ann T. Tarbell and R. M. Joyce, 'The Students of Ira Remsen and Roger Adams', *Isis*, 71/4 (1980), 620–6.

142 Mathias, 'Entrevista (1997)', 11; Mathias, 'Entrevista (1982)', interview given to Bernardo Kucisnki, *Canal Ciência* November/December 1982, available at: http://www.canalciencia.ibict.br/notaveis/livros/simao_mathias_60.html.

143 Mathias, 'Entrevista (1982)'; Mathias, 'Cem Anos', 26; Mathias, 'Entrevista (1977)', 11–12; Barros et al., 'Ímã que Anima', 44–5, 62–3.

144 Mathias had developed interest in a theoretical-experimental topic that called much attention at that time, to wit, the relationship between the volume of atoms and ions and the volume of electrons; see Mathias, 'Entrevista (1977)', 53.

145 Barros et al., 'Ímã que Anima', 45, 61; Mathias, 'Entrevista (1977)', 11–13, where he tells that his enthusiasm was such, that he succeeded in raising the funds needed for the construction of the physical chemistry laboratory, which called much attention at that time.

146 Senise, 'Entrevista', 154; Mathias, 'Entrevista (1977)', 50–3. Fajans (1887–1975) a specialist in radioactivity, having worked at Ernest Rutherford's laboratory in Manchester, coined word 'quanticle' to denote one or more quantized electrons with respect of one of more nuclei within the context of studies on oxidation; see Peter Day, *Nature Not Mocked: Places, People and Science* (London, 2005), 136.

was called to advise on the establishment of new research centers for chemistry. In recognition of his achievements, the Brazilian Society of Chemistry gave his name to its highest award, the Simão Mathias Medal.[147]

Our second example is Cilento, who entered the chemical course in 1941, graduated in 1943, and earned his doctoral degree in 1946 with a dissertation on 'Isosterism, Isology and Isomorphism'. For his dissertation he worked on azo compounds, a subject suggested by Rheinboldt, his supervisor.[148] Like Mathias, Cilento had neither the required equipment, nor the resource for a new analytical method devised by Rheinboldt himself while still in Germany.

The next stage in Cilento's career was probably determined by a lack of available positions, though extant records do not establish this. As was mentioned above, assistantships were limited. Cilento had to wait until 1951, when Jandira França resigned from her assistantship. Then Cilento accepted an invitation by the Andrea and Virgínia Matarazzo Foundation to conduct research on chemical carcinogenesis at the School of Medicine of USP, in collaboration with the National Research Council of Canada. He never gave up his original interest in azo compounds, which constituted the subject of his senior lecturer dissertation, 'Structural Spectral Behavior of Azo-Carcinogens' (1955). Briefly, Cilento's studies concerned the possible isomorphic substitution between two compounds with identical constitution. This was precisely the focus of the studies conducted by Frank Westheimer (1912–2007) first at the University of Chicago, then at Harvard, with special emphasis on the effects of isotopic substitution on the reactivity of organic molecules and eventually on the mechanisms of ATP formation in cell respiration.[149] Cilento took advantage of a postdoctoral grant provided by the Rockefeller Foundation to spend one year with Westheimer at Harvard, which triggered his academic shift to biological chemistry, a field that he developed in Brazil.[150] Mathias considered Cilento one of the best chemists he had ever met, an impression later

[147] More detail on the Simão Mathias Medal is provided at http://www.sbq.org.br/portal2/simaomathias/medalhasm.htm. On the predominant role of physical chemistry and the part of Mathias in the development of chemical science in Brazil, see Goldfarb and Colombini, (eds.), *Ímã que Tudo Anima*.

[148] All the information on Cilento was taken from Medeiros, 'Contribuições de Cilento'.

[149] Jeremy Pearce, 'Frank Westheimer, 95, Who Developed Model Valuable in Biochemistry, Dies', *New York Times*, 21/4/2007, http://www.nytimes.com/2007/04/21/obituaries/21westheimer.html; Addison Ault, 'Frank Westheimer's Early Demonstration of Enzymatic Specificity', *Journal of Chemical Education*, 85/9 (2008), 1246.

[150] Indeed, his research in Harvard on the enzyme aspects of ATP formation led him to investigate the nature of electron transfer, which eventually resulted in the development of photobiochemistry without light.

confirmed in international circles through the establishment of the Cilento Award by the Inter-American Photochemical Society.[151]

In 1970, the various courses on fundamental chemistry and biochemistry were reunited in the Institute of Chemistry, USP,[152] which became the most advanced center for chemical teaching and research in Brazil.[153] Ever since replacing Rheinboldt as department chair, Hauptmann was virtually obsessed with the idea of reuniting all these courses in a single building at USP Cidade Universitária.[154] For this purpose, he sought consensus among the professors at the various schools. A preliminary project for a common building was approved in 1960—which the architects named 'the Chemistries Suite'. But Hauptmann died soon afterward. Mathias was appointed department chair and led the project to its successful conclusion.[155]

At the same time, the ethos of the Chemistry Department had already been progressively conveyed to other parts of the country through some of its earliest graduates. These chemists spread across the state of São Paulo and Brazil, mainly as professors and consultants. This is, for instance, the case for Waldemar Saffioti, who graduated in 1942, entered the doctoral program under Rheinboldt's supervision, and earned his doctoral degree in 1948. After some time as a high school teacher and textbook author, in 1960 he was appointed to a chair in physical chemistry and superior chemistry that later became the chemistry course of the School of Philosophy, Sciences and Literature of Araraquara, São Paulo.[156] Saffioti and Cilento are just two of the links in a chain of researchers that extend to other institutions. The chemists thus trained became responsible for a large part of the research performed in São Paulo and Brazil.

Final Remarks

Our main focus in the present chapter is the training of the earliest generation of professional chemical researchers in Brazil, as a case study of the

[151] Mathias, 'Entrevista (1977)', 23–4. For further detail on the Cilento Award, see: http://www.i-aps.org/awards.asp#G._Cilento_Award.

[152] For instance, there were chairs of organic chemistry at FFCL, the Pharmacy School, and the Polytechnic School.

[153] Maria C.L. Santos, *USP, Universidade de São Paulo: Alma Mater Paulista, 63 Anos*, 2nd ed. (São Paulo, 1998), 162–3.

[154] Literally, 'University City'; it is the largest campus of University of São Paulo.

[155] Senise, 'Entrevista', 156–7.

[156] C. Antonio, Antonio C. Massabni, Cristo B. Melios and Douglas W. Franco, 'In Memorian', *Química Nova*, 22/ 4 (1999), 630–1. A Chemistry Department was established by this time, which was raised to the level of institute in 1977; see Antonio C. Massabni, José R. Ernandes and Cristo B. Melios, 'Quatro Décadas de Química na UNESP/Araraquara', *Química Nova*, 26/3 (2003), 439–44.

institutionalization of science and the scientific professions in the country. This we approached against a wider background, by considering the countries that had been former Spanish colonies, and famously had a university-learning tradition for over 400 years. While information in this regard is available in the literature, it is rather scattered, and our first task was to compile it. The resulting picture was unexpected: a long tradition of university education did not seem to facilitate the introduction and spread of the research ethos in these countries, at least not in the case of chemistry.

Based on our previous studies on Ibero-America, we have argued that, indeed, research in the strict sense and consequently the training of researchers could not take off until modern research universities were created. That this was a late affair in the former Portuguese America permeates practically all the specialized studies on higher education and the institutionalization of science in Brazil, and much scholarship was produced to account for the possible reasons.

However, when seen from a broader time perspective, research on chemistry arguably began soon after the move of the Portuguese court to Brazil in the first decade of the nineteenth century. The period from 1808 to 1934—the year of the foundation of USP, its FFCL, and the Department of Chemistry—was characterized by countless attempts at establishing research facilities and communities, not all of them doomed to failure, as is shown by the cases of the Agronomic Institute of Campinas and the Manguinhos Institute (present-day Oswaldo Cruz Foundation, FIOCRUZ). In addition, before the creation of USP, several courses on industrial chemistry at technical institutes were merged to become the present-day chemical engineering programs. Nevertheless, these institutions and programs were implemented for highly practical purposes: to boost development and solve immediate social and economic problems. A more thorough reassessment of the role of science and technology was necessary to professionalize research, following the trends developing in Europe since the beginning of the nineteenth century. This was achieved with the foundation of USP and the spread of the research and innovation ethos. In the case of chemistry, this process evolved under the influence of the German style of university training as implemented by Rheinboldt in São Paulo. Rheinboldt's program was heavily grounded on the laboratory, the development of skills and scientific reasoning, creativity, initiative, teamwork, and internationalization. With these tools, a chain of professional chemical researchers and educators soon developed to foster the creation of the first institutions for chemical research, and to find themselves places in the expanding global network of experts.

Perhaps this at least partially explains why chemistry as a fundamental science did not derive in Brazil from its applied sister disciplines, but was established directly in accordance to the research ethos underlying the founding of USP in the model of the German, French, and Italian universities. By contrast, in Mexico and Argentina chemistry was tied to its practical applications, particularly to pharmacy, until it became an autonomous field of research at the turn of the twentieth century.[157] As was mentioned, though an attempt at establishing a German-style research university in Argentina was made in 1821, it never actually took off, and quickly entered a phase of decline that lasted until the end of the century.

Starting in 1968, through a federal law passed by a new military government and under strong North American influence,[158] the graduate education system was enthroned in Brazil as the privileged locus for professional research. It remains so to this day. But this is a story to be told on another occasion.

Pontifical Catholic University of São Paulo, Brazil

[157] Matharan, 'Constitución de la química'.

[158] Brazil, *Law no. 5540, from November 28th, 1968,* available at: http://www2.camara.leg.br/legin/fed/lei/1960-1969/lei-5540-28-novembro-1968-359201-publicacaooriginal-1-pl.html; see also, Maria F. de Paula, 'A Formação Universitária no Brasil: Concepções e Influências', *Avaliação*, 14/1 (2009), 71–84, on 76–7; Alexandre T.N. Lira, 'Reflexões sobre a Legislação da Educação durante a Ditadura Militar (1964-1985)', *Histórica* 36 (2009), article 1. Available at: http://www.historica.arquivoestado.sp.gov.br/materias/anteriores/edicao36/materia01/

11

Inventing Laboratory Science in Meiji Japan

Yoshiyuki Kikuchi

Introduction

In this chapter, I address the question of how laboratory science emerged in Japanese universities in the Meiji period (1868–1912), with a strong emphasis on the 'laboratory' as both a concept and a physical space designed to facilitate students' training. In the following, I discuss how three issues—the concept, design, and training function of the laboratory—developed and became inseparably intertwined with each other. In the Japanese case, I argue that there was an additional linguistic element; hence, the chapter starts with the following question: How was the word 'laboratory' understood by the Japanese in the vernacular?

Making Sense of the Laboratory

The Meiji Restoration in 1868 is often credited as the starting point of Japan's introduction to Western science and Western culture more broadly. But this is not exactly the case. One should also consider the development of Dutch learning in Japan during the Tokugawa period (1603–1868) from the eighteenth century onward, mainly through the activities of medical doctors and astronomers.[1] Dutch learning was later expanded into 'laboratory' science, including chemistry, by the 1840s, exemplified by the landmark publication between 1837 and 1847 of *Seimi kaisō* 舎密開宗 (*Introduction to Chemistry*), based on William Henry's highly experimental

[1] For an overview of the history of Dutch learning in Japan, see Tadashi Yoshida, 'Tenbō: Rangakushi', *Kagakusi Kenkyū*, 23 (1984), 73–80. On the chemistry components of Dutch learning, see Togo Tsukahara, *Affinity and Shinwa Ryoku: Introduction of Western Chemical Concepts in Early Nineteenth-Century Japan* (Amsterdam, 1993).

Yoshiyuki Kikuchi, *Inventing Laboratory Science in Meiji Japan* In: *A Global History of Research Education: Disciplines, Institutions, and Nations, 1840–1950*. Edited by: Ku-ming (Kevin) Chang and Alan Rocke.
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DOI: 10.1093/oso/9780192844774.003.0012

Epitome of Chemistry (1801) and other chemistry textbooks translated by UDAGAWA Yōan 宇田川榕菴 from Dutch.

That said, the laboratory as a specific space for experimentation was relatively new to Japan, despite some practitioners of Dutch learning who were familiar with experimentation. It is known that Udagawa added the outcomes of his own chemical experiments to *Seimi kaisō*.[2] Nevertheless, no specific term seems to have been coined to designate the place where practitioners conducted experiments, in spite of the fact that they, including Udagawa, were masters at creating Japanese neologisms. This strongly suggests that scholars of Dutch learning in the Tokugawa period did not recognize the laboratory as a concept worthy of being assigned a vernacular term.

It is still difficult to pinpoint when the laboratory as a concept was introduced to Japan; however, one of the earliest documented examples of a laboratory in Japan was the Osaka Seimi-kyoku 大阪舎密局, a chemistry teaching laboratory established by the Dutch army surgeon and chemist, Koenraad Wolter Gratama in Osaka in 1869. It had its origin in a laboratory attached to the Dutch-run shogunate hospital and medical school in Nagasaki, the Seitokukan 精得館.[3] Gratama himself called the Seimi-kyoku *het Laboratorium* in his letters to his brother.[4] It therefore makes sense to tentatively consider *Seimi-kyoku* as a candidate for the first Japanese translation of 'laboratory'.

This conjecture is supported by a perusal of contemporary dictionaries. An English-Japanese dictionary published in 1869 defined a laboratory as 'the workplace of chemists (*seimi-ka*)'.[5] The author of this entry was clearly aware of the laboratory's connection with chemistry, but could not yet find or coin a Japanese term corresponding to it. Two years later, a French-Japanese dictionary was published that translated the French word *laboratoire* into the Japanese *Seimi-kyoku*, following the example of the Osaka Seimi-kyoku.[6] One senses, here, how the name of a particular institution began to crystallize the Japanese notion of a laboratory that had already vaguely existed, but was not yet well articulated.

Seimi-kyoku, as the translation of 'laboratory' (*seimi* meant chemistry) might puzzle and surprise Japanese scientists today, who are used to *jikken shitsu* 實驗室 or *jikken sho/jo* 實驗所 as the translation of 'laboratory'.

2 Ibid, 147.

3 H. Beukers, A. M. Luyendijk-Elshout, M. E. van Opstall, and F. Vos (eds.), *Red-hair Medicine: Dutch-Japanese Medical Relations* (Amsterdam and Atlanta, GA, 1991).

4 K. W. Gratama, *Leraar onder de Japanners: Brieven van Dr K. W. Gratama betreffende zijn verblijf in Japan, 1886–1871 (*Amsterdam, 1987), 103 *et passim.*

5 My translation, in *Eiwa taiyaku shūchin jisho/A Pocket Dictionary of the English and Japanese Language*, second and revised Edition (Tokyo, 1869), 221.

6 *Kankyo Futsuwa Jiten/Nouveau Dictionnaire Français-Japonais renfermant les Principaux Mots composés et un grand nombre de locutions* (Shanghai, 1871), 239.

Indeed, reflecting the relative novelty of the laboratory as a concept in Japan, there was no fixed Japanese term for a laboratory until the 1890s. To illustrate this, I shall take as examples Tokyo University (*Tokyo Daigaku* 東京大學) and the Imperial College of Engineering (*Kōbu Daigakkō* 工部大學校), Tokyo, as the two flagship institutions for higher education in science and technology in Japan during the 1870s and early 1880s.

Shiken Shitsu or *Jikken Shitsu*? Translating 'Laboratory'

The calendars and annual reports of Tokyo University during this period, in both English and Japanese, show a noticeable dichotomy and eventual convergence in their translations of 'laboratory' into Japanese. The two terms most often used are *shiken shitsu* 試験室 and *jikken shitsu* 實驗室. *Shitsu* means a room and was often replaced by *jō* 場, meaning a place, as in *jikken jō* 實驗場 or 試驗場 *shiken jō*, without changing its meaning.

In 1874, a *jikken jō* first appeared in university annual reports, referring to a physics laboratory (i.e., *butsurigaku jikken jō* 物理學實驗場). By contrast, a chemistry laboratory was first called *kagaku seiren jō* 化學製煉場, literally a 'chemical refining place', but renamed *shiken shitsu* the following year.[7] The 1874 annual report of Tokyo University did not mention a laboratory for any other subject than physics and chemistry.

This *jikken/shiken* dichotomy continued until 1877, when a laboratory for chemistry started to acquire a term similar to that of a physics laboratory, namely, *jikken shitsu*.[8] From 1878, *jikken shitsu* gradually spread to other subjects taught at Tokyo University, such as metallurgy, mining, and zoology.[9] These developments were codified in 1880, when *jikken jō* started to be used as the translation of 'laboratory' in Tokyo University's calendar, within the instruction that '[the] lecture-rooms and laboratories assigned to Professors are put under the care of their respective assistants, or under the care of the secretary of the University'.[10] The point here is that *jikken jō* was adopted as a generic term applying to all the laboratories in Tokyo University by 1880. It took some time for *jikken shitsu/jō* to become part of the Japanese vocabulary; it was in the 1900s that

[7] Tokyo Daigakushi shiryō kenkyūkai (ed.), *Tokyo Daigaku nenpō* (6 vols, Tokyo, 1993–1994), i, 18 and 25. This source is hereinafter referred to as *Tokyo Daigaku Nenpō*.

[8] Ibid, 68. [9] Ibid, 94, 115, and 157.

[10] *Tokyo Daigaku Hō- Ri- Bungakubu Ichiran, Meiji jūsan yon nen*, 132; University of Tokyo, *Academic Calendar 2540–41 (1880–81)*, 82. See also the calendar for the Medical Faculty of Tokyo University, *Tokyo Daigaku Igakubu Ichiran. Meiji jūsan yon nen* (Tokyo, 1881), 98–9.

English-Japanese and German-Japanese dictionaries started to adopt *jikken shitsu* as the primary translation of 'laboratory'.[11]

I have so far explained these linguistic minutiae because there were subtle, but important, differences between a *shiken* and *jikken*. On the one hand, *shiken* simply means 'to examine' or 'to prove'. For example, if one examines a person, it means an examination, but if one examines materials, it means an analysis or assay. That is why *shiken shitsu/jō* was first used to refer to a chemical and assaying laboratory designed specifically to use blowpipes at Tokyo University.

In this context, it is worth mentioning that the Imperial College of Engineering, Tokyo, adopted *shiken jō* for both physical and chemical laboratories throughout its existence between 1873 and 1886, when it merged with Tokyo University to form Tokyo Imperial University.[12] It is important to keep in mind that the Imperial College of Engineering was, as its name suggests, an *engineering* school under the control of the Ministry of Public Works. Examining materials such as chemicals, ores, and electrical wires was the main concern of both the physics and chemistry laboratories there; it is arguably for this reason that they retained the name of *shiken jō*. Indeed, this industrial connotation of *shiken* is underscored by the fact that industrial research laboratories were consistently called *shiken jo* 試驗所, at least until the mid-twentieth century.[13]

Meanwhile *jikken* has a more complex history,[14] essentially being a composite term of *jissai* 實際, meaning 'in actuality' or 'actually', and *shiken*. It can also be a composite of *jitchi* 實地, meaning 'on site', and *keiken* 經驗, meaning 'experience'. One could shuffle these words to obtain various combinations. *Jikken shitsu/jō* then meant a place 'to actually experience/examine' natural phenomena—a suitable term for scientific pedagogy applicable to physics, chemistry, and other subjects. In addition, in the medical context, there was a long-standing tradition

[11] Naibu Kanda et al. (eds.), *Shin'yaku Eiwa Jiten* (Tokyo, 1902), 558; Shinkichi Fujii (ed.), *Nijusseiki Dokuwa Jisho/Deutsch-Japanisches Wörterbuch des Zwanzigsten Jahrhunderts* (Tokyo, 1907), 580. By contrast, in the 1880s and 1890s English-Japanese dictionaries adopted more industry-oriented translations such as *seiren kyoku* (refining place), *kōsaku jo* (workshop), and *gunki seizō sho* (arsenal) in addition to the earlier *seimi kyoku*; for example, Shōkichi Shibata and Takashi Koyasu (eds.), *Eiwa Jii/An English and Japanese Dictionary, Explanatory, Pronouncing and Etymological* (Tokyo, 1882), 566; Sumio Nakazawa et al. (eds.), *Eiwa Jiten/A New English-Japanese Dictionary. Based on the Current English Literature* (Tokyo, 1897), 359.

[12] *Kōbu Daigakkō daini nenpō (Meiji jūroku nen shigatsu yori Meiji jūshichi nen sangatsu ni itaru)*, 70 *et passim*.

[13] See, for example, Chikayoshi Kamatani, *Gijutsu taikoku hyakunen no kei: Nihon no kindaika to kokuritsu kenkyū kikan* (Tokyo, 1988), 17.

[14] See Kiyonobu Itakura, 'Nihon ni okeru jikken gainen to sono kotoba no rekishi', *Kasetsu jikken jigyō kenkyū*, 3/5 (1994), 22–53.

dating back to the eighteenth century of equating *jikken* 實驗 with 實見, meaning 'to actually see', which later turned into 'to diagnose'.[15] In Japanese (though not in Chinese) these two words are pronounced in exactly the same way. *Jikken*, in the annual reports of Tokyo University's Medical Faculty during the 1870s and 1880s, followed this definition.[16]

Thus, the gradual renaming of a chemical laboratory, from *seiren jō* and *shiken shitsu* to *jikken shitsu,* at Tokyo University likely signaled the broadening of its meaning. It came to include both a place to refine chemicals and analyze samples and a place for students to see and experience natural phenomena, such as in a physics laboratory. The University's adoption of *jikken shitsu* or *jikken jō* as the generic translation of 'laboratory' by the early 1880s was due to its capacity to convey wide-ranging meanings. That is, 'to actually examine/experience/see' or even 'to diagnose'.

I argue that this broad meaning of *jikken shitsu/jō* qua laboratory led to its proliferation in a variety of disciplines at Tokyo Imperial University by the early 1900s,[17] when it became part of the Japanese vocabulary. Two informative, albeit incomplete, sources to consider at this point are the bilingual albums of Tokyo Imperial University, published for display at the International Expositions in Paris in 1900 and in St. Louis, Missouri, in 1904.[18]

Photographs included in the 1900 album featured an anatomy laboratory at the College of Medicine; laboratories for electrical engineering, mechanical engineering, applied chemistry, and assaying at the College of Engineering; laboratories for zoology and geology at the College of Science; and a laboratory for agricultural chemistry at the College of Agriculture.[19] When this album was revised for the 1904 International

[15] See, for example, the memoir of Sugita Genpaku (1733–1817), the pioneer of Dutch-style medicine in the Tokugawa period, *Rangaku kotohajime* (1815). Sugita Genpaku (annotated by Ogata Tomio), *Rangaku Kotohajime* (Tokyo, 1959), 36 et *passim*. I owe this point to Masao Uchida of Dokkyo University.

[16] For example, *jikken roku* 實驗録 meant medical records typically taken in consultation rooms. See, e.g., *Tokyo Daigaku Nenpō*, i (1881), 214. James R. Bartholomew, *The Formation of Science in Japan: Building a Research Tradition* (New Haven, CT, 1989), 93, briefly mentioned *jikken* in the medical context, but simply translated it as 'experimentation' and did not discuss the various meanings of *jikken*.

[17] More precisely, it was first named the Imperial University (*Teikoku Daigaku* 帝國大學) in 1886 and was renamed Tokyo Imperial University (*Tokyo Teikoku Daigaku*) in 1897 when the second imperial university, Kyoto Imperial University, was instituted. Throughout this chapter, I use Tokyo Imperial University to avoid confusion.

[18] Kazumasa Ogawa, *Imperial University of Tōkyō/Tokyo Teikoku Daigaku* (Tokyo, 1900) and its 1904 version.

[19] The 'Colleges' referred to in this paragraph were constituent units of Tokyo Imperial University, equivalent of the German idea of *Fakultäten* (faculties). The College of Engineering was an independent institution before its merger with the university.

Exposition, the laboratories for physiology (both a vivisectorium and laboratory for electro-physiology), pathology, pharmacology (both a laboratory of kymographic experiments and a chemistry laboratory), hygiene, internal medicine, medical chemistry, and ophthalmology were added—all as part of the College of Medicine. An important example not included in the 1904 album was the laboratory for psychophysics, completed in 1903 and attached to the Department of Philosophy at the College of Literature in Tokyo. It is in this laboratory that the history of experimental psychology began in earnest in Japan.[20]

Although these rooms had a variety of forms, functions, and equipment, they shared the common purpose of giving students opportunities for individual training, enabling them to actually witness and experience disciplinary practices. That is why they were called, in the same way as in Japanese, *jikken shitsu.* The rapid development of experimental medicine, physiology, and psychology in Europe and North America throughout the nineteenth century is certainly part of the story.[21] The broad, all-encompassing nature of *jikken* in Japanese science was also a factor in this development.

Research Training at the *Jikken Shitsu* in Tokyo

If the common purpose of laboratories in Japanese universities at the turn of the century was to provide students with individual training in, and actual experience of, disciplinary practices, how did such training relate to the training of researchers, which is the main theme of this volume?

To address this question, one first has to look broadly into the way in which research activities were situated within Tokyo Imperial University during the Meiji period. Article One of The Imperial University Ordinance, enacted in 1886 to give a legal basis to Tokyo Imperial University, laid out the objective of the institution as instruction in the sciences (*gakujutsu* 學術) and arts (*gigei* 技藝, or skills) according to the needs of the nation, and the profound study [*unnō o kōkyū suru* 蘊奥ヲ攷究スル] of such sciences and arts. Within the university, *bunka daigaku* 分科大學 (subject-based undergraduate colleges or faculties such as the College of Science) were instituted as the places for instruction, and the *daigakuin* 大學院 (the graduate school attached directly to the Imperial University) as the place for 'profound study' (Article Two of the ordinance). These designations

[20] Tatsuya Satō, *Nihon ni okeru shinrigaku no juyō to tenkai* (Kyoto, 2002), 338–62.
[21] William Bynum, *Science and the Practice of Medicine in the Nineteenth Century* (Cambridge, 1994), 92–117.

suggest that places for instruction and for advanced research were neatly divided within Tokyo Imperial University from its inception in 1886.

The reality, however, was much messier and the positioning of research much more ambiguous within Tokyo Imperial University throughout the whole Meiji period. It continued until the establishment of the Institute of Physical and Chemical Research (*Rikagaku Kenkyūjo* 理化學研究所 or RIKEN) in 1917, except for a few practical fields such as medicine, engineering, meteorology, and seismology.[22] As SAKURAI Jōji 櫻井錠二, one of the founding professors of the Department of Chemistry at the College of Science, Tokyo Imperial University, vividly recollected in his autobiography:

> No funds in the university budget were allocated to research expenditure. Professors only secretly diverted part of the budget, which was officially allocated to student experiments based on the number of students, to their own research.
>
> It is beyond comprehension that there are no funds at all allocated for research expenditures within university budgets in spite of the fact that its object was grandly defined as 'to instruct the theory and application of sciences and arts in needs of the nation and to study them deeply' in Article One of the Imperial University Ordinance in 1886 as well as of the University Ordinance in 1918. By the same token, the so-called 'graduate school' was almost nothing but a name. These are an utter contradiction to half of the objectives of the university, which were completely forgotten.[23]

This is an important statement, because the original 'laboratory science' in Japan was none other than chemistry, as discussed. Nevertheless, if, as Sakurai suggested, the institutional push for research was nominal in Tokyo during the Meiji period, it does not necessarily follow that research training was non-existent there. To verify its existence, we must go beyond the macro-level institutional framework of decrees and budgets (though they were both important) and look into the development of laboratory training at the micro level.

A good focal point for such micro-level investigations is the first chemistry laboratory project completed at Tokyo Imperial University: the

[22] James R. Bartholomew, *The Formation of Science in Japan*, 111–24 and 162–98; and Ito Kenji, 'The question of research in prewar Japanese physics', in David. G. Wittner and Philip C. Brown (eds.), *Science, Technology, and Medicine in the Modern Japanese Empire* (London and New York, 2016), 193–210.

[23] My translation, from Sakurai Joji, *Omoide no kazukazu: Danshaku Sakurai Jōji ikō* (Tokyo, 1940), 18–19. This statement was referred to in Bartholomew, *The Formation of Science in Japan*, 213; and Yoshiyuki Kikuchi, *Anglo-American Connections in Japanese Chemistry: The Lab as Contact Zone* (New York, 2013), 104.

construction of the Main Building of the College of Science (*Rika Daigaku Honkan*) between 1885 and 1888, the second floor of which accommodated a laboratory for its Department of Chemistry (while the first floor was shared by the Department of Physics, the Department of Mathematics, and the College of Science Administrative Office).

As I discussed elsewhere,[24] this building was first designed by NAGAI Nagayoshi 長井長義, a pharmaceutical chemist trained at the University of Berlin by August Wilhelm Hofmann. Nagai designed a laboratory complex accommodating a variety of laboratories, a lecture theatre, lecture rooms, and operation rooms, imitating the Chemical Institute at Berlin designed by Hofmann (Figures 11.1 and 11.2). This contained only one office for a full professor and one for an assistant professor, clearly reflecting the one-chair-per-discipline system of the German universities. It also had a 'pharmaceutical research laboratory', which in all likelihood was intended as Nagai's personal laboratory and would have been in a good position to facilitate the laboratory work of students and assistants. This had been the main concern of Hofmann in planning his laboratories.

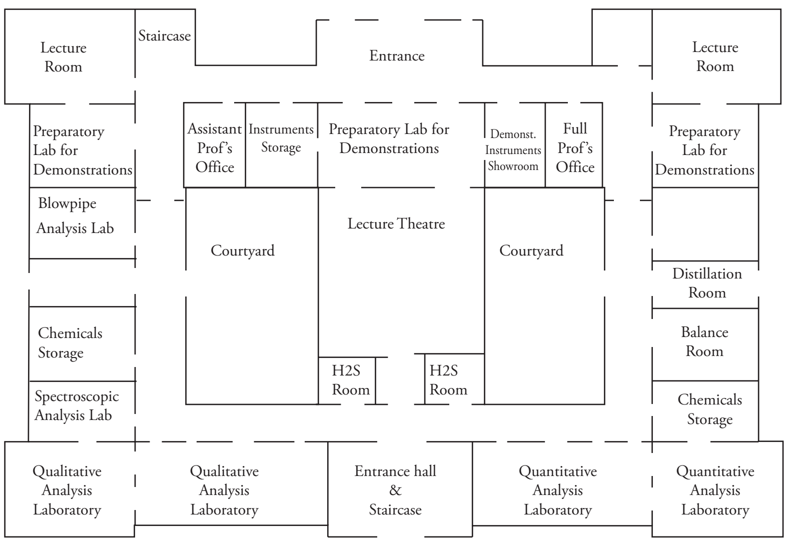

Figure 11.1 Nagai's Laboratory Design (First Floor). Reproduced from Yoshiyuki Kikuchi, *Anglo-American Connections in Japanese Chemistry: The Lab as Contact Zone* (New York: Palgrave Macmillan, 2013), 112. Courtesy of the author.

[24] Ibid, 107–26.

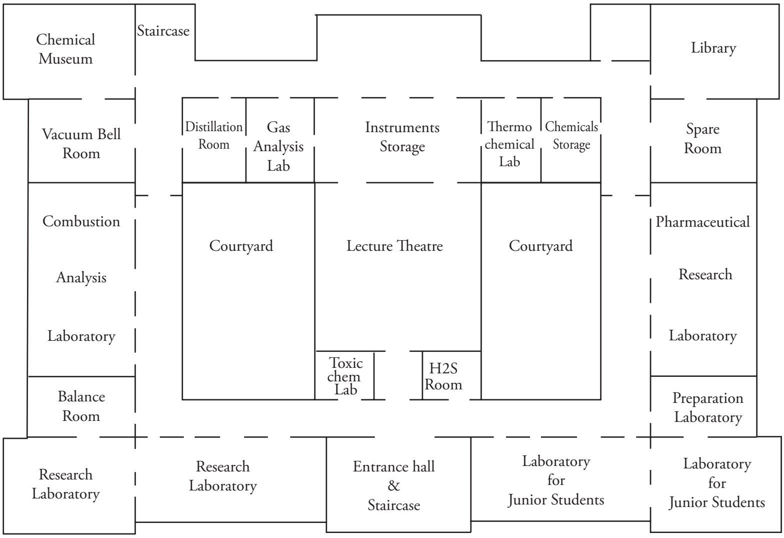

Figure 11.2 Nagai's Laboratory Design (Second Floor). Reproduced from Kikuchi, *Anglo-American Connections in Japanese Chemistry*, 112. Courtesy of the author.

This, however, was eventually finished and partly occupied by Edward Divers and Sakurai, the two founding professors of the Department of Chemistry at Tokyo Imperial University. Prior to his appointment at Tokyo Imperial University, Divers was trained at the Royal College of Chemistry (RCC), London, and taught at the Imperial College of Engineering, Tokyo. Sakurai was first trained at Tokyo University, then at University College London (UCL), and taught at Tokyo University, his alma mater. Divers and Sakurai adapted Nagai's design while keeping its basic character as a departmental space for chemistry. Though adaptation was needed anyway to cope with the reduction of space for chemistry, other factors, I argue, were influential.

To understand this, one has to look at Divers' and Sakurai's views of the training of researchers. The idea of educating students through research had existed before the establishment of Tokyo Imperial University in 1886. Robert William Atkinson, the first professor of chemistry at Tokyo University and a teacher of Sakurai, left this testimonial in 1875:

> The second-year students of this department showed a remarkable aptitude for chemistry through this year's learning and began to do chemical investigations (*kagaku shiken*) on their own. From this I have to say that they take this science seriously and more and more aspire to study it.[25]

[25] My translation, cited in Ibid, 44.

Sakurai was included in these 'second year students' and later started his career as a research chemist at UCL with Atkinson's former teacher, Alexander William Williamson.[26]

Likewise, in 1877, during his professorship at the Imperial College of Engineering, Tokyo, Divers formulated a view of the pedagogical meaning of laboratory training:

> The best of them [chemistry students] have shown powers of close observation of the phenomena which they have developed in their experiments, and, as a consequence, a capacity for making original observation [*sic*], and, along with this, the ingenuity and perseverance necessary to give fruit to their observations.[27]

Therefore, the question one should address here is not whether, but how, Divers and Sakurai trained students in chemical research in the laboratory.

Divers's approach to research training was what might be called an 'apprenticeship model'. It arguably originated in his experiences at RCC, where he attended the lectures of August Wilhelm Hofmann and received laboratory training from William Crooks, who was then a teaching assistant. At Queen's College, Galway, he was a teaching assistant serving the professor of chemistry. Divers's teaching style crystallized at the Imperial College of Engineering, Tokyo, in which '[the] students have been assisted at their work by the assistants and myself, and the juniors by the seniors'. Divers was actively engaged in joint research with assistants and advanced students, both at the Imperial College of Engineering and then Tokyo Imperial University, which often led to papers with joint authorship.[28]

Divers' experience in research training described above included three categories of people: professors, assistants, and students. When professors trained students, what was the role of assistants? Interestingly, Divers considered assistants both as trainers and trainees. As he wrote in 1877:

> The aid I have hitherto had in the laboratories has been that of three assistants, only two of whom had any knowledge of chemistry. These officers have always shown themselves exceedingly willing to do their best, but they seem to me to have not taken much interest in teaching. In saying this I do not mean to impute any blame to them, for their time has been too occupied by their duties to improve themselves. [...] In such ways and others they prove themselves most useful and necessary to me, but at the same

[26] Ibid, 65.

[27] Cited in Yoshiyuki Kikuchi, 'Cross-National Odyssey of a Chemist: Edward Divers at London, Galway and Tokyo', *History of Science*, 50 (2012), 289–314; on 299.

[28] Kikuchi, 'Cross-National Odyssey', 301f and Kikuchi, *Anglo-American Connections*, 138–40.

> time are deprived of much opportunity of training themselves as teaching assistants.[29]

This quotation shows what Divers expected from assistants: they *should* have taken interest in teaching and *were supposed* to be engaged in self-training. Divers was clearly frustrated with Japanese assistants at the Imperial College of Engineering, since his assistants did not meet these expectations. It is not difficult to understand why Divers struggled to find suitable talent in 1877. The first chemistry students in his laboratory did not graduate until 1879, meaning that the assistants with whom Divers had been working in 1877 had not received adequate training. He finally succeeded in finding such talent in HAGA Tamemasa 垪和爲昌, one of Divers' best students (who graduated in 1881), who later became assistant professor at the Imperial College of Engineering, and his life-long collaborator there and at Tokyo Imperial University.

By contrast, Sakurai's approach can be characterized as a laissez-faire, individualistic approach to research training. Following Williamson as a role model, he considered lecturing as the main pedagogical medium, whereby he suggested promising research topics, but rarely supervised students' laboratory work, which he delegated to a teaching assistant.[30] Himself a research chemist with a modest output, Sakurai published papers only in singular authorship and never conducted joint research.[31]

Instead, in the hope of nurturing students' independence and 'inquisitive minds' through presentation and discussion, Sakurai helped introduce to the Department of Chemistry the reading seminar in the form of the *Zasshi-kai* 雑誌會, which was managed by students.[32] *Zasshi-kai* as a term was coined by KUHARA Mitsuru 久原躬弦, Sakurai's classmate at Tokyo University, who later studied at the Johns Hopkins University with Ira Remsen. It was a direct translation of 'journal meeting' as organized there by Remsen. However, Sakurai had a similar pedagogical experience in UCL's Chemical and Physical Society, which had a student-centered structure similar to that of the *Zasshi-kai*. For Sakurai, it was important that students be voluntarily engaged in research.

The above discussion shows that Divers and Sakurai held different views on the training of researchers. There was, however, one commonality in their views: the crucial role of a teaching assistant (played by a junior professor) as a supervisor of students' laboratory work and as a mediator between students and senior professors. Together with the Japanese

[29] Imperial College of Engineering *(Kobu-Dai-Gakko)*, Tokei, *Class Reports by the Professors for the Period 1873–1877* (Tokyo, 1877), 36.
[30] Kikuchi, *Anglo-American Connections*, 118 and 129–35.
[31] Ibid, 142–5. [32] Ibid, 120–3.

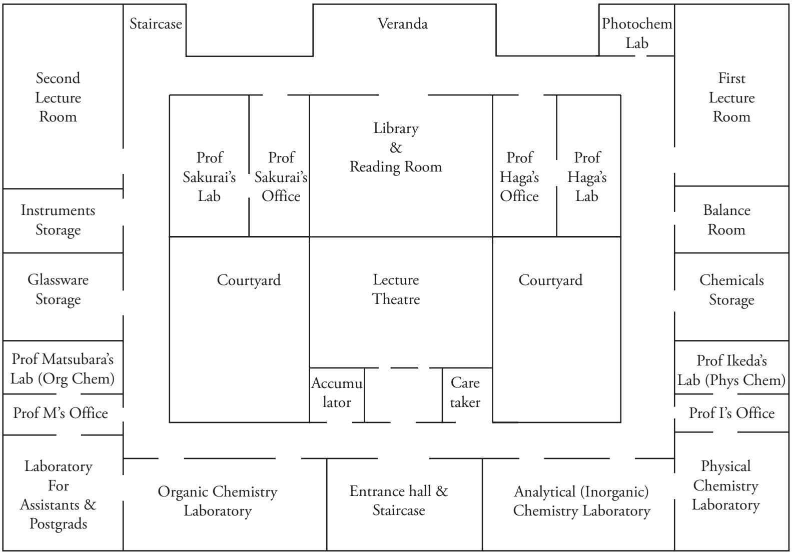

Figure 11.3 Sakurai and Divers' Laboratory Design: Reproduced from Kikuchi, *Anglo-American Connections in Japanese Chemistry*, 117. Courtesy of the author.

conceptualization of laboratories as *jikken shitsu*, this is key to understanding Divers' and Sakurai's laboratory design (Figure 11.3).

Firstly, unlike Hofmann's and Nagai's laboratories that focused on analytical training and were divided into junior and advanced spaces, Divers' and Sakurai's student laboratory was divided into laboratories for organic, analytical (inorganic), and physical chemistry, based on Sakurai's own laboratory teaching program that aimed to provide students with a wide range of experiences and was aligned with the broad meaning of the *jikken shitsu* at Tokyo University. In the drawing (Figure 11.3), these student laboratories filled the base of the quadrangular building, together with a small laboratory for assistants and postgraduates. Laboratories for undergraduates and postgraduates were divided, though they were labeled with the same designation: *jikken shitsu*. We cannot tell from the plan which laboratories were for basic training and which were for research training, and there were no formal postgraduate curricula or courses for the whole period this chapter covers.

The positions of the professors' offices and private laboratories in relation to those of the students' laboratories were important features of Sakurai's and Divers' teaching spaces. According to their laboratory design (Figure 11.3), the two offices for senior professors, facing the courtyards, were close to lecture rooms, but physically isolated from the students' laboratories. By contrast, the two offices for junior professors were located between senior professors' offices and the students' laboratories and were directly connected to the latter. Students could enter the junior professors' offices and vice versa, without using corridors.

This arrangement effectively defined the respective roles of the senior and junior professors as determined by Sakurai and Divers, who designed the entire floor. The supervision of students' experiments *at all levels* was basically the responsibility of junior professors, whereas the main role of the senior professors, in relation to the undergraduates, was to prepare and deliver lectures. The centrality of the *Zasshi-kai* in the pedagogical regime of Sakurai's Department of Chemistry is underlined by the central location of the departmental library and reading room in the departmental space, adjacent to the offices of two senior professors.[33] Perhaps the scarcity of Western books and periodicals made a specialized library all the more important for science professors and students in Meiji Japan. But the central location of the library is also due to the important role Sakurai ascribed to the *Zasshi-kai* in his transfer of 'pure' chemical research, as mental training, to Japan.

One implication of this pedagogical structure was its effect on how research practice developed in Tokyo's Department of Chemistry. Though its curriculum did not include a graduation thesis for final-year students in 1886, close relationships in laboratories between junior professors and chemistry undergraduates, which were encouraged by the spatial structure of the department, did occasionally lead to research partnerships. Haga's supervision of MAJIMA Rikō's 眞島利行experimental training resulted in research partnerships.[34] IKEDA Kikunae 池田菊苗, who succeeded Haga as assistant professor to Divers, also co-authored research papers with his students.[35] By the same token, as a long-time collaborator of Divers, Haga also played a role in bridging students and Divers, which resulted in fruitful research collaborations. The annual departmental conference for the presentation of graduation theses (*Sotsugyōsei Gyōseki Hōkokukai* 卒業生業績報告會), where final-year students were obliged to present graduation theses, was instituted in 1906, though not at the

[33] Ibid, 122–3.

[34] See their research paper: Tamemasa Haga and Riko Majima, 'Über einige anhydrobasen aus diaminen der Fettreihe', *The Journal of the College of Science, Imperial University of Tokyo, Japan*, 19 (1903), Article 7.

[35] Kikunae Ikeda and Tokuhei Kametaka, 'Dōzokutai no futten ni tukite', *Tokyo Kagaku Kaishi,* 20 (1899), 5–41. See also Masao Katayama, 'Über die Natur der Jodstärke', *Zeitschrift für anorganische Chemie*, 56 (1907), 209–17, in which Katayama acknowledged Ikeda's help, but not Sakurai's.

initiative of any senior professors, but on the suggestion of Majima, who was then assistant professor and had already started to look to Germany rather than England for a model to follow.[36] In the 1900s, the culture of instilling the 'research imperative' among students at the Department of Chemistry was initiated by junior professors rather than top-down from senior professors. The publication of research by students had started earlier, in the early 1890s.[37] These papers were generally published when their authors were postgraduates, but as the above Departmental Conferences showed, research training at Tokyo's Department of Chemistry started when students were advanced undergraduates.

Study Abroad

It is important to emphasize that the training of most Japanese scientists in the Meiji period was not complete without government-funded overseas study. As seen above, Nagai and Sakurai had studied abroad and brought home what they considered the ideal chemical teaching and laboratory from their time abroad. Nagai's overseas study, spanning between 1871 and 1884, was based at one institution, the University of Berlin. It was funded by the Japanese government, but his status changed from a student to a Japanese government employee in 1876, and Nagai received additional income as Hofmann's assistant starting in 1881 when he acquired his PhD at Berlin.[38] Sakurai's study abroad, from 1876–1881, was shorter than Nagai's, but was still substantially longer in comparison with those of Japanese scientists later. He was also based at one institution alone—University College London. His stipends, first paid by the Japanese government, were augmented by a scholarship from UCL.[39] Both Nagai and Sakurai were awarded the Japanese degree of Doctor of Science (DSc) in 1888 by the recommendation of the Imperial University Council (*teikoku daigaku hyōgikai* 帝國大學評議會, the highest governing body of the University) after their overseas study. Their degrees mainly recognized their publications that had started in Europe. Indeed, they were essentially products of European research education.

[36] See Majima, 'Waga Shōgai no Kaiko', *Kagaku no ryōiki*, 8 (1954), 1–11 and 137–46; on 6.

[37] Kikunae Ikeda, 'Capillary attraction in relation to chemical composition, on the basis of R. Schiff', *The Journal of the College of Science, Imperial University, Japan*, 3 (1890), 241–68. A list of publications from the department is appended to Jitsusaburō Sameshima, 'Kagakuka', in *Tokyo Teikoku Daigaku gakujutsu taikan: Rigakubu, Tokyo Tenmondai, Jishin Kenkyūjo* (Tokyo, 1942), 122–36.

[38] Seizō Kanao, *Nagai Nagayoshi den* (Tokyo, 1960), 453–5.

[39] Kikuchi, *Anglo-American Connections*, 65–70.

In a later period, overseas study became shorter but continued to be a *sine qua non* for Japanese academics. They usually studied abroad in multiple places when they were assistant professors, and were promoted to full professorships after the study.[40] They did not study for degree abroad, and often received doctorates at home after their time abroad. Connections between their overseas study and the conferrals of their Japanese doctorates became more complex. Doctorates then were conferred either on the recommendation of the university council, as in the above cases of Nagai and Sakurai, or based on the evaluation of their published papers from research done either before or during overseas study.[41] Ikeda was awarded a DSc in 1902 *after* his overseas study at Leipzig and London between 1899 and 1901, but the conferral of his degree was based on papers published *before* overseas study.[42] In pursuing research in Japan, Ikeda often received advice from Sakurai.[43] Haga, in contrast, was awarded a DSc in 1894 *before* his overseas study (1896 to 1898) in Germany, France, and Britain on the basis of his previous publications. He was an exception because, fortunately, he could work with his former teacher, Divers, at Tokyo.[44] One of Haga's study destinations was the laboratory of organic chemist Carl Harries at the University of Kiel, which proved of great use for his later teaching (rather than research) at Tokyo Imperial University, as he initiated Majima into the experimental methods of organic chemistry after his return to Tokyo.[45]

Majima's case was somewhere in the middle. He studied overseas between 1907 and 1911 first with Harries in Kiel and then with Richard Willstätter at the Zurich Polytechnic. He was awarded a Japanese DSc in 1907 while he was studying overseas with Harries. His dissertation project on the urushiol compounds, the main components of Japanese lacquer, had started in 1905 while he was assistant professor at Tokyo Imperial University, that is, before his overseas study. The key techniques for the experimental part of the project (distillation under reduced pressure and ozonolysis) were only available at Harries' laboratory. It is important to

[40] Yoshiyuki Kikuchi, 'International Relations of the Japanese Chemical Community', in S. C. Rathmussen (ed.), *Igniting the Chemical Ring of Fire: Historical Evolution of the Chemical Communities in the Pacific Rim* (Singapore, 2018), 139–55; on 141.

[41] Ikuo Amano, *Daigaku no tanjō, jō: Teikoku daigaku no jidai* (Tokyo, 2009), 193–7.

[42] Kōzō Hirota, *Kagakusha Ikeda Kikunae: Sōseki, umami, Doitsu* (Tokyo, 1994), 68.

[43] Kikuchi, *Anglo-Japanese Connections*, 140–1.

[44] 'Rigaku hakushi', in Kurō Iseki (ed.), *Gakui taikei hakushi roku*, 14th ed. (Tokyo, 1939), 1–3. The first Japanese scientists to be awarded the DSc on the basis of a written examination were the physicist Hanshichi Muraoka and the chemist Mitsuru Kuhara in 1891, but they were both trained abroad, at the University of Strasbourg, then in Germany, and the John Hopkins University, USA.

[45] Yūji Shibata, 'Edward Divers sensei to Haga Tamemasa sensei', *Kagaku*, 16 (1961), 782–6; on 785. See also Note 34 in this chapter.

note, however, that such a well-calculated choice of destinations for overseas study would not be possible without advice and a letter of introduction from Majima's former teacher, Haga, who had known Harries personally.[46] Doctorates awarded on the basis of purely domestic research became the norm in the 1920s and early 1930s in Japanese chemistry, as shown by the careers of SAMESHIMA Jitsusaburō 鮫島實三郎, who specialized in colloid and surface chemistry, and MIZUSHIMA San-ichirō 水島三一郎, a specialist in conformational analysis. Both of them became professors of physical chemistry at Tokyo Imperial University during this period.[47]

In summary, there was a transition that took place between 1890 and 1930. Prior to this period, doctoral degrees were awarded on the basis of the research done during overseas study. Gradually, scientists received their doctorates based on research they did at home. This transition seems to have been completed by 1930. It is important to note that there was no doctoral coursework before, during and after this transition at Japanese universities.

Conclusion

This chapter has examined the development of research training in the first 'laboratory science', chemistry, at Tokyo Imperial University from the late nineteenth until the early twentieth century. Although heavily restricted by limited resources and the weak position of postgraduate education, research training existed and is best characterized by the gradual emergence of research practice and the 'research imperative' from laboratory pedagogical practice at the undergraduate level. It is difficult to exactly demarcate research training from basic laboratory training. But advanced undergraduate and postgraduate students were trained well enough to produce research outcomes, though supervised by teaching assistants or assistant professors, at the Department of Chemistry of Tokyo Imperial University.

In detail, the difference between Nagai's laboratory design and that of Divers and Sakurai reflected the shifting meaning of a laboratory in

[46] Takashi Kubota, 'Rikō Majima: Founder of Organic Chemistry in Japan, Part 1', *Kagakushi*, 30 (2003), 36–51, on 41 and 44–5; and Kubota, 'Rikō Majima: Founder of Organic Chemistry in Japan, Part 4', *Kagakushi*, 30 (2003), 231–55, on 251. See also Majima, 'Waga Shōgai no Kaiko', 4 and 7–8.

[47] On Mizushima, see Yoshiyuki Kikuchi, 'Mizushima, San-ichiro', in Noretta Koertge (ed.), *New Dictionary of Scientific Biography*, 8 vols. (Farmington Hills, MI, 2008), v. 167–71. On Sameshima, see Tarō Tachibana, 'Academic Achievements of Dr. Jitsusauro Sameshima', *Kagakushi*, 9 (February 1979), 23–36, and 10 (June 1979), 39–47.

Meiji Japan and their learning, research, and teaching experiences in Berlin, London, Galway, and Tokyo. First, Nagai's focus on analytical training would have suited the earlier chemistry laboratory qua *shiken shitsu* ('a place to examine') whereas Divers and Sakurai's design was more in line with its later broad meaning of *jikken shitsu/jō*; that is, 'a place to examine/experience/see'. It is also noteworthy that the latter assigned an important role to the departmental library as a venue for reading seminars (the *Zasshi-kai* at Tokyo's Department of Chemistry) for aspiring original researchers. Manual training in the laboratory, in the narrower sense, was complemented by discussion in the library (just as in the humanities), both of which comprised the laboratory in the wider sense, better captured by the Japanese *jikken shitsu/jō* than *shiken shitsu/jō*.

The difference between Nagai's, Divers' and Sakurai's, laboratory designs was also clearly expressed in how they embedded the hierarchical structure of supervisory practice in the chemistry laboratories as pedagogical spaces. In contrast to Nagai's director-centered design, Sakurai's and Divers' answer to this problem was a binary structure based on the two-chair departmental system. The latter also underlined the crucial role of junior professors qua teaching assistants as mediators between students and senior professors, and as laboratory supervisors.

The development of laboratory supervision and its setting in Tokyo did not stop there. For example, Sakurai and Divers adopted an alignment of laboratory benches running parallel to the main, longer walls, presumably to make the most of the natural light and ventilation through the large windows. They were not alone in adopting this alignment: it had been used in Liebig's famous analytical laboratory at Giessen, built in 1840, and adopted in UCL's Birkbeck Laboratory when it was built in 1846.[48] However, it was not an ideal layout for efficient laboratory supervision, since supervisors had to walk along the aisles several times, their vision being blocked by bottle racks on the benches. This was not a problem with the small number of enrolled students at the Department of Chemistry in the 1880s, but it would become so in the 1890s when the number reached 20 in 1897.

Later laboratories of Tokyo Imperial University, such as the Chemical Laboratory in the Institute of Pharmacology (1902), the Laboratory of Medical Chemistry (1901, Figure 11.4), the Laboratory of Applied Chemistry

[48] Peter J. T. Morris, *The Matter Factory: A History of the Chemical Laboratory* (London, 2015), 92–6 and 109–15.

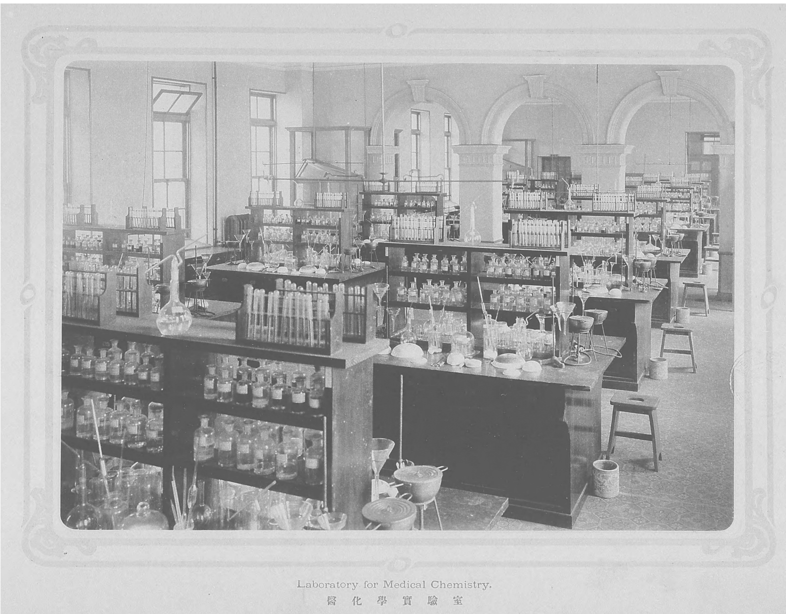

Figure 11.4 Laboratory for Medical Chemistry, College of Medicine, Tokyo Imperial University. Reproduced from Ogawa Kazumasa, *Imperial University of Tokyo* (Tokyo: Ogawa Shashin Seihanjo, 1904). Courtesy of the National Diet Library, Japan.

(1896), and the Laboratory of Agricultural Chemistry (1899, Figure 11.5), adopted a different layout,[49] similar to the one in the laboratory of Hermann Kolbe at the University of Leipzig, completed in 1868. There, a wide aisle ran down the middle of the room and parallel to the main walls, with several benches laid between the aisle and a wall on both sides and perpendicular to them.[50] This arrangement spread to other laboratories in Europe and North America and, indeed, reached Tokyo by the turn of the century, arguably because it was more efficient for supervising ever-increasing numbers of students in laboratories.

In conclusion, I have shown that the training of researchers in laboratory science in Japan started to take root by the 1900s in a modest way,

[49] Ogawa, *Imperial University of Tōkyō*. For the dates of the erection for these laboratories, see *Tokyo Teikoku Daigaku Gojūnenshi*, ii (Tokyo, 1932), 1258–83.

[50] Morris, *The Matter Factory*, 155–7; Alan J. Rocke, *The Quiet Revolution: Hermann Kolbe and the Science of Organic Chemistry* (Berkeley, CA, 1993), 278–86 and the picture of Kolbe's teaching laboratory at Leipzig between pages 264 and 65.

Figure 11.5 Laboratory for Agricultural Chemistry, College of Agriculture, Tokyo Imperial University. Reproduced from Ogawa, *Imperial University of Tokyo*. Courtesy of the National Diet Library, Japan.

when *jikken shitsu* as the translation of 'laboratory' also became part of the Japanese vocabulary, and that the domestic production of doctorate holders became the norm by the early 1930s. The process started in the late 1860s and included a variety of elements—conceptualizing the laboratory, designing and building it, systematizing laboratory supervision, training skilled teaching assistants, building research partnerships, setting up seminars, securing the publication of research findings, creating the culture of the 'research imperative' among students, and implementing the ideal of laboratory research that the chemists brought home from their study abroad. This list is not likely to be complete, but is enough to show the complexity of laboratory science and the training of its researchers in a non-Western country.

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12

Teaching and Research in Colonial Bombay

John Mathew and Pushkar Sohoni

Introduction

This article seeks to foreground the fact that in Bombay, a city and Presidency predominantly founded and sustained on mercantile interests (unlike Madras and Calcutta), education itself became a commodity, and the broader commercial context shaped its academic contours, particularly in the sponsorship of scholastic ventures through personal investment. For example, the Royal Institute of Science was inaugurated with great fanfare in 1920 by George Clarke, first Baron Sydenham of Combe (1848–1933), Governor of Bombay, with the mission of imparting scientific knowledge to Indians, inasmuch as it might contribute to a vibrant industry. The Institute was the first in the city of Bombay founded to disseminate specialised scientific education, but with a clear industrial motive.[1] An establishment like this was in stark contrast to attitudes displayed in Calcutta almost exactly a century earlier when an appeal by Raja Rammohan Roy (1772–1833) to Governor-General Lord Amherst (1773–1857) for training Indians in Western science was rejected.[2]

The original 1903 conception of the Royal Institute had received a decided fillip when buildings were constructed for it in 1915. In 1903, at the Industrial Conference in Bombay, presided over by Dorabji Tata (1859–1932), Harold Hart Mann (1872–1961), Agricultural Advisor to the Government of Bombay, moved a resolution to create a technological

[1] Significantly, an entity devoted to science had already come into being in the country in 1909. This was the Indian Institute of Science located in Bangalore, the brainchild of Jamsetji Nusserwanji Tata (1839-1904), who was ironically based in Bombay and did not live long enough to see his project come to fruition.

[2] Uma Das Gupta, 'Introduction' in Uma Das Gupta (ed.), *Science and Modern India: An Institutional History: c. 1784-1947,* xil-lxxvii, endnote 47.

John Mathew and Pushkar Sohoni, *Teaching and Research in Colonial Bombay* In: *A Global History of Research Education: Disciplines, Institutions, and Nations, 1840–1950*. Edited by: Ku-ming (Kevin) Chang and Alan Rocke. *History of Universities* XXXIV/1, Oxford University Press (2021).
DOI: 10.1093/oso/9780192844774.003.0013

faculty in universities. He faced a deep-rooted prejudice against technology; delegates to the Industrial Conference believed that culture was 'only obtainable through literary pursuits, and that those who studied technology belonged to a lower level of civilisation and culture'.[3] Mann's feelings on the subject may have had a considerable deal to do with his own training as an agriculturist. Apart from his aforementioned role, he was also the first Principal of the Agricultural College in Poona, subsequent to its separation from the existent College of Science, with a strong emphasis laid on the practical and experimental.[4] However, the real change resulted with the onset of World War I (1914–1918), where a need for training a mass cadre of scientists, technologists and educators was suddenly felt. The rapid departure of British personnel after the War and the emerging requirement of a trained workforce led to an accelerated growth of educational institutions of science and technology. These events would eventually lead to the University Department of Chemical Technology (now known as the Institute of Chemical Technology) in 1933. This marked a complete shift in attitudes towards technical and applied education in Bombay. Even by then, the University of Bambay had not engaged in offering any courses, contenting itself with administering examinations, setting curricula, awarding degrees and affiliating colleges. In fact, 'scientific education, let alone technological education, formed a marginal part of the higher education curriculum' from the inception of the University in 1857 to the end of World War I.[5] Thus, even modest scientific institutions, such as the Plague Research Laboratory (PRL), started in 1899 by Dr Waldemar Haffkine (1860–1930), became significant in the scientific establishment of Bombay.[6]

In the early nineteenth century, the lack of interest by Lord Amherst (1773–1857) in Rammohun Roy's initiative would not necessarily have been shared by his compatriots. After all, among the British Presidencies in India, Bengal had, 40 years earlier, taken pride of place for the establishment of a savant society in Calcutta. Called the Asiatic Society of Bengal, it had, almost from its inception, proven to be a significant locus for the production of knowledge. Founded in 1784 by the erudite

[3] Nasir Tyabji, 'Exemplar of Academia-Industry Interchange: The Department of Chemical Technology at Bombay University' in Uma Das Gupta (ed.), *Science and Modern India: An Institutional History, c. 1784-1947* (gen. ed. D.P. Chattopadhyaya) *History of Science, Philosophy and Culture in Modern India*, xv.4 (New Delhi, 2011), 927-946, esp. 930.

[4] Kishor D. Gaikwad, 'Poona Agricultural College: Catering to the 'Colonial Food' Requirement, 1908-47 in Uma Das Gupta (ed.), *Science and Modern India: An Institutional History, c. 1784-1947*, 311-26, esp. 324.

[5] Nasir Tyabji, 'Exemplar of Academia-Industry Interchange', 927.

[6] Pratik Chakrabarti, *Bacteriology in British India: Laboratory Medicine and the Tropics* (Rochester, NY, 2012), 51.

puisne judge in Calcutta, Sir William Jones (1746–1794), the society sought to replicate the form of the Royal Society in London, but with a very definite focus on the study of Asian languages, customs and traditions, along with a plethora of other desiderata.[7] The other Presidencies would follow suit in the early nineteenth century. While Madras had taken the lead in securing an official naturalist, Johann Gerhard Koenig (1728–1795) in 1778, a more general approach to the aims stated for the Asiatic Society of Bengal would be attempted only in 1812 through the formation of the Literary Society of Madras. This was at the instance of Sir John Newbolt (1769–1823), Chief Justice of the Supreme Court of Judicature in Madras, aided by the physician Benjamin Guy Babington (1794–1866), the first Secretary of the Civil Service. In 1829, a distinct body known as the Auxiliary of the Royal Asiatic Society was created in the same city. A year later, both Societies merged under the umbrella of the organisation in London to become known as the Madras Literary Society AND Auxiliary of the Royal Asiatic Society.

The stirrings of a learned enterprise were felt in Bombay nearly a decade before Madras. With respect to the sciences, a Presidential address to the newly constituted Literary Society of Bombay (1804), by Sir James Mackintosh (1765–1832), the Recorder (Chief Judge of Bombay), was duly couched in these terms:

> The Physical Sciences afford so easy and pleasing an amusement; they are so directly subservient to the useful arts; and in their higher forms, they so much delight our imagination and flatter our pride, by the display of the authority of man over nature, that there can be no need of arguments to prove their utility, and no want of powerful and obvious motives to dispose men to their cultivation. The whole extensive and beautiful science of Natural History, which is the foundation of all physical knowledge, has

[7] Jones declared the object of the Society to be the 'investigation of whatever is rare in the stupendous fabric of nature; correcting the geography of Asia by new observations and discoveries; tracing the annals and eve traditions of these nations….and bringing to light their various forms of government, with their institutions, civil and religious; examining their improvements and methods in arithmetic and geometry—its trigonometry, mensuration, mechanics, optics, astronomy and general physics; their systems of modality, grammar and rhetoric and dialectic; their skill in chirurgery and medicine, and their advancement, whatever it may be, in anatomy and chemistry. To this you will add researches into their agriculture, manufacture and trade, and, whilst you enquire into their music, architecture, painting and poetry, will not neglect those inferior arts, by which comforts, and even elegances of social life, are supplied or improved. If now it be asked, what are the intended objects of our enquiries within these specious limits, we answer, Man and Nature; whatever is performed by the one, or produced by the other.' From the 1st Discourse by the President, quoted in C.R. Chaudhuri, *The Asiatic Society* (Calcutta, 1995). For a general history of the Asiatic Society, see O.P. Kejariwal, *The Asiatic Society of Bengal and the Discovery of India's Past, 1784-1838* (New Delhi, 1988).

> many additional charms in a country where so many treasures must still be unexplored.[8]

The Literary Society of Bombay merged with the nascent Royal Asiatic Society of Great Britain and Ireland (founded 1824) that same year.[9] Modelled after and inspired by the learned societies of the period, this would become the first institution in the Bombay Presidency to nurture empirical knowledge of the natural world. Initially, the focus seems to have been on antiquarian pursuits, along with Sanskrit literature, philology, archaeological remains, ethnographic descriptions, and religious practices.[10] There was limited engagement with natural history in the early years, though it was desired. As the President of the Society, Rev. John Wilson said in his address in 1836, 'there are in our Transactions only a few distinct contributions'. He then urged the Society to imitate the Asiatic Society of Bengal in that regard, so also in its focus on geology, botany, and zoology.[11]

By the time Sir George Birdwood (1832–1917) came to the city of Bombay in 1857, the state of scientific collection and publication had completely changed. Birdwood was appointed Acting Professor of Anatomy and Physiology in Grant Medical College, which had been established in 1845 in memory of the former Governor of Bombay, Sir Robert Grant (1779–1838). On his travels through the Deccan, Birdwood sent drawings, dried plants, stuffed birds and other items of natural history to the newly formed Central Museum of Natural History, Economy, Geology, Industry and Arts in Bombay. This museum was founded in 1855, but closed to the public in 1857 and its collections moved to the Town Hall, before disbursal to a number of museums of the city, the chief beneficiary being the Victoria & Albert Industrial Museum (opened in 1872).[12] Pleased with Birdwoood's efforts, Lord John Elphinstone (13th Baron, 1779–1859), Governor of Bombay, appointed him Secretary and Curator of the collections in the Town Hall, which would result in the establishment of the Victoria & Albert Industrial Museum, not least in part to house them.[13] Birdwood's personal interest in research in science and medicine, his engagement with public education, and his stewardship of several institutions led to a unified

[8] Quoted in K.R. Kirtikar, 'Progress in Natural History during the last Century', *The Journal of the Bombay Branch of the Royal Asiatic Society,* Extra Number – The Centenary Memorial Volume, Part V. Science Section. 1 (1905), 353-81.

[9] 'Brief History', Asiatic Society of Mumbai website [http://asiaticsociety.org.in/index.php/about-us/history-asiatic] accessed 25th July 2018.

[10] Mrinal Kulkarni, *Sir James Mackintosh* (Mumbai, 2014), 70-80 *passim*.

[11] Rev. John Wilson, 'Address read before the Bombay Branch of the Royal Asiatic Society, on the 27th January, 1836', *The Madras Journal of Literature and Science*, 4 (July-October 1836), 443.

[12] Vijaya Gupchup, *Sir George Birdwood* (Mumbai, 2014), 3-4.

[13] Ibid, 4.

vision on his part. Birdwood had also championed the inclusion of Indians in many of these institutions, making them truly public.[14]

Thus, the middle two decades of the nineteenth century witnessed a revolution in the scientific establishment within the Bombay Presidency. New institutions such as museums were envisioned to house scientific collections, the University of Bombay was established (1857), and Victorian polymaths like Birdwood were serving in India, for decades at a time, founding and running the institutions of knowledge production that would supplement the rather meagre role of the university in the promulgation of science.

The foregoing discussion reveals a number of issues. Central to them is the multiplication of scientific disciplines in the early decades of the nineteenth century (for instance, natural history ceding place to botany, zoology, and geology), a feature amply described by Michel Foucault in *The Order of Things* (1966). Another key element is the matter of inclusion. The Asiatic Societies in India were notably chary in terms of admitting native members – ironically, it took the welcoming of a Parsi, Manekjee Cursetjee (1808–1887) into the Royal Asiatic Society in London, after he had been refused entry to the Bombay Branch on grounds of his race, for the matter to be reconsidered favourably for him, given that his continued exclusion from the Bombay chapter would have been ludicrous. Admittance would facilitate engagement and the possibilities for greater native participation, though this would still remain minoritarian through the nineteenth century.

Allied to such inclusion was a major rift owing to the importance given to Western education versus that in the vernacular, a battle that would result decidedly on the side of the former through a series of imperial interventions, particularly Macaulay's notorious 1835 Minute on Education.[15] A flamboyant 50-round salute attended the first dissection of a human body by a native surgeon, Madhusudhan Gupta, a year later at the Calcutta Medical College.[16] Yet, despite these successes, there was little attention paid to a general training of native students for anything other than teaching, a tendency that would be central to the mandates of the Presidency universities upon their establishment in 1857.[17] Affiliated

[14] Ibid, 5.

[15] T.B. Macaulay, 'Minute on Indian Education' in John Clive and Thomas Pinney (eds.), *Selected Writings* (Chicago, 1972 (1835)).

[16] David Arnold, *Colonizing the Body: State Medicine and Epidemic Disease in Nineteenth-Century India* (Berkeley/Los Angeles/London, 1993), 6.

[17] Identical preambles marked the Acts of Incorporation for the three universities, defining their objects to ascertain 'by means of examination the persons who have acquired proficiency in different branches of Literature, Science and Art and of rewarding them by Academic Degrees as evidence of their respective attainments.' In Suresh Chandra Ghosh, *The History of Education in Modern India*, 1757-2012, Fourth Edition (Hyderabad, Telangana, 2013), 85.

colleges were given no control over the courses required with 'their only function', 'to prepare students for examinations conducted by the university'.[18]

By the mid-nineteenth century, however, public engagement in science education existed in at least some version of these primary institutions. Very soon, local expression of this pedagogy was formulated when European-language works were slowly translated into vernacular languages. By the 1850s, there were books published in Bengali on most branches of science.[19] In 1868, the Bihar Scientific Society was set up with the mission of translating European scientific works into vernacular languages.[20] It was closely modelled on the Scientific Society of Aligarh founded by Sir Sayyad Ahmad Khan in 1864, which translated scientific works in English and other European languages into Urdu.[21]

Rammohun Roy had looked to the British East India Company for patronage in the early 1820s, and it was again in Calcutta that a significant moment of direct native intervention instead occurred. This was the formation of the Indian Association for the Cultivation of Science in 1869 at the instance of Dr Mahendra Lal Sircar (1833–1904), a leading Bengali social reformer and practitioner of both allopathy and homoeopathy.[22] Nationalistic temper was also to make itself manifest through the establishment of the Bengal Chemical and Pharmaceutical Works in 1887 by the University of Edinburgh-trained Prafulla Chandra Ray (1861–1944)[23] and the experimental demonstration of Hertzian waves by Jagadish Chandra Bose (1858–1937) at Presidency College,[24] both events occurring in Calcutta as well. Not to be outdone in terms of educational philanthropy, the Bombay-based Sir Jamsetji Nusserwanji Tata (1839–1904), a Parsi industrialist, endowed a new institution envisaged on the lines of Britain's Imperial Institute to the tune of three million rupees at the turn to the 20th century, which would eventually be located in

[18] Ibid, 86.

[19] Uma Das Gupta, 'Introduction', in Uma Das Gupta (ed.) *Science and Modern India* (Gen. Ed. D.P. Chattopadhyaya) *History of Science, Philosophy and Culture in Modern India*, xv Part 4, xil-lxxvii, esp. xli.

[20] V.A. Narain, 'The Role of Bihar Scientific Association in the Spread of Western Education in India' in *Proceedings of the Indian History Congress* -1969, 421-4.

[21] H.K. Sherwani, 'The Political Thought of Sir Syed Ahmad Khan' in *The Indian Journal of Political Science*, 5/4 (1944), 306-28, esp. 311.

[22] Pratik Chakrabarti, *Western Science in Modern India: Metropolitan Methods, Colonial Practices* (New Delhi, 2004), 150.

[23] Dhruv Raina, 'Ray's Life and Experiences as a text on the history of science', in Santimay Chatterjee, M.K. Dasgupta and Amitabha Ghosh (eds.), *Studies in History of Science* (Calcutta, 1997), 25–42, esp. 28.

[24] Jon Agar, *Science in the Twentieth Century and Beyond*, (Cambridge, 2012), 17.

Bangalore, coming into being in 1909 under the name the Indian Institute of Science.[25]

It was in such a context of both the centralising impulse of empire and the reactionary response of nationalists that two chemists, J. L. Simonsen of Canning College, Lucknow, and P. S. Macmahon of Presidency College, Madras, proposed the introduction of an annual Indian Science Congress, arising from their disappointment that original research at the level of the university in India was wanting,[26] well over half a century after the establishment of those in Madras, Bombay and Calcutta. The first Congress was held in 1914 in Calcutta under the presidency of the renowned lawyer and then Vice-Chancellor of Calcutta University, Sir Ashutosh Mukherjee (1864–1924), with one-third of the papers being read by Indians. It was this important period in the 1910s that would allow for the formation of such a research-oriented establishment as the Royal Institution of Science to come into being by 1920 in Bombay.

Every colonial institution and congress was facilitated by the rise of a set of nineteenth-century bodies. In what was the most important British city in western India, these were dominated by a group of seven institutions. In chronological order, they were: 1. The Bombay Branch of the Royal Asiatic Society (originally established as the Literary Society of Bombay, 1804), 2. the Victoria and Albert Industrial Museum (indirectly conceived in 1855 and built in 1871), 3. the University of Bombay (1857), 4. the Bombay Natural History Society (1883), 5. the Haffkine Institute (1899), 6. the Royal Institute of Science (envisioned in 1903 and established in 1920) and 7. the Prince of Wales Museum (imagined in 1904 and brought into being in 1922). Brief accounts of these institutions are essential to understand the role of the dissemination of science in the Bombay Presidency in particular, and colonial India in general.

The Institutions

The Bombay Branch of the Royal Asiatic Society

Founded in 1804, as a forum to contribute to the knowledge of Asia in all fields, the Bombay Branch of the Royal Asiatic Society was ably guided by a number of office-bearers drawn from the ranks of administrators and

[25] David Arnold, *Science, Technology and Medicine in Colonial India*, (Cambridge, 2000), 161.

[26] Colleges and universities began early—a case in point being Hindu College (later Presidency College) in 1818. With the mid-nineteenth-century origination of the Universities of Calcutta, Bombay and Madras, there was an effort to include a number of subjects across the board roughly equivalent to those found in Britain. Nonetheless disciplines like zoology still found short shrift until the dawn of the twentieth century.

educators in the Bombay Presidency. The Society never formally conducted classes or examinations, and even most of the research, barring the library, was pursued at the initiative of individual members. Enterprising members of the Society, who were otherwise employed as administrators, military men, civil engineers, and physicians, undertook research that was aligned with their own wide-ranging interests, to which *The Transactions of the Bombay Branch of the Royal Asiatic Society* was a testament. The Society filled the role for providing informal education and furthering new exploration in the absence of genuine state-sponsored research institutions in the Bombay Presidency for almost a hundred years. With the creation of specialised research institutions, covered below, the role of the Asiatic Society was trimmed down to philological, linguistic, historical and cultural fields.

The Victoria and Albert Industrial Museum

Established chiefly through the efforts of Birdwood and his great friend Dr Bhau Daji Lad (1822–1874), among others, the oldest extant museum in the city (opened 1872), the Victoria and Albert Industrial Museum (now renamed the Bhau Daji Lad Museum) was among the earliest institutions to promote a union of arts and traditional crafts, besides being the first building specifically constructed to house a museum, which to the colonial mind, represented native industry.[27] As a result, the museum became the locus of extensive research into craft practices, including the study of properties for material to be commercially exploited (for instance, coir or different kinds of wood). This kind of institution was replicated in most major cities of British India (e.g. Poona, now Pune) and subordinated princely states (e.g. Jaipur) and performed the dual task of educating the public, and undertaking applied research. The possibilities of commercial enterprise, based upon natural resources, were supplemented by the other great institution for economic botany, namely the botanical garden.[28]

[27] Gupchup, *Sir George Birdwood*, 52-3. Also, see 'Museum Story', Dr. Bhau Daji Lad Mumbai City Museum website [http://www.bdlmuseum.org/about/museum-story.html] accessed 25th July 2018.

[28] The Horticultural Society of Bombay, also realised through the endeavours of Sir George Birdwood, carried out a different kind of research, wherein new gardens were laid out and exotic plants were imported gratis from Liverpool and Zanzibar in exchange for native species; see George Birdwood, *Report of the Government Central Museum and On the Agricultural and Horticultural Society of Western India for 1863* (Bombay, 1864), 72.

The University of Bombay

The Minute by Sir Mountstuart Elphinstone (1779–1859) in 1824 emphasised education primarily in terms of reading and writing to teach natives the skills of administration as a means of 'civilising them'.[29] Elphinstone was, paradoxically, also very keen to ensure that traditional institutions like temples and madrasas in which teaching was done were preserved.[30] But native education in English was already underway with the founding of The Bombay Native Education Society in 1815, which was later merged into the Board of Education in 1840. This body established Grant Medical College in 1845, and the Engineers' Class, attached to Elphinstone College, was shifted to Poona in 1854 as the Engineering Class and Mechanical School.[31] However, colleges in Bombay did not fulfil the role of a university, but merely prepared students for examinations administered in England. With the passage of the Calcutta University Bill in December 1857, the University of Bombay was incorporated, and the Bachelor of Arts, Master of Arts, Bachelor of Laws, Licentiate in Medicine, Doctor of Medicine and Master of Civil Engineering, were degrees that could be conferred by the new University.[32] Up until 1904, the only function of the university was to affiliate colleges, dictate curricula and conduct examinations. The University itself did not engage in any teaching or research. In 1917, Chimanlal Sethalvad was appointed the Vice-Chancellor, a position that he occupied for an unsurpassed six years comprising twelve terms. The Government of Bombay had offered a grant for a School of Research in Economics and Sociology, which was realised during his sinecure.[33] Sir Chimanlal was of the opinion that the university should be directly involved in teaching as part of its mandate. The Royal Institute of Science (founded 1920) applied to the University to be affiliated for the award of a Bachelor's degree in Science, whereas many members of the University wanted the Institute to be admitted as a postgraduate department of study. Finally, in 1925, the University affiliated the Royal Institute but reiterated that the main function of the Institute was research – this was in line with the University's new role of ensuring that it retained control of teaching.[34] However, as

[29] B.D. Basu, *History of Education in India under the rule of East India Company* (Calcutta, 1922), 1.

[30] V. Raghunathan and Veena Prasad, *Beyond the Call of Duty* (Noida, Uttar Pradesh, 2015), 58.

[31] Aroon Tikekar, *The Cloister's Pale: A Biography of the University of Mumbai* (Mumbai, 2006), 10-11.

[32] Ibid, 19. [33] Ibid, 158-9. [34] Ibid, 160-1.

this example illustrates, research was still carried out only in affiliated or independent institutions.

The Bombay Natural History Society

Right from its inception in 1841, the *Journal of the Bombay Branch of the Asiatic Society* had included natural history. Of the five articles contained in the first volume, one dealt with palaeobiology, and was titled 'Note on the Discovery of Fossil Bones of Mammalia in Kattiawar' by Captain Fulljames. The body was locally significant: a call, for instance, to increase the size of the collections of the Museum of Economic Geology in Calcutta found mention very early in the journal's run (No. V, April 1843). In 1883, The Bombay Natural History Society (henceforth BNHS), as it was called, came into being at the instance of eight residents of the city who thought it an 'excellent idea to form a Society for the study of Natural History,' and proposed 'to meet monthly for exchange of notes, for exhibiting interesting specimens, and for otherwise encouraging one another.'[35] There were eight founders, six of whom were European and two Indian: Dr. D. MacDonald, Mr. E. H. Aitken, Colonel C. Swinhoe, Mr. J. C. Anderson, Mr. J. Johnston, Dr. Atmaram Pandurang, Dr. G. A. Maconochie and Dr. Sakharam Arjun.[36] The Society would swiftly assume the mantle of systematic investigations in the subject from the contributors of what were relatively slim pickings in the *Journal of the Bombay Branch of the Royal Asiatic Society*. The *Journal of the Bombay Natural History Society* (henceforth *JBNHS*) was launched in 1886 under the editorship of R. A. Sterndale and E. H. Aitken and printed at the Education Society's Press at Byculla, consisting of four issues and twelve illustrations. The introduction explained the circumstances of the origin of the *JBNHS* and the focus on the subjects under study, which included Mammals and Birds, Reptiles and Fishes, Insects, Other Invertebrates, and Botany.[37]

Two points should be stressed here. First, decided importance was afforded to zoology at eighty per cent, accounting for four out of five sections under study, two vertebrate, the remainder invertebrate. By contrast, botany was treated in total, rather than being sectioned into

[35] Bombay Natural History Society (1883–1983), 'The History of a Century of Natural History. The First Fifty Years, 1883-1933,' *Hornbill*, 7 (1983), 2-23. R.A. Sterndale and E.H. Aitken (eds.), 'Introduction'. *Journal of the Bombay Natural History Society*, 1/1 (1886), 1-3.

[36] The presence of the two native Indians in this organising body, Dr. Pandurang and Dr. Arjun was a remarkably high percentage given the relative paucity of Indians countrywide in the arena of natural history.

[37] Sterndale and Aiken, 'Introduction', 2.

mosses, fungi, ferns, gymnosperms and angiosperms. Second, there was an immediate *raison d'être* provided for the introduction of a journal to meet the needs of naturalists who had been suffering for want of such a vehicle in the Presidency of Bombay (as opposed to the *Journal of the Asiatic Society of Bengal* and the *Journal of the Literary Society of Madras,* the *Journal of the Literary Society of Bombay* and later the *Journal of the Bombay Branch of the Royal Asiatic Society* were decidedly thin on matters of natural history).

The membership of the Society as listed in the first volume indicated an interesting trend. While the vast majority of the 235 names were of British extraction, there were 12 native members as well, over half of whom belonged to the Zoroastrian Parsi community.[38] This was unsurprising—the Parsis had been in the vanguard of exposure to western education in terms disproportionate to their tiny numbers, and this fact translated itself into the realm of interest in natural history in its European inflection as well.[39] Significantly, taking into account the dearth of women sojourning in South Asia who had contributed to natural history in print (with some illustrious exceptions such as Emily Eden (1797–1869) and Fanny Parkes (1794–1875)), there were also five women members, none of whom, however, belonged to the native Indian community.[40]

In the corresponding dearth of representation by Indians and women in the first volume, the former category included one Keswal (included as 'A Member of the Society') who wrote the first part of a series on the 'Waters of Western India' (the others would appear in subsequent volumes) and K. R. Kirtikar who had several contributions on botany. The latter was represented by Mrs. W. E. Hart, whose offering was also botanical, in describing a root parasite. That, however, was the sum of the matter – three individuals, two of whom were disproportionately represented

[38] Jehangir Manekjee Cursetjee, Sorabjee D. Dubash, Babajee Gopal, K.R. Kama, Rustom K.R. Kama, Diasha P. Kanga, Surgeon K.R. Kirtikar, Ragoonath Mukund, K.D. Naigumwala, Rev. Danjibhai Naoroji, Ardeshir Shapurji Panday and Sorabjee Cavasjee Powwalla.

[39] Not merely in education and politics but even in sports. Please see for instance, R. Guha, *A Corner of a Foreign Field* (Delhi, 2002), for the pivotal Parsi contribution to the development of cricket in India.

[40] Miss Dewar, Mrs. W.E. Hart, Miss Johnstone, Mrs. H.S. Symons, and Mrs. Thomson. Only Mrs. Symons appeared to be associated with the Society along with other members of her family from the names on the roster, though Mr. W.E. Hart would also become a long-standing member of the Society. It is also interesting that two of the lady members are spinsters, indicating a certain level of independent initiative in a largely male-dominated society. See E. Eden, *Up the Country: Letters to her Sister written from the Upper Provinces of India* in two volumes (London, 1866); and F. Parkes, *Wanderings of a Pilgrim, in Search of the Picturesque, during Four-and-Twenty Years in the East; with Revelations of Life in the Zenana* (London, 1850).

owing to multiple articles authored by them. It would take time for more Indians to contribute, as indeed, European women. Even more time (over three quarters of a century) would need to elapse for contributions by Indian women. Nonetheless the Society and its journal would undoubtedly provide the chief activity of natural history through much of the twentieth century, and indeed continues to play a significant role in this regard to the present day.

The Haffkine Institute

The Third Pandemic of the Plague had found its origins in Hong Kong and southern China in 1894 and two years later struck the Bombay Presidency with tremendous ferocity. Over the next fifty years, even as the intensity of the disease waxed and waned, there were up to 15 million deaths worldwide, of which approximately 12 million were in India alone.[41] The colonial government was slow to respond, even as state intervention reigned, rumours abounded, riots resulted, and mass flight occurred from cities.[42] As a result of a threat of an embargo on goods from India in 1897, the Epidemic Diseases Act in February 1897 was passed.[43] The legislation 'authorised the health authorities to confiscate or destroy any property including houses) that they believed to harbour the disease; gave them the right to prohibit fairs and festivals where these might endanger public health; permitted the hospitalisation and segregation of suspected plague victims; allowed the rapid disposal of the dead to prevent the spread of disease; and instituted systematic inspection of travellers by road, rail, and sea to search for physical signs of infection and detain plague suspects'.[44] The result was widespread fear and rumour-mongering in both the Western educated Indian elite and the less fortunate masses. The unpopular Plague Commissioner in Poona, Walter C. Rand, was a direct casualty, assassinated on the 22nd of June 1897, at the hand of three Chitpavan Brahmins, the Chapekar brothers.[45]

That same year, nearly 400,000 people, approximately half the population of the city, fled Bombay.[46] Some measure of addressing immediate discontent was attempted through the anti-plague serum

[41] Myron J. Echenberg, 'Pestis Redux: The Initial Years of the Third Bubonic Plague Pandemic, 1894–1901' in *Journal of World History*, 5/2 (2002), 429-49.

[42] David Arnold, 'Disease, Rumour, and Panic in India's Plague and Influenza Epidemics, 1896-1919' in Robert Peckham (ed.), *Empires of Panic: Epidemics and Colonial Anxieties* (Hong Kong, 2015), 112.

[43] Arnold, *Colonizing the Body*, 205.

[44] Arnold, 'Disease, Rumour, and Panic', 114.

[45] Kalpish Ratna, *The Quarantine Papers* (New Delhi, 2010), 230-1.

[46] Arnold, 'Disease, Rumour, and Panic', 116-17.

developed by Waldemar Haffkine (1860–1930), a Jewish Ukrainian bacteriologist trained in Paris, who had, half a decade earlier, assisted in addressing an outbreak of cholera in Calcutta. Haffkine's serum itself would, after a contaminated sample over which he had no direct control was disseminated, compromise his work and standing in the country.[47] Nonetheless, the plague pandemic did allow for the systematic employment of a laboratory-derived antidote from within the confines of a nation hitherto under thrall to more environmental considerations in the treatment of disease, rather than those of pathogens.

The locus for the production of the antidote that was being developed by Haffkine was known as the Plague Research Laboratory, out of what was called Room 000, originally housed in the Pharmacology Department of Grant Medical College.[48] As mentioned in the introduction, the Plague Research Laboratory (PRL), was started in 1899 by Haffkine, accompanied by 'one native clerk and three peons lent by the municipality' in one room.[49] In 1906, the PRL would become the Bombay Bacteriological Laboratory (BBL), only to be renamed the Haffkine Institute in 1925, an irony, given the obloquy into which his name had fallen in the early part of the century. The scope and strength of this institution improved rapidly through the first two decades of the twentieth century, as the BBL became a provisional laboratory for general diagnosis and research funded by the government of Bombay and the Indian Research Fund Association.[50]

The power differential that extended to the roles of European versus native practitioners was entrenched. When Dr A. G. Viegas (1856–1933) became the first person to detect a case of the plague in Bombay, he was a member of the Bombay municipal standing committee, under whose remit was the responsibility of controlling the disease.[51] Viegas was a local physician, of Goan extraction, with a thriving practice in Mandvi, whose suspicions regarding the rebarbative symptoms of a woman on whom he had been called to attend in Pydhonie on the 18th of September 1896, had led to his determination of her illness as the plague. This fact was duly confirmed on the 23rd of September by a standing committee, leading to the then

[47] Arnold, *Science, Technology and Medicine in Colonial India*, 143.

[48] For an exhaustive account, if couched in fiction, please see Ratna, *The Quarantine Papers*, and Kalpish Ratna, *Room 000: Narratives of the Bombay Plague* (New Delhi, 2015).

[49] Chakrabarti, *Bacteriology in British India*, 51.

[50] This was the forerunner of the Indian Council of Medical Research, founded in 1911. For the role of the BBL as a research and public health laboratory, see Mridula Ramanna, 'The Haffkine Institute, 1899-1947', in Uma Das Gupta (ed.), *Science and Modern India: An Institutional History, c. 1784-1947*, History of Science, Philosophy and Culture in Modern India, xv. Part 4 (New Delhi, 2011), 573.

[51] Mridula Ramanna, *Health Care in Bombay Presidency, 1896-1930* (New Delhi, 2012), 11.

Governor of Bombay, Lord Sandhurst, notifying the Governor-General and Viceroy of India, Lord Elgin on the 29th of September, that the plague had broken out in Bombay.[52] Viegas, despite his considerable reputation, did not belong to the Indian Medical Service (IMS),[53] at the time still largely the preserve of white colonial officers (Kirtikar was an exception). It is against this backdrop that his work, as well as that of other native practitioners of Western medicine who did not belong to the IMS, became so important, as did that of Indian supporters of, for example, the Aga Khan, who were in charge of an inoculation station from March to December 1897.[54] One particularly influential figure was Khan Bahadur Dr Sir Nusserwanji Choksy (1861–1939), the physician responsible for the Arthur Road Hospital and the Mahratta Hospital, who through four epidemic outbreaks of the plague would garner the largest clinical experience of the plague in Bombay, with over 4,000 cases.[55] He conducted experiments using eight different vaccines developed by Yersin and Roux, Haffkine and Lustig, as well as others by Terni, Tavel, Palthauf, Brazil and Kitasato, with regular reports sent to *The Lancet* and *The British Medical Journal*. These studies represented 'an important yet little known instance of bacteriological investigations in India, both for its international implications as well as for local factors'.[56]

Part of the issue with the British standing at some point of remove from bacteriology was that it was largely seen as the preserve of continental Europeans, in particular, the French and the Germans. However, what was largely denied in Britain became permissible in British India at the turn of the twentieth century, namely the formation of Pasteur Institutes in various places across the country, from Coonoor to Kasauli, Calcutta to Rangoon. These, along with establishments of government, be it the short-lived Imperial Bacteriological Laboratory in Poona, later shifted to Muktesar (1890), or the still existent Calcutta School of Tropical Medicine (1921), pointed to colonial crucibles of experimentation, where case studies aplenty presented themselves with such outbreaks as the Plague or the Great Influenza. In the years between 1900 and 1914, the Government instituted a number of agencies that would dominate Indian medical research for decades, such as the King Institute in Madras (1904) and the Central Research Institute in Kasauli (1906), the same year in which the Bacteriological Department (later known as the Medical Research Department) came into being. In 1911, the Indian Research Fund

52 Kalpish Ratna, *Room 000: Narratives of the Bombay Plague* (New Delhi, 2015), 24-5.
53 Significantly, neither was Haffkine.
54 Ramanna, 'The Haffkine Institute', 567.
55 Ratna, *Room 000*, 153.
56 Chakrabarti, *Bacteriology in British India*, 53.

Association (IRFA) was established for the recruitment and training of medical researchers as well as a conduit for funding both from the government and from private philanthropists. From 1913 its research appeared in the *Indian Journal of Medical Research*, which itself came to be widely regarded for the publication of pioneering research on cholera, hookworm, kala-azar, malaria and the plague. In the meantime, work proceeded at the Plague Research Laboratory in Bombay (1899). With concerted state support, research soared, a significant case in point being the work of W. G. Liston (1872–1950), who made rapid strides in the study of plague in Bombay.[57]

The Royal Institute of Science

As mentioned earlier, the Royal Institute of Science was inaugurated in 1920 (17 years after its actual founding) by Sir George Clarke, first Baron Sydenham of Combe (1848–1933), Governor of Bombay, with the mission of imparting scientific knowledge to Indians; a Principal and other members of staff were appointed.[58] In the interim (by 1915), the buildings had been constructed through financial support obtained even earlier,[59] although the demands of war saw them being utilised as a makeshift hospital.[60] This pecuniary support was forthcoming through private funding from Sir Cowasjee Jehangir (Rs. 400, 000), Sir Jacob Sassoon (Rs. 1,000,000) and Sir Currimbhoy Ibrahim (Rs 450, 000),[61] representing respectively three religious mercantile groups in the city – Parsi, Jewish, and Ismaili, despite the fact that the institution itself fell under the purview of the government.[62] An eminent alumnus was Homi Bhabha, who entered Elphinstone College at the age of 15 after finishing his Senior Cambridge, and went on to conduct research at the Royal Institute of Science until 1927. As a pioneer institution of modern scientific research, well equipped for the prosecution of both undergraduate and postgraduate research (especially in Physics, Chemistry, Zoology and Botany, with

[57] Arnold, *Science, Technology and Medicine in Colonial India*, 144-5.

[58] 'XXI Royal Institute of Science, Bombay' in *Bombay University Calendar, 1928-29 and 1929-30* (Bombay, 1931), 101-3.

[59] Nasir Tyabji, 'Exemplar of Academia-Industry Interchange', 944.

[60] *Bombay University Calendar*, *1928-29 and 1929-30*, 101.

[61] This entry in the *Bombay University Calendar* indicates the relative amounts of emolument afforded by each individual. Sir Currimbhoy Ibrahim specifically mandated that 1 out of the 450,000 rupees was to be reserved for 'Mohamedans attending the institution'. The establishment of the institutional library was supported to the tune of Rs 250,000 by Sir Vasanji Trikumji Mulji, while 500,000 rupees were promised by the Government from Provincial Funds.

[62] Kenneth X. Robbins and Pushkar Sohoni, *Jewish Heritage of the Deccan* (Mumbai, 2017), 41.

training for M.Sc. students in German as well),[63] it was assimilated into the University of Bombay as the latter sought to have an active research programme that matched its teaching mandate,[64] even if it was still held somewhat at bay by the principal objectives of the University.[65]

It is important to recognise that at the time of the inauguration of the institution, much of the administration in other governmental establishments, at least at middle levels, was beginning to pass into native hands, not least because of 'white flight' back to the United Kingdom, following World War I. There was also a recognition on the part of some colonial workers that the transition was not only inevitable but essential, and attention was therefore paid towards careful recruitment of promising native workers. One significant example was the Zoological Survey of India (established in 1916), where the founder-director (also at the time, the Superintendent of the Indian Museum in Calcutta), Thomas Nelson Annandale (1876–1924), rendered yeoman service in this regard. Early impetus for such a turn would be found before the onset of the Great War, however, through the Minto-Morley reforms that culminated in the Indian Councils Act of 1909, where the term 'Indianisation' began to gain currency and which proved to be the 'first notable step in Indianising the political system'.[66] By 1916, as a consequence of the Report of the Islington Commission (1912–1915), the Indian Industrial Commission was established under the Presidency of Thomas Holland (1868–1947), formerly the director of the Geological Survey of India, which emphasized the development of local artisanal and industrial education.[67] It is of particular note that in the same year that the Royal Institute of Science opened its doors, the Institute of Engineers (India) also came into being, where guiding principles urged it to 'welcome engineers, both public and private, and to endeavour to meet the increasing needs of Indians to participate in

[63] *Bombay University Calendar*, 102.

[64] An early Principal and a professor of organic chemistry, Dr A. N. Meldrum, was a known proponent of both undergraduate training and active research at the Royal Institute of Science. Please see Royal Society of Science, *Nature*, 142 (1938), 786.

[65] The Second Report of the Royal Institute of Science for 1926-34, noted that in light of the fact that in that period, the total number of papers was 128 and the number of approved M.Sc. theses, it would, in order to 'make further progress in the same direction it would be necessary. . . (1) gradually to discontinue the undergraduate teaching which takes up at present 50 per cent (2) to create a number of bursaries so that the holder may become self-supporting and work after taking the M.Sc. degree for the Ph.D. and D.Sc. degrees of the Bombay University.' Please see 'Report of the Royal Institute of Science 1926–34', *The Journal of the University of Bombay*, 4 (1935), 237.

[66] Aparajith Ramnath, *The Birth of an Indian Profession: Engineers, Industry, and the State, 1900-47* (New Delhi, 2017), 30.

[67] Ibid, 51.

professional meetings and discussions'.[68] Only a year later (1921), the private enterprise TISCO (Tata Iron and Steel Company Limited) would establish an in-house training centre for its native employees, the Jamshedpur Training Institute.[69] The point of interest here is that the Royal Institute of Science was therefore a product of its time, where the tide was ineluctably turning towards the training of Indians in practical terms, and where it gradually became proper to consider that native minds were not merely capable, but well-equipped to conduct sustained research.

The Prince of Wales Museum

In 1904, a group of citizens of Bombay, such as Sir Pherozeshah Mehta, Justice Badrudin Tyabji, Narotamdas Gokuldas, Justice Chandavarkar, and Sassoon J. David, decided that the visit of the Prince of Wales to India would be celebrated with a public museum named in his honour. Accordingly, the following year, the foundation stone for the museum was laid by Edward Albert, the Prince of Wales, but it was only in 1923 that the museum building was officially opened by Lady Lloyd, wife of Sir George Lloyd, Governor of Bombay (1918–1923). Bombay was the only Presidency city not to have a large public museum, while the Indian Museum in Calcutta and the Government Museum in Madras were drawing large crowds.[70] A marker of modernity, the public museum was much desired, and while Bombay had the quintessential industrial arts museum in the form of the Victoria and Albert, a universal museum was lacking. In addition, there was a shortage of display and storage space in the city to accommodate the works of art at the J. J. School of Art and also the rapidly increasing number of antiquities and finds of the Western Circle of the Archaeological Survey of India.[71] Very early on, there was a suggestion put forth by Mr. H.M. Phipson, honorary secretary of the Bombay Natural History Society (BNHS), that the site should have three components, a Museum of Art and Archaeology, a Public Library, and a Natural Science Museum – he made these recommendations in his capacity as a member of the museum committee in 1906.[72] In accordance with such a plan, the burgeoning collections of the BNHS were transferred to the new Prince of Wales Museum, an example of the efforts of individuals involved

[68] Ibid, 72. [69] Ibid, 204.

[70] Tapati Guha-Thakurta, *Monuments, Objects, Histories: Institutions of Art in Colonial and Post-colonial India* (Ranikhet, 2004), 80.

[71] S.F. Markham and H. Hargreaves, *The Museums of India* (London, 1936), 111.

[72] *The Bombay Natural History Society, 1883-1933*: Printed in *Commemoration of the Golden Jubilee of the Society, 1933* (Bombay, 1934), 10-11.

in two or more institutions. But several other collections and bequests changed the nature of the museum completely. The building was partially funded by Sir Jacob Sassoon and Sir Ibrahim Currimbhoy. Artefacts were also transferred from other institutions such as the defunct Poona Museum, the Royal Asiatic Society and the Anthropological Society.[73] Sir Dorabji Tata and Sir Ratanji Tata along with several other patrons donated their entire art collections. Very soon, the Prince of Wales Museum became the centre of a number of educational programmes and publishing activities. The illustrious curators of the museum included a mix of British and Indian scholars, well in keeping with the pattern that was common in India after World War I. Despite changes in name, the museum remains one of the few places in the region where original scholarship on art and the history of art continues. The collections serve at least a dual purpose, to educate the masses and as an archive and repository for scholars.

Imbricated Institutions

Many of the institutions described above shared personnel and other resources, in many cases one being born out of the other. Three examples of such intertwined institutional histories illuminate this point. Perhaps the single most important contributor to zoological and geological aspects in the *Journal of the Bombay Branch of the Royal Asiatic Society* was Henry John Carter, Assistant Surgeon in the Medical Service, Bombay Establishment, who was responsible for the first original paper in zoology of some significance in the *Journal*: 'Observations on the Sindh Musquitoe'; four years later, an article that he penned on the freshwater sponges of Bombay would appear in its pages as well.[74] The author of *Geology of the Island of Bombay* (1852), *Summary of the Geology of India* (1854), and *Geological Papers on Western India* (1857), he would eventually receive the Royal Medal of the Royal Society in 1872.[75]

Although there was little elucidation of habit, classification or physiology by 'native' Indians in local scientific journals during most of the 19th century, there was at least in Bombay the supply for their dispensation through the financial support of Mr. Juggurnauth Sunkersett [Murkute].

73 S.F. Markham and H. Hargreaves, *The Museums of India* (London, 1936), 111.

74 H.J. Carter, 'Observations on the Sindh Musquitoe, By H.J. Carter', *Journal of the Bombay Branch of the Royal Asiatic Society*, 1/7 (1844), 430-4. Described by the author as the same species as the 'sandfly' as named by the Europeans, a taxonomic description was provided, along with diagrams. H.J. Carter, 'A Descriptive Account of the Fresh-water Sponges in the Island of Bombay, with observations on their Structure and Development', *Journal of the Bombay Branch of the Royal Asiatic Society*, 3.1/12 (1848), 29-50.

75 D.G. Crawford, *History of the Indian Medical Service* (London, 1914), 148.

Seven years later, Sunkersett's financial contribution to the cause of natural history was made known in a eulogy.

> Mr Sunkersett's connexion with this Asiatic Society had existed for twenty years, . . .he was the third native gentleman who entered it. Though he had not directly contributed to its researches (and this was not expected of him) . . .he had greatly enlarged its library in an important and attractive department, that of Natural History, by his presentation to it of five thousand rupees, which had enabled the Society to purchase the beautiful volumes (bearing his name) now exposed to view in the Society's rooms.[76]

It is interesting that the records of native input at the time related to purely pecuniary matters. The sentiment enshrined in the passage above is revealing—the fact that even the third native gentleman who had entered the society was not expected to contribute to the researches themselves. Ray Desmond draws attention to this fact relating to Indian academic scholarship contending that it was the 'paucity of educational facilities and colonial proscriptions that deprived students of the advantages of western culture, especially in science and technology', while he attempts a partial refutation by suggesting that 'although the criticism is not without substance, there were enlightened Europeans who promoted the cause of Indian education.[77] If such enlightenment, however, did not extend to the expectation of actual research, the question must perforce be begged. Lieutenant Colonel K. R. Kirtikar (1849–1917), surgeon in the Indian Medical Service and distinguished botanist, would himself read a paper on the *Progress of Natural History over the Last Century* in 1905 to the Bombay Branch of the Asiatic Society. The sensibility inhering in Kirtikar's narrative was clear. There was a decided vector of knowledge transfer and it was European. The response was to be, in his view, just as obvious—fawning gratitude. It was precisely such a perspective that would mark the conduit of the negotiation of knowledge on natural history at this juncture. Such a conduit that would inflect the training of an increasing number of Indians in the field through the development of the Zoological Survey of India, *The Fauna of British India* series and of the oldest and still extant organisation devoted to the subject that occurs in its eponymous title, The *Bombay Natural History Society*.

Another thread that tied institutions together related to the sharing of office-bearers. For example, Sir George Birdwood was simultaneously the Secretary and Curator of the Government Central Museum, the Secretary

[76] Anonymous, 'Appendix: Eulogy to the Honorable Juggernauth Sunkersett', *Journal of the Bombay Branch of the Royal Asiatic Society,* 8/24 (1872), lxxix–lxxxiii.

[77] Ray Desmond, *The European Discovery of the Indian Flora* (Oxford and London, 1992), 188.

of the Agricultural and Horticultural Society of Western India, the Honorary Secretary of the Bombay Branch of the Royal Asiatic Society, the Sheriff of Bombay, and the Registrar of the University of Bombay, in the 1860s. Crucially, he was an early advocate for the training of Indians so as to fit them for positions of authority in administrative service.

The extraordinary circumstances in Bombay where the University did not engage in research, nor even teaching (this was delegated to pre-existing colleges) in the first fifty years of its existence, lent unique significance to independent and subscription-based societies and institutions in the production of knowledge. The enterprising and remarkable personalities who shaped several of these institutions in an imbricated manner comprised Europeans and Indians, the latter rising in numbers in the first half of the twentieth century. Bombay itself, already the mercantile capital of India as a consequence of both the Second Opium War (1856–60) and the U.S. Civil War (1861–65), became increasingly connected with a larger world in which men of letters and technology circulated freely. While there remained a strong British presence, it must be noted that several other Western presences found themselves in Bombay, such as Mark Twain and the Fisk Jubilee Singers from the U.S.A. The city also became the site of early adoption of technological advancement, particularly ship-building and elements of mass media: photography, printing and cinema. Thus, Bombay established itself as a crucial node in the story of networks of international knowledge systems.

Contrasting Characters

We examine here the lives of two pioneering scientists in India, educated in different centuries. One was of English extraction, born in India, educated in England, only to return to India for much of his working life. The other was Indian, educated in both India and England, and worked in India for the rest of his life. Their training across continents did not prevent either of them from being larger-than-life individuals in their respective areas of influence. Their interests encompassed much wider domains than those of their formal training. Although owing to a statement he made towards the end of his life that plunged him into notoriety and has afforded him a reputation of an arch colonial figure, Sir George Birdwood was deeply rooted in the culture of the Indian subcontinent.[78] Homi Bhabha,

[78] At a meeting where Sir George Birdwood was chairing the proceedings of the Indian Section of the Royal Society of Arts, on the 13th of January, 1910, he stated that in all of his experience of seventy-eight years, he was yet to find an example of fine art in India. In relation to a photograph drawn to his attention of an image of the Buddha, he declared, 'This senseless similitude, in its immemorial fixed pose, is nothing more than an uninspired

by contrast, had an upbringing, education and access that were essentially European, even if situated in India. His family had the resources so that he was trained at the best of institutions. The paradox could not be starker!

Sir George Birdwood

Polymath and translocate,[79] Sir George Birdwood was born in Belgaum in 1832.[80] His father retired as a general in India in 1877, having served for 52 years, of which 45 were in India. At seven, he was sent to England to study at the New Grammar School, and eventually to the University of Edinburgh, where he became a physician in 1854.[81] He returned to India a year later, and established himself not only in medical and military circles, but also in the cultural affairs of Bombay. As noted earlier, he served several institutions at the same time, shaping new fields and conducting original research. Birdwood presented the results of his investigations in learned societies in whose development he had a seminal role to play. He was fierce in his advocacy of admitting Indian scholars and researchers, many of whom he mentored, to these bodies.

Homi Bhabha

Lionised as the father of the Indian nuclear programme, Homi Bhabha grew up in an affluent Parsi family in Bombay.[82] He attended the Cathedral and John Connon School where his love of science was fostered, as he himself wrote in a letter to C. H. Hammond, the former Headmaster of

brazen image, vacuously squinting down its nose to its thumbs, and knees, and toes. A boiled suet pudding would serve equally well as a symbol of passionless purity and serenity of soul!' See George Birdwood, *Journal of the Royal Society of Arts*, 58 (1910), 287.

[79] One of us (Mathew) has denominated the 'translocate', as a European expatriate whose working life was in major part or wholly devoted to work in the colonial world (in this case, India) Mathew adopts the term 'translocate', if in somewhat modified form, from classical cytogenetics, where during crossover in the first meiotic phase of reproductive cell division there is exchange of chromosomal material in a process known as translocation. The result is an altered chromosome, possessed of a significantly different character from its original form. See John Mathew, 'To Fashion a Fauna for British India', PhD thesis, Harvard University, 2011. The translocate is a subset of the expatriate, but assumes an inflection of specialization, where his or her action is actively directed towards the accrual of information and where he/she mediates the flow of knowledge between systems that at first glance may appear to be incommensurable.

[80] Luois Mallet, 'Sir George C.M. Birdwood: His Life and Work', in *Journal of Indian Art and Industry*, 8 (1900) 45-7.

[81] Gupchuk, *Sir George Birdwood*, 2.

[82] B.S. Kademani, *Scientometric Portrait of Homi Jehangir Bhabha: The Father of Indian Nuclear Research Programme* (Mumbai, 2009).

the school.[83] His father's sister was married to Dorabji Tata, son of the pioneer industrialist Jamsetjee Tata, and it was at their house where he spent a considerable amount of his childhood that he saw the alliance between industrialists and nationalist politicians being forged.[84] He passed his Senior Cambridge exam before he was sixteen, in 1924, and thus was ineligible for any college abroad; he therefore enrolled in Elphinstone College and then later simultaneously at the Royal Institute of Science in Bombay. The American physicist Arthur Holly Compton gave a speech at the Institute in 1926 (the year before he won the Nobel Prize), introducing the young Bhabha to cosmic rays.[85] The very next year, Bhabha left for Cambridge and embarked on his illustrious career.[86] The importance of that one year at the Royal Institute of Science for Bhabha is best described in his own words: 'The fine location of the Royal Institute of Science, its handsome building and the enthusiasm of some of the members of the staff made it a real pleasure to work there. The one year I spent studying there before I left for Cambridge was a very happy one. I remember that it was in the main lecture hall that I first heard of cosmic rays, the subject which was later to become my own special field of study.'[87]

[83] Spenta R. Wadia, 'Homi Jehangir Bhabha and the Tata Institute of Fundamental Research' in *Homi Jehangir Bhabha on Indian Science and the Atomic Energy Programme: A Selection* (Mumbai, 2009), 10-24, esp. 11.

[84] Indira Chowdhury and Ananya Dasgupta, *A Masterful Spirit: Homi Bhabha* (New Delhi, 2010), 20.

[85] Ibid, 23.

[86] At Cambridge, by studying for the Tripos of Mechanical Sciences and that of Mathematics, he was thoroughly brought up to date with questions in applied and theoretical mathematics. Under Paul Dirac's direct supervision and working with the eminent physics at Cambridge's Cavendish Laboratory who were at the forefront of bringing latest findings in theoretical physics to terms with experimental realities, Bhabha was steeped in the cutting-age experimental nuclear physics at the time. For this doctoral and post-doctoral work, he was also able, on the Isaac Newton studentship from Cambridge, to collaborate with the leading theoretical and experimental quantum physicists outside Britain, such as Pauli in Zürich, Fermi in Rome, and Bohr in Copenhagen. 'Having secured first-class marks in engineering in 1930, Bhabha began learning theoretical physics just at the time when Cockcroft, Walton, Blackett, Occhialini, and Chadwick were doing important work on the structure of the nucleus in the Cavendish Laboratory. Bhabha published his first physics paper in German in October 1933 in *Zeitschrift für Physik* at age twenty-four. The following year he was elected to the Isaac Newton studentship that enabled him to remain at Cambridge for the next three years, complete his PhD under the supervision of R. H. Fowler, and travel in Europe. During this time, he visited the groups of Pauli in Zurich, Kramers in Utrecht, and Fermi in Rome, then centres for both theorists and experimenters. He also worked in the extremely active institute at Copenhagen that housed Niels Bohr's group'; see Robert Anderson, *Nucleus and Nation: Scientists, International Networks, and Power in India* (Chicago, 2010), 99.

[87] Chowdhury and Dasgupta, *A Masterful Spirit*, 24, reproduces the text of the 'Note on Royal Institute, 12 September 1945'.

Bhabha would come back to India at the beginning of World War II, and by 1945, set up the Tata Institute for Fundamental Research (TIFR). Initially in Bangalore, it moved to Bombay within six months, and fulfilled his desire to establish 'a vigorous school of research in fundamental physics'.[88] The site of the institute was in proximity to the University of Bombay, in order that there would be collaboration with the latter, but that was not to be.[89] In keeping with the university's past of not being involved directly with research, just like his alma mater the Royal Institute of Science, his creation TIFR would also not be imbricated within the university curriculum and structures.

Conclusion

A brief account of the institutional histories of centres of higher learning in Bombay charts a trend of increasing interest in scientific and technological research through the 19th and early 20th centuries. The University of Bombay, unlike its most other peers around the world, was not the locus of original research, nor the production of knowledge, being content with serving administrative functions. The onus of technical apprenticeship and the cultivation of wider interests, therefore, fell to the quasi-academic institutions that have been enumerated here. These institutions produced and were serviced by a cadre of dedicated and self-motivated individuals who took it upon themselves to nurture a spirit of original thought. As access to education and technical training became increasingly Indianized through the first half of the 20th century, it was initially an elite native element that benefited. The University was still, for the most part, curiously absent.

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Indian Institute of Science Education and Research, Pune, India

[88] Wadia, 'Homi Jehangir Bhabha', 14-15. [89] Ibid, 16.

13

A Cradle of Chinese Physics Researchers

The Master of Science Program in the Physics Department of Yenching University, 1927–1941

Danian Hu

Introduction

This chapter examines, for the first time, the development of the Master of Science (MS) program in physics at Christian Yenching University in Beijing[1] and compares its accomplishments with that of its counterparts at Peking and Tsinghua universities. Yenching University ('Yenching' hereafter) was born from the union of four missionary institutions around Beijing between 1915 and 1920.[2] As of 1925, Yenching already ranked among the top ten universities in China, both public and private.[3] Physics instruction appeared to have been available at Yenching from the beginning,

[1] During the first half of the 20th century, the city of Beijing was also referred to in the West as Peking or Peiping. Except for direct quotes from primary sources and institutions' proper names, I refer to the city as Beijing throughout.

[2] Philip West, *Yenching University and Sino-Western relations, 1916–1952*, Harvard East Asian Series (Cambridge, MA, 1976), 34–5.

[3] A study at the University of California in the mid-1920s rated Yenching University 'Class B', meaning that its graduates 'might be permitted to enter graduate schools in the United States without deficiencies'. Only one other mission college and eight government institutions in China received the same or higher rating. See Yoshi S. Kuno, *Educational Institutions in the Orient, with Special Reference to Colleges and Universities in the United States* (Berkeley, CA, 1928), 56; Jessie Gregory Lutz, *China and the Christian Colleges, 1850–1950* (Ithaca, 1971), 202; ZHANG Weiying, WANG Baiqiang, and QIAN Xinbo, *Yanjing daxue shigao* 1919–1952 (A draft history of Yenching University) (Beijing, 2000), 16. In Kuno's ranking, the four top rated 'Class A Universities' were Peiyang, Tang-Shan, and Tsing Hua universities and the College of Agriculture of the University of Nanking; following them were seven 'Class B Universities': Conservancy (or Hohai) Engineering College, The Fourth National Chung-Shan (National Southeastern) University, Nanyang (The First Chiao-Tung) University, the University of Hong Kong, the University of Nanking, Yenching University, and National University of Peking, See Kuno, *Educational Institutions*, 55–6.

Danian Hu, *A Cradle of Chinese Physics Researchers: The Master of Science Program in the Physics Department of Yenching University, 1927–1941* In: *A Global History of Research Education: Disciplines, Institutions, and Nations, 1840–1950*. Edited by: Ku-ming (Kevin) Chang and Alan Rocke. *History of Universities* XXXIV/1, Oxford University Press (2021). © Oxford University Press. DOI: 10.1093/oso/9780192844774.003.0014

because it had previously existed in its constituent missionary institutions. Such instruction at Yenching was first carried out in collaboration with the Premedical School of Peking Union Medical College (PUMC).[4] In 1927, Yenching established the first MS program in physics in China, from which nearly three dozen Chinese students graduated before 1941—more than half of whom would become prominent physics researchers. It was this MS program that transformed the Yenching Department from a largely premedical training center serving the PUMC into a prominent cradle of physics researchers in Republican China. This Yenching Department, despite its small faculty and brief existence, nurtured many eminent Chinese physicists, which reveals significant but often overlooked Western contributions to Chinese science in the early twentieth century through missionary colleges alike.

Paul Anderson and the Inauguration of the Master of Science Program

In the early years, there were only a few students enrolled in the Department of Physics at Yenching University, whose mission was to prepare premedical students for the PUMC. It was not until 1922 that the department produced its first Bachelor of Science (BS). Physics enrollment remained scant in the 1920s. Between 1922 and 1929, a total of only nine students received their BS degrees in physics at Yenching.[5] A significant transformation, however, began during 1925–1926 as a result of the closure of the Premedical School of the PUMC and the change of the department's leadership.

In 1917, the PUMC established its own Premedical School because other schools in China were unable to supply qualified applicants with adequate scientific training. By the summer of 1925, the science departments at Yenching and other colleges and universities in China had made so much

[4] The PUMC, established in 1915 and funded by the Rockefeller Foundation, was designed to promote modern medical education in China and went on to become 'the most famous medical education and research center' in not only China but 'all of Asia'. Qiusha Ma, 'The Peking Union Medical College and the Rockefeller Foundation's Medical Programs in China,' in William H. Schneider (ed.), *Rockefeller Philanthropy And Modern Biomedicine : International Initiatives from World War I to the Cold War* (Bloomington, 2002), 179.

[5] These statements are based on my study of the following: *Yanjing lixueyuan xiaoyou xiaoxi* (Yenching's School of Natural Sciences Alumni News) (Beijing, 1934), deposited at Peking University Archives in Beijing, China, 15–16; *Wuli xuexun* (Physics News, the Department of Physics and the Physics Club of Yenching University) 8 (1940). *Yenching University Bulletin, Directory of Faculty and Students* in relevant years; and Chieh-san LIU's thesis deposited at Peking University Library. It was previously claimed that CHOU Chi-yun 周啟運 earned her BS in this department in 1925; see PAN Yongxiang 潘永祥, WU Ziqin 吳自勤, and FAN Shulan 范淑蘭, '*Yanjing daxue wuli xuexi shigao*' (A draft history of the Physics Department at Yenching University), *Wuli* (Physics), 22/8 (1993), 494. But her BS was actually in mathematics (see the *Alumni News* above, 18).

progress that they could replace the primary function of the Premedical School. As a result, the China Medical Board of the Rockefeller Foundation decided to close the Premedical School and turn it over to Yenching in 1926 when the latter began to move to its brand new and greatly expanded campus near the imperial Summer Palace (in the west suburb of Beijing). The merger, which included the transfer of the complete library and entire collection of equipment and apparatuses of the Premedical School to Yenching University, was another significant and substantial boost to the development of Yenching's department of physics. Moreover, at least one physics faculty member of the Premedical School, D. K. Yang, found his new academic home at Yenching.[6]

In January 1926, Corbett, who was on furlough in America, unexpectedly resigned from both the University and his mission. [7] Paul Alexander Anderson (1898–1990), who came to Yenching in 1925 and was serving as the department's acting chairman while Corbett was away, succeeded the latter. Born in Chicago on November 26, 1897, Anderson earned his Bachelor degree at University of Illinois in 1920. He then spent one academic year (September 1920-June 1921) at University College in London before attending Harvard University in fall 1921. While studying at Harvard, Anderson also began to work at Eastman Kodak Company Research Laboratory in July 1923. In June 1925, he received his Ph.D. in physical chemistry at Harvard, supervised by Theodore W. Richards, winner of the Nobel Prize for chemistry in 1914. Upon receiving his doctorate, Anderson left Eastman Kodak Company in July and accepted the joint appointment of Yenching University and Rockefeller Foundation. Arriving at Yenching with his wife, Anderson was initially appointed as an 'Instructor in Physics' and 'Acting Head' of the department of physics, who became the department's full 'Chairman' in 1927.[8]

[6] Dwight W. Edwards, *Yenching University* (New York, 1959), 161. The merger could have taken place as early as the summer of 1925 when the Premedical School was closed, Mary E. Ferguson, *China Medical Board and Peking Union Medical College; a chronicle of fruitful collaboration, 1914–1951* (New York, 1970), 39. The transfer of the library and equipment: MENG Chao-Ying 孟昭英, 'Yanjing daxue wulixi de bianqian' (The evolution of the Department of Physics at Yenching University), *Wuli*, 11/11 (1982), 653.

[7] Archives of the United Board for Christian Higher Education in Asia, RG 11, 324–4957, Special Collections, Yale Divinity School Library, New Haven, CT. Reactions of Stuart and the Mission to Corbett's resignation: Smith and Corbett, 75.

[8] For sources of Anderson's biographical data, see: NAS Archives, NRC Rockefeller Fellowships, Fellowship Applications, Paul Alexander Anderson, 1929–31. Deposited at National Academy of Sciences, Washington, D.C., U.S.A. Cheryl Gunselman, the manuscripts librarian at Manuscripts, Archives, and Special Collections Washington State University Libraries, e-mail message to author, 4 August 2016; National Research Council (U.S.), *National Research Fellowships, 1919–1944: Physical Sciences, Geology and Geography, Medical Sciences, Biological Sciences* (Washington, D.C., 1944), 25; Sabrina Zearott, '95 Years of Physics: The Department, Its Leaders, And The Research That Helped Make It

Figure 13.1 Paul A. Anderson in 1924. (Special Collections, Divinity Library, Yale University, The United Board for Christian Higher Education in Asia Records, RG 11, 421-5927, 7201)

Under Anderson's leadership, the department began to reform. As Corbett predicted, 'Progress [in the physics department] will be more rapid under the younger and better trained men.'[9] Along with other science departments at Yenching, the Department of Physics attempted 'to extend its scientific work beyond the premedical level, offering additional courses and engaging in important research.'[10] Anderson expanded Yenching's physics curricula with new courses such as thermodynamics, advanced electricity and magnetism, direct-current electrical measurements, mathematical methods in physics, and modern developments in physics.[11]

Anderson was a passionate practitioner and promoter of physics research who believed that research was not merely 'part of the graduate training process' but also 'a normal activity for any trained physicist or physics professor'.[12] Under his leadership, the department raised the bar for the

Great', *Physics Matters - Washington State University Department of Physics & Astronomy*, 17 (2014), 22–5. Anderson's dissertation was titled 'I. The Electrochemical Behavior of Liquid Barium Amalgams. II. The Activity of Hydrogen Desorbed from Platinum and Palladium' (http://id.lib.harvard.edu/aleph/003739931/catalog, accessed on 1 August 2016). Anderson's appointment at Yenching, see *Colleges of Arts and Sciences: Announcement of Courses, 1925–26*, *Yanjing daxue xuebao* (hereafter Yenching University Bulletin), vii.21 (Beijing, 1925), 46; *Announcement of Courses 1927–28* (note 4), 54; Pan, Wu, and Fan, 'A Draft History of the Physics Department', 494. *Yenching University Bulletin*, x.21 (Beijing, 1927). I used the copy of *Yenching University Bulletin* in Special Collections, Divinity Library, Yale University, The United Board for Christian Higher Education in Asia Records, RG 11, 308-4745, x–xi.

9 Archives of the United Board for Christian Higher Education in Asia, RG 11, 324-4957, Special Collections, Yale Divinity School Library, New Haven, CT. January 8, 1926.

10 Edwards, *Yenching University*, 161.

11 *Announcement of Courses, 1927–28*, 55.

12 Zearott, '95 Years of Physics', 24.

awarding of BS degrees in physics, stressing 'original investigation'. To receive the BS degree, Anderson decreed that students not only should earn a certain number of credits in physics, mathematics, chemistry, and sociology, but must also complete a thesis that comprised 'a simple original investigation and the preparation of a bibliography and historical resume of previous work in the field, with practice in the use of the original literature'.[13] Correspondingly, Anderson launched 'Senior Thesis', a new course required for undergraduate students in the physics major, during the 1926–27 academic year. In this course, Anderson encouraged students to prepare '[a] historical and critical resume of some branch of physics, a careful redetermination of an important constant, or a simple original investigation, as decided in conference with the staff'.[14]

In 1927, Anderson established a Master of Science Program in physics—the very first such program in the country.[15] To earn the new MS degree at Yenching, the students needed to demonstrate their 'ability in original investigation'. This ability was 'construed as including: (1) a thorough understanding of the method fundamental to all scientific research; (2) the necessary command of experimental technique, and especially (3) initiative in carrying forward a problem without the detailed direction of the instructor. The ability to translate scientific German at a practicable rate [was] also required'.[16] To help students meet the new requirements, he offered another new course, 'Graduate Research,' with two objectives: to direct 'graduate students with the necessary training' to 'undertake original work', utilizing the department's facilities of equipment; and 'to teach the fundamentals of method and technique' to those without research experience.[17] Anderson's first graduate student, Pei-hsiu WEI, earned his Master's degree in 1929 with a thesis titled 'Chemical Decomposition of Silver Oxide by Slow Electrons', in which Wei attempted to determine the critical electron velocity or energy for decomposition of a silver oxide film. Anderson had suggested the problem to Wei and recommended the method used in this thesis.[18]

[13] *Announcement of Courses 1927–28*, Curricula, xi.

[14] *Announcement of Courses, 1926–27*, 44.

[15] Pan, Wu, and Fan, 'A Draft History of the Physics Department', 494; DONG Guangbi, *Zhongguo xiandai wulixue shi* 中國現代物理學史 (A history of modern physics in China) (Jinan, 2009), 5.

[16] *Announcement of Courses 1927–28*, Curricula, xi.

[17] Ibid., 56.

[18] Dong, *Zhongguo xiandai wulixue shi,* 5; Yenching University College of Natural Sciences, 'Statement Presented to the Rockefeller Foundation', October 1929, in *Archives of the United Board for Christian Higher Education in Asia, RG 11, 64A-843*, deposited in Special Collections, Yale Divinity School Library, New Haven, CT, 55; WEI Pei Hsiu 魏培修, 'Chemical Decomposition by Slow Electrons' (M.S. Thesis, Yenching University, 1929), 1, 22, 23.

Anderson particularly valued experiments in physics education. This special appreciation of experiments soon became a characteristic feature of the department. He worked hard to improve the department's laboratories, constructing many experimental instruments himself, for instruction as well as for research. One of his contributions of long-lasting impact was the machine shop he established in the department. He even trained two mechanics, one for metalwork and the other for woodwork.[19]

In addition to his administrative work, lectures, and responsibility to supervise students' theses, Anderson carried out his own experimental investigations, studying the purification of barium, demonstrating his distinguished experimental skill and bringing advanced apparatuses to the department. In January 1928, he published his research results in a paper titled 'The Electromotive Behaviour of Single Metal Crystals' in *Nature*.[20]

The department was advancing its quality in teaching and research under Anderson's leadership when he unexpectedly resigned from the chairmanship in September 1928—his wife had suddenly died, likely from childbirth, leaving him an infant boy to take care of.[21] Nevertheless, he seems to have continued teaching at Yenching in fall 1928 since his salary arrangements there did not expire until the end of January 1929. This was probably because it was too late to cancel his scheduled courses that fall.[22]

Anderson returned to America at the beginning of 1929 and immediately applied for the prestigious American National Research Fellowships (NRF) in Physics, Chemistry, and Mathematics. By the end of January, he was awarded the annual Fellowship, which was later renewed twice, eventually extending the normal twelve-month NRF tenure to an extraordinary one of twenty-eight months (February 1929-June 1931).[23] While the success of Anderson's application for the NRF reveals the

[19] Pan, Wu, and Fan, 'A Draft History of the Physics Department', 494. Quotes about the training of mechanics: Records of the Council for World Mission, Box 27, 2073, London Missionary Society Archives at School of Oriental and African Studies Library, University of London in London, U.K.

[20] Pan, Wu, and Fan, 'A Draft History of the Physics Department', 494. Quotes about Anderson's experimental study at Yenching: Anderson's 1928 paper: Paul A. Anderson, 'The Electromotive Behaviour of Single Metal Crystals', *Nature* 123/3089 (1928).

[21] NAS Archives, NRC Rockefeller Fellowship Applications, Paul A. Anderson. Anderson's son was born in either August or early September 1928. Mrs. Anderson, named Marion Parker Perrin before her marriage, graduated with a BA from Wellesley College in 1922. (https://newspaperarchive.com/boston-evening-globe-jun-20-1922-p-9/, accessed on June 12, 2018)

[22] Ibid., Anderson had been scheduled to teach five courses in 1928–29 academic year; see Yenching University, *Benke kecheng yilan* 本科課程一覽 (Announcement of Undergraduate Courses) 1928–29 (Beijing, 1928), 47–52.

[23] NAS Archives, NRC Rockefeller Fellowship Applications, Paul A. Anderson.

significance of his investigation at Yenching, the repeated extensions of his NRF clearly attests Anderson's eminence as a young American researcher.

Upon the completion of his NRF fellowship in the summer of 1931, Anderson accepted the appointment at Washington State College in Pullman, Washington, where he chaired the Department of Physics, starting in September 1931, for the next 30 years.[24] In his first ten years at Pullman, Anderson had two distinguished accomplishments: he was the first investigator to achieve ultra-high vacuum conditions ($P < 10^{-11}$ Torr), a feat so extraordinary that it 'could not be measured or reached by other laboratories for 20 years', and he constructed the first electron microscope outside of Germany.[25] Anderson's post-1929 accomplishments characterize him as not only an extraordinarily skillful experimentalist but also an adept administrator—one embraced by his colleagues. One cannot help but wonder how much more he might have done for the development of Yenching's physics department had he stayed there longer. More than half a century after Anderson's departure from China, Meng, now a prominent Chinese physicist, still vividly remembered Anderson as 'a knowledgeable physicist who actively initiated and promoted extracurricular scientific investigations, shepherding and supervising students' research-based thesis work'.[26]

Y. M. Hsieh: The First Chinese Chair in the Physics Department

The unexpected early departure of Anderson was a big loss for the physics department at Yenching, but it also provided an opportunity for Yu-Ming Hsieh to take charge of the department. Hsieh would be the first Chinese to do so in the department's history, and likely sooner than the university intended.[27]

[24] National Research Council Questionnaire, in ibid, and Zearott, '95 Years of Physics', 24.

[25] In his attempts to measure the 'work functions'—the energy required to release an electron from the surface of a metal—of metals in the early 1930s, Anderson achieved the ultra-high vacuum conditions. See Edward E. Donaldson and J. Thomas Dickinson, Pioneering Research on Work Functions in Ultra-High-Vacuum at W.S.U. (unpublished), (Department of Physics and Astronomy, Washington State University, 1998). The quote appears in Zearott, 24. Working with Kenneth Fitzsimmons at WSC in 1935, Anderson constructed this early electron microscope. See 'A Story of Two Washingtons: The Earliest Electron Microscopes in America', https://www.microscopy.org/images/posters/washington.pdf (accessed on 4 August 2016).

[26] Meng, 'The Evolution of the Department of Physics at Yenching University', 653.

[27] In his letter of resignation in January 1926, Charles Corbett had urged Yenching's trustees to consider putting Hsieh or D.K. Yang in charge of the physics department 'as soon as possible'. However, the university apparently did not feel that either of these two Chinese physicists was ready and decided to let Anderson head the department at least for a period of transition. (See Charles H. Corbett to Peking University Trustees, January 8, 1926.)

Born in a poor family and raised by his widowed mother alone in Fujian, China, Hsieh received his early education in church schools. Upon his graduation from Westminster College (培元中學), a secondary missionary school in Quanzhou, Fujian, he was admitted to the North China Union College on recommendation. After earning his B.A. at Peking University[28] in 1917, Hsieh taught physics and mathematics at Westminster College until 1921 when he returned to Beijing at the invitation of Corbett, Hsieh's past physics professor at NCUC.[29] During 1921–1923, Hsieh not only served as an instructor of physics at Yenching, but also took courses in physics and physical chemistry at the Premedical School of the PUMC, an experience that apparently kindled his desire to study physics in America. Corbett, President Stuart, and Howard S. Galt at Yenching strongly supported Hsieh's plan to study in America, as did Mr. Bird R. Stephenson of the Premedical School and Mr. Nathaniel Gist Gee—an adviser to the Chinese Medical Board (CMB) of the Rockefeller Foundation and former science professor of Soochow University. In February 1923, the CMB granted Hsieh 'a fellowship for study of pre-medical subjects in America or Europe for one year beginning approximately August 1, 1923'.[30]

Hsieh began his study abroad at Columbia University in New York City, where he took at least nine courses, eight in physics and one in mathematics, between September 1923 and June 1924, earning an A.M. By February 1924, Hsieh had informed the CMB that he wished to study in America one more year, requesting a renewal of his fellowship. The CMB thus investigated Hsieh's performance at Columbia by interviewing Professors Pegram, Davis, and Webb, with whom Hsieh took courses. All three agreed that Hsieh 'worked hard and [had] done well in all courses' although none of them considered him a man 'of unusual ability'.[31] The request was not approved until late July.

Regardless, Hsieh was determined to study as much as he could while in the U.S. Hence, merely three days after Columbia's Spring Session ended, Hsieh arrived in the University of Chicago on June 14, enrolling in

[28] This was the new Peking University, a predecessor of Yenching, born in 1916 out the union of The North China Union College (Congregational) and the Methodist Peking University. Apparently, Hsieh was initially admitted to the NCUC before 1916 and graduated from the new Peking University in 1917. Edwards, *Yenching University,* 76–7.

[29] It was very likely that Corbett summoned Hsieh, his protégé student, to Yenching in 1921 to help maintain the physics teaching in the department while he was studying at University of Chicago between 1921 and 1922.

[30] 'Hsieh, Yu-Ming', Box 16, Discipline 13: China Medical Board (CMB) Medical Fellowships; Premedical & Miscellaneous Subjects, Chinese, Subgroup 2, RG 10.2, Fellowships, Fellowship Recorder Cards, FA426, Rockefeller Foundation Records, Rockefeller Archive Center, Card #1a. The fellowship includes a stipend of $90/month, tuition, and necessary traveling expenses for Hsieh himself between China and America.

[31] Ibid., Card #2b.

Figure 13.2 Y. M. Hsieh at his desk in Yenching, Oct. 1926. (Special Collections, Divinity Library, Yale University, The United Board for Christian Higher Education in Asia Records, RG 11, 421-5928, 7251).

three physics courses, one and a half months before learning of the renewal of his Rockefeller fellowship for another year. In Chicago, Hsieh was able to take courses with eminent American physicists and mathematicians such as Albert A. Michelson (the first American physicist to win the Nobel Prize in 1907), Arthur H. Compton (1927 Nobel laureate for physics), Henry G. Gale, L.E. Dickson, and G.A. Bliss in the following Autumn and Winter Quarters. Hsieh apparently greatly enjoyed his study in Chicago. Evidence shows that Hsieh had requested no later than January 1925 CMB's permission to extend his study for another year, even at his own expense,[32] arguing that the time given to his study in America was not sufficient to qualify him 'to carry the type of work which [the CMB] wish[ed] him to do at Yenching;' he promised that 'with another year's work he [would] feel thoroughly qualified'.[33] Probably because of Hsieh's request, Corbett inquired of Gale about the former's performance. Gale,

[32] Ibid., Card #3b. [33] Ibid., Card #3a.

who was then not only Hsieh's teacher and the chairman of the Department of Physics, but also the Dean of the Ogden Graduate School of Science at the University of Chicago, told Corbett in February 1925 that he was 'quite favorably impressed by [Hsieh's] ability', performing 'well above the average of the Chinese students [in Chicago]'.[34] Gale's favorable evaluation of Hsieh must have contributed to the eventual approval of the latter's request. Despite their initial reluctance due to the urgent demand of Hsieh's service at Yenching, the CMB eventually approved Hsieh's request to continue his work at the University of Chicago for the 1925–1926 academic year, but without any additional financial support.

Hsieh spent a total of eight quarters at the University of Chicago, during which he took twenty-four courses, audited three more, and completed English and German exams. It is important to note that Hsieh took several courses in mathematics and theoretical physics, including those on relativity and quantum theory, even though his main research interest was in experimental optics. Since June 1925, he had been working diligently in the Ryerson Physical Laboratory for eleven months on his thesis research, which was closely related to Michelson's work concerning the impact of the Earth's rotation on the velocity of light. A few weeks later, he finished writing his dissertation titled 'The Effective Wave-length in White-light Interferometry'. Having passed the final examination for his doctorate on June 19, Hsieh sailed from San Francisco on August 3, 1926, bound for China. Exactly one month after Hsieh's departure from America, the University of Chicago officially conferred him the Ph.D. degree in physics and mathematics.[35]

With systematic modern physics education and research skills gained in the United States, Dr. Hsieh returned to Yenching in fall 1926, just in time for lectures that semester. This newly promoted Assistant Professor (ranking just below Professor at Yenching) resumed his classroom instructions with two courses, one of which, Advanced Optics, was brand new in Yenching's curriculum but had an identical title to a course he took in Chicago. Obviously, Hsieh was eager to pass on to his students what he had learned in America. Hsieh's return strengthened the department in not only class instructions but also scholarly research, making it possible to create the MS program in the department. As a co-founder of this program, Hsieh shared with Anderson the responsibility of directing and supervising the first two graduate students: Wei and Wu. While Anderson mentored Wei,

[34] On H.G. Gale: https://www.lib.uchicago.edu/e/scrc/findingaids/view.php?eadid=ICU.SPCL.GALE&q=Gale,%20Henry%20Gordon (accessed on June 25, 2018)

[35] Yenching University College of Natural Sciences, 'Statement Presented to the Rockefeller Foundation,' 50; Yu-Ming Hsieh, Y.M. Hsieh's Matriculation Records at the University of Chicago.

Hsieh advised Wu. Supported by Hsieh and other physicists at Yenching as well as at Peking and Tsinghua universities, Wu completed his MS thesis titled 'The Rectification of Alternating Current by Crystals with Metallic Contact' in June 1929, in which he attempted to clarify the mechanism of rectification by crystals, important devices for contemporary wireless telegraphy and telephony.[36]

Hsieh, who succeeded Anderson to head the department in 1928, was likewise a diligent educator. He taught various undergraduate and graduate courses, including general physics, analytical mechanics, physical optics (or advanced optics), molecular physics and heat (or kinetic theory of gases), modern physics, advanced experiments, modern developments in physics, and an outline of theoretical physics. Apparently inspired also by his experience in the University of Chicago, Hsieh initiated in Fall 1929 the 'Physics Journal Club' at Yenching, which consisted of all instructors, graduate students, and 'senior students' in the physics department. This Club met weekly to review and discuss the current physics literature. Beginning in Fall 1930, the students mentioned above were required to attend the Club regularly.[37]

Under Hsieh's leadership, the department announced publicly in 1929 that nurturing physics researchers was part of its mission. The Yenching Department of Physics was the first in China to set their sights on training physics researchers domestically. According to this departmental mission statement,[38]

[36] Wu concluded in his thesis that 'the rectifying property of certain crystals may be due to capacity effects and electronic movement, or more briefly, it may be due to a 'Tungar-condenser Effect.' See Ching-huan Wu 吳敬寰, 'The Rectification of Alternating Current by Crystals with Metallic Contact' (M.S. Thesis, Yenching University, 1929), 1–2, 49–50. Wu's thesis research was a great example of collaboration between private Christian Yenching University and two other leading national universities in Peking because Peking University loaned Wu 'the e/m apparatus' which allowed him to carry out the first part of the experimental work and it was Pen-Tung Sah (薩本棟), a physics professor at Tsinghua University, who suggested Wu to conduct this experiment.

[37] 褚聖麟 CHU Shenglin and 吳自勤 WU Ziqin, 'Xie Yuming jiaoshou shilue' (A short biography of Yu-ming Hsieh', *Wuli,* 16/3 (1987), 185; *Yenching University Bulletin, Announcement of Courses, 1927–28*), 55; *Announcement of Undergraduate Courses 1928–1929* (note 21), 51; Yenching University Bulletin, *Announcement of Courses, Graduate Division, 1929–30* (Beijing, 1929), 31; *Announcement of Courses, Graduate Division, 1930–31*, *Yenching University Bulletin*, xii.20 (Beijing, 1930), 39. When Hsieh was at the University of Chicago, there was a 'Physics Club' which was conducted by members of the physics department and met 'regularly for the discussion of the results of research work done in the Ryerson Laboratory and elsewhere'. University of Chicago, *Annual Register, 1922–1923* (Chicago, 1922), 255. The prerequisite for Yenching's 'Physics Journal Club' was two years of courses in physics; students who met that requirement were the so-called 'advanced students' or 'senior students'.

[38] Yenching University College of Natural Sciences, *Announcement of Courses 1929–30* (Beijing, 1929), 44.

> The instructional work in physics is directed toward the following ends: (1) the training of premedical and pre-engineering students for professional study; (2) the training of general students in scientific methods of work and in the understanding of the place of physical science in the modern world; (3) the training of teachers of physics; (4) the training of research workers in physics.

Considering the department's historical connections with the PUMC and the contemporary demands of the Chinese society, one can understand why 'the training of research workers in physics' was of relatively low priority. The new mission, nonetheless, prompted the department to recruit William Band, an energetic young British physicist, as the new instructor for theoretical physics that fall.

Hsieh emphasized experimental work and underscored the cultivation of students' practical ability to operate in the laboratory. In 1931, he offered two more new courses. One was 'Advanced Experimental Optics,' taught concurrently with his 'Advanced Optics'. This new experimental course dealt with 'lens systems, prisms, diffraction phenomena due to single slit, double slit, diffraction grating of the concave reflection types, photometer, refractometer, Michelson interferometer, polariscope and polarimeter'. The other was 'The Teaching of Physics' which offered students not only the 'experience in the preparation of laboratory materials, in the conduct of laboratory work under supervision and in helping professors to set up demonstration lectures for General Physics', but also opportunities for 'making and repairing simple physical apparatus'.[39] In 1933–34, Hsieh was scheduled to teach new courses such as 'Atomic Physics', 'Electron Physics', and 'Spectroscopy', but did not return to Yenching from California until the following year.[40]

Hsieh was an accomplished researcher. Collaborating with William V. Houston (1900–1968) at California Institute of Technology (Caltech), Hsieh completed in 1933 some very significant experiments which 'born directly on the worth of quantum field theory in general and the renormalizability of quantum electrodynamics in particular.' Examining the fine structure of the Balmer lines of hydrogen, Houston and Hsieh found a 'large'—about 3 percent—discrepancy between the theoretical prediction and their experimental results. Based on their 'sufficiently accurate' measurements and inspired by J. Robert Oppenheimer's and Niels Bohr's remarks concerning the widespread ignorance of 'the effect of the interaction between the radiation field and the atom' or self-energy in contemporary

[39] Chu and Wu, 'A Short Biography of Yu-ming Hsieh', 185; College of Natural Sciences, 1931–1932, *Yenching University Bulletin*, xvi.25 (Beijing, 1931), 71, 73.

[40] *Announcement of Courses, Graduate Division, 1933–34*, *Yenching University Bulletin*, xviii.20 (Beijing, 1933), 30–1.

theoretical predictions, they boldly suggested that 'the theory is no longer satisfactory' and attributed the discrepancy to 'the effect of the interaction between the radiation field and the atom [that is, self-energy]'. Houston was the primary investigator in this experiment, who, well versed in theoretical quantum mechanics, likely led the investigation to reach this remarkable conclusion. Unfortunately, the excellent paper of Houston and Hsieh was largely neglected and forgotten for more than a decade until Willis Eugene Lamb (1913–2008) confirmed the same discrepancy with his precise measurement in a newly designed experiment in late 1947. In 1955, Lamb received the Nobel Prize in physics 'for his discoveries concerning the fine structure of the hydrogen spectrum'. The significant contribution of Houston and Hsieh was not recognized until 1986, when Crease and Mann published their study concerning the intriguing genesis of the famous Lamb Shift.[41]

William Band: A 'Mathematical and Practical' Physicist from England

When Hsieh left Beijing in 1932 for Pasadena to work at Caltech, William Band (1906–1993) took over as department chair. Band received his M.Sc. at University of Liverpool (UOL) in 1927, with a master's thesis titled 'An Examination of Professor Whitehead's Theory of Relativity', which was praised by Arthur S. Eddington. According to Eddington, the M.Sc. thesis 'fell only [a] little short of the standard' for an ordinary Ph.D. dissertation

[41] Born in Mount Giliad, Ohio, William V. Houston received a B.A. in physics and a BS in education from Ohio State University (OSU) in 1920. After studying with Michelson, Millikan, and Gale and earning his MS degree at University of Chicago in 1922, Houston returned to OSU and received his Ph.D. in physics in 1925. He was a 1925–27 National Research Fellow, working at Caltech on 'experimental and theoretical study of spectral fine structure'. As a Guggenheim Fellow, Houston also studied in Germany in 1927–28, working with Sommerfeld and Heisenberg successively. Since 1928, he had been on the faculty of Caltech until becoming the second president of the Rice Institute in 1946. (National Research Council (U.S.), 30. Interview of William V. Houston by Gerald Phillips and W. J. King on 3 March 1964, Niels Bohr Library & Archives, American Institute of Physics, College Park, MD USA, www.aip.org/history-programs/niels-bohr-library/oral-histories/4682; 'Biographical Note' in W. V. Houston, 'Guide to the William V. Houston personal papers, 1925–1968, bulk 1941–1968 MS 426MS 426', http://www.lib.utexas.edu/taro/ricewrc/00056/rice-00056.html.) Robert P. Crease and Charles C. Mann, *The Second Creation: Makers of the Revolution in Twentieth-Century Physics* (New York, 1986), 110–28. The quotes appear in pages 110, 113. 'Willis E. Lamb - Facts', Nobelprize.org. Nobel Media AB 2014. Web., http://www.nobelprize.org/nobel_prizes/physics/laureates/1955/lamb-facts.html. Houston as the primary investigator: On Feb. 16, 1933, Hsieh wrote to Rockefeller Foundation, saying that he was doing research under Houston's guidance. ('Hsieh, Yu-Ming', Box 16, RG 10.2, Fellowships, Fellowship Recorder Cards, FA426, Rockefeller Foundation Records, Rockefeller Archive Center, Card #4b.)

in Britain.[42] In 1929, the physics department at Yenching was very happy to hire this 23-year-old teaching assistant at UOL not only because of the shortage of instructing staff in the department after Anderson's departure, but also, or even mostly, because of Band's 'particular qualifications' which 'fit in very well with their needs'.[43] The department needed someone like Band who was able to teach and lead students' research in both theoretical and experimental physics. His thesis on relativity demonstrated his theoretical qualification. Moreover, Band also had substantial working experience in experimental physics. After earning his M.Sc., while serving as a 'Demonstrator' in the physics department at University of Liverpool, he collaborated with A. J. Maddock, a graduate student, in a research on the crystal structure of titanium dioxide (TiO_2) by means of X-rays under the direction of R.W. Roberts, the Lecturer in the department. According to Roberts, Band and Maddock 'very ably carried out' their research which 'proved invaluable to the development of this subject by subsequent workers in this department'. James Rice, Band's M.Sc. thesis advisor, consequently, stated that when Band left Liverpool for Beijing in 1929, 'he was exceptionally well equipped for his age on the mathematical and practical sides of physical science'.[44]

Band arrived in Yenching at the end of September. His arrival greatly helped the physics department both in coping with the growing student enrollment since the late 1920s and in enhancing its graduate education and research. It is said that the department admitted 20 freshmen in 1931 and maintained a similar annual admission rate in the following few years.[45] The increasing number of Yenching's physics graduates in the 1930s, as shown in Table 13.1, indeed indicates the growing undergraduate and graduate student enrollment since 1927. Yenching's physics enrollment, however, fluctuated over the following decade.

At Yenching, Band was a diligent and popular mentor with broad teaching and research interests. During his eleven-year-residence in Beijing, he taught at least 24 different courses, which covered a wide range of subjects

[42] James Rice, Recommendation Letter, August 14, 1934. Special Collections, Divinity Library, Yale University, The United Board for Christian Higher Education in Asia Records, RG 11, 320–4877.

[43] 'J. B. Tayler to W. Band, Peking, March 14, 1929'. 1929. Records of the Council for World Mission, Box 27, Folder 2073, London Missionary Society Archives at the School of Oriental and African Studies Library, University of London.

[44] R.W. Roberts, Letter, July 10 1934; William Band, *Autobiography:* 班威廉 *William Band*, Archives, and Special Collections, Washington State University Libraries, Pullman; James Rice, Letter, August 14, 1934.

[45] Pan, Wu, and Fan, 'A Draft History of the Physics Department', 494–5. The claimed admission of 20 freshmen in 1931 appears to contradict the fact that the department awarded no BS degree in 1935 (see Table 3) when that group of students were scheduled to graduate. It is hard to believe that all these 20 students would have failed to graduate.

Figure 13.3 William Band in traditional Chinese dress standing in apparently his residence at Yenching likely soon after his arrival in China. (Cage 617, William Band Papers. Manuscripts, Archives, and Special Collections, Washington State University Libraries, Pullman, WA.)

from elementary 'college physics' to advanced 'relativity theory' and 'quantum mechanics', from experimental 'premedical laboratory' to mathematical and theoretical 'tensor and vector analysis' and 'statistical mechanics', and from practical and specialized 'meteorological physics' and 'thermomagnetic effect' to metaphysical 'natural philosophy of modern physics'.

It was particularly remarkable for Band, a 24-year-old instructor of theoretical physics, to commence 'The Natural Philosophy of Modern Physics' at Yenching, which must have been the first college course of its kind in China. This seminar began with a summary of the theories of relativity, wave mechanics of the atom, and statistical mechanics and then explored the natural philosophy of Alfred N. Whitehead, Charlie D. Broad, Bertrand Russell, and Arthur Eddington. Band intended to give students in various disciplines 'a grasp of the significance of [modern physics]'. By design, this course was not 'exactly elementary in nature'. Although Band attempted to keep its physics content 'as non-technical as possible', there

Table 13.1 Yenching physics graduates (BS & MS), 1929–1941[1]

	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	Total
BS	2	1	6	5	3	4	0	6	9	6	8	4	11	65
MS	2	0	2	2	2	8	2	3	2	2	0	6	2	33

[1] This table is a result of this author's examination of existing theses of Yenching's physics department deposited in Peking University Library in Beijing, China as well as 燕大理学院 [School of Natural Sciences at Yenching University]; The Department of Physics and the Physics Club of Yenching University, 22–24.

remained 'sufficient difficulty' 'in understanding the philosophical part of the subject'. Band therefore restricted the participants of his seminar to 'mature' or graduate students, who he had personally approved.[46] The seminar was apparently so successful that Band offered it in three consecutive years and a total of four times before 1935. In fact, it attracted not only advanced students but also some professors from other departments. For instance, Dr. Randolph C. Sailer of the Department of Psychology and Dr. Lechung Tsetung HWANG (or HUANG Zitong 黃子通) of the Department of Philosophy attended the seminar. Both of them, according to Band, offered 'many helpful suggestions' and had 'thought-provoking discussions' with the young instructor.[47] Probably partially inspired by the seminar and his discussions with Band, Hwang, then a full professor and the chairman of the philosophy department, later published an essay about Whitehead's theory of space-time.[48]

Between 1930 and 1941, Band also supervised 26 BS and 22 MS theses, which represented respectively 42% and 73% of the total number of relevant degrees the department awarded during that same period. Most of these theses dealt with experimental subjects. Of the total of 48 theses, only seven (14.6%) were theoretical treatises. This demonstrates a peculiar situation in the contemporary development of modern theoretical physics in China.

As a theoretical physicist working in Beijing, Band soon became keenly aware of peculiar local challenges. In his 1933 essay 'Modern Theoretical Physics in China', he discussed the value of theoretical physics in the

[46] *Announcement of Courses, Graduate Division, 1930–31, Yenching University Bulletin*, xii.20 (Beijing, 1930), 39.

[47] William Band, *The Philosophy of Modern Physics* (unpublished manuscript: Washington State University Libraries, Manuscripts, Archives, and Special Collections, Pullman, WA, 1931), 'Foreword'. Band spelled Hwang's name as 'L.T. Huang'.

[48] *Yenjing daxue jiaozhiyuan xuesheng minglu* (Yenching University Directory), 1930–1931 (Beijing, 1930), 5; Lechung Tsetung HWANG 黃子通, 'Huaiheide de shikong guan (Whitehead's view of space-time)', *Zhexue pinglun* (The philosophical review) 6/1 (1935). Hwang was an uncle of Kun HUANG, a famous Chinese physicist, who earned his BS at Yenching in 1941 under Band's direction.

country, the status of the subject in Chinese universities, and the possible ways of improving its instruction in colleges. Band recognized that theoretical physics was then 'one of the most vulnerable to the common criticisms of university enterprises in China' because it 'appear[ed] to be the least connected with the needs of the nation; and advanced work in the subject the least useful of all research'. He admitted that as a subject of research, theoretical physics was actually 'a hobby' instead of 'a vocation' in China and hence had 'a subordinate place in the [university] curriculum'. Nevertheless, he valued the subject as efficient 'mental gymnastics' and for 'its inherent stimulating interest'. More importantly, he argued that the advanced work in theoretical physics could keep China '[in] touch with the progress in other countries' and help 'maintain her position in the world of Science'. After all, Band believed, 'China cannot afford to be always training her progressive physicists abroad!' In conclusion, he observed,

> [T]heoretical physics has not yet come to its own in this country. Probably the natural emphasis on technical science will delay the otherwise inevitable process of growth for some time, but already sufficient original work has been done by Chinese physicists to prove that eventually their breed will be as prolific in theoretical research as the western variety.[49]

By 1934, Band had realized from his experience that many Chinese students had 'a considerable natural aptitude for theoretical work', but there was practically no place in China where they could receive adequate training in theoretical physics. Band therefore planned to spend his prospective 1935–1936 sabbatical leave engaging in advanced theoretical studies at Harvard University 'in order to bring back to Yenching a better stimulus for more complete and proportionate development therein'. Being chiefly interested 'in the philosophical basis of modern theoretical physics', Band wished to set up a 'joint major' where students would study and benefit from both physics and philosophy.[50]

In pursuit of this objective, Band applied for a fellowship from the Rockefeller Foundation, but failed to win one, most likely due to unfortunate timing. It was evident that the Foundation had by then changed its policy on the fellowships in China: no more were being offered

[49] William Band, 'Modern Theoretical Physics in China', *Lingnan Science Journal* 12 (1933), 105–10.

[50] To The Rockefeller Foundation: Application for Fellowship for Advanced Study in Physics at Harvard University, Cambridge, Massachusetts, ca. December 1934. Special Collections, Divinity Library, Yale University, The United Board for Christian Higher Education in Asia Records, RG 11, 320-4877.

for pure sciences.[51] As a result, Band was forced to postpone his sabbatical and left for Cambridge University instead of Harvard in 1936–37, where he studied with Ralph Fowler, Arthur Eddington, Paul Dirac, and Rudolf Peierls. Apparently, Fowler was most influential on Band's later teaching and study: he not only added a new course 'Statistical Mechanics' to Yenching's curriculum but also supervised four theoretical theses in statistical physics, all completed between 1940 and 1941. His popular textbook *An Introduction to Quantum Statistics* was first drafted at Yenching after 1936.[52]

Band never fulfilled his wish to establish a study center for theoretical physics, as the Japanese occupied Beijing and launched the full-scale invasion of China in July 1937. By the late August of 1937 when Band returned to Yenching, many of its faculty and students had already departed Beijing, including both Hsieh and Meng, which left the department with no faculty ranking at either Full Professor or Lecturer. As the head and the sole remaining Assistant Professor in the department during 1937–38 and the only Full Professor afterwards, Band was forced to spend most of his energy and time maintaining the department's normal operation; there was little chance for him to prepare and launch a new program for theoretical physics before he had to flee from Beijing himself at the end of 1941.

Despite the shortage of senior faculty and other hardship in the aftermath of the Japanese occupation of Beijing, Band managed to keep the department running with normal or even above-average productivity in the following four years, as shown in Table 13.2. After returning to China from England, Band supervised at least six students through to the completion of their theses in theoretical physics. By 1940, Yenching's physics department excelled at nurturing researchers who were able to carry out original studies, in contrast with its counterparts in the country. When the Chinese Physical Society convened its 8th annual meeting in Kunming in September 1940, a total of forty papers were presented, of which Yenching's faculty and students submitted twelve (30%) and Band co-authored five—almost half of the contributions from Yenching.[53]

[51] Gunn to Hanson, March 19, 1935, Folder 349, Box 42, Series 601E, RG 1.1, Projects, FA386, Rockefeller Foundation records, Rockefeller Archive Center; Gunn to Mason, August 28, 1935, Folder 349, Box 42, Series 601E, RG 1.1, Projects, FA386, Rockefeller Foundation records, Rockefeller Archive Center.

[52] William Band, *An Introduction To Quantum Statistics* (Princeton, 1955); Willam Band, 'William Band: Interview by George E. Duvall and James L. Park, April 25, 1985', transcript, Archives 202 Box 1, WSU Centennial Oral History Project, Manuscripts, Archives, and Special Collections, Washington State University Libraries, Pullman, WA, 11–12.

[53] The Department of Physics and the Physics Club of Yenching University, 'The Eighth Annual Meeting of the Chinese Physical Society', *Wuli xuexun* (Physics News), 8 (1940), 21; *Zhongguo wuli xuehui liushi nian* (The sixty years of the Chinese Physical Society) (Changsha, 1992), 7.

An Outstanding Cradle of Physics Researchers in China

Within about two decades, the department of physics at Yenching grew from a premedical training center to a prominent cradle of Chinese researchers in the field. The continuous successful development of research programs in Yenching's Department of Physics was due above all to the enlightened leadership of the first four department chairmen and their devotion. Corbett, an American missionary with much passion for but limited scientific training in physics, founded the department. He clearly realized the importance of advancing professional work in the department even though he had no desire to become a professional physicist himself. Hence, he recruited Anderson, a promising young researcher from Harvard, and actively supported Hsieh's graduate study in the United States. Anderson initiated and stressed original research among the students and faculty, both adding a thesis requirement to the Bachelor's degree and launching the first MS program in physics in China. Hsieh actively promoted original experimental researches which often addressed local practical issues in Chinese society. Under Hsieh's leadership, 'the training of research workers in physics' became part of the department's mission in 1929. He also strengthened the theoretical study in the department by recruiting William Band. Band chaired the department between 1932 and 1941 and supervised most of the MS theses in the department. In fact, he probably directed more MS students in physics than anyone else in Republican China. He provided one of the most comprehensive sets of courses in advanced theoretical physics at Yenching and supervised the first master thesis in modern theoretical physics in the country.[54] It is also important to note that Anderson, Hsieh, and Band were all active and accomplished researchers themselves.

The abundant funding and profound educational connections with Western institutions also contributed greatly to the department's success. As noted in the earlier discussions, the Rockefeller Foundation was the leading sponsor for the department. The Foundation handed over the entire Premedical School of the PUMC together with its library and lab equipment to Yenching in 1925 and funded the advanced training of the department's leading faculty such as Corbett, Hsieh, Yang, and Meng. It also sponsored Anderson's and Band's stay at Yenching. Most of these

[54] Band, 'Modern Theoretical Physics in China', 106. Since Band stated that he did not find in 1933 'any master theses written on theoretical topics', H.Y. Hsu's 1934 thesis 'Relativity and Wave Mechanics' became likely the first MS thesis in China concerning modern theoretical physics. (C. C. Wang 王竹溪 at Tsinghua University published a theoretical paper titled 'Turbulent Wake behind a Body of Revolution' also in 1934, but it is not on modern physics.)

faculty and many of their students studied at American universities like Columbia, the University of Chicago, the University of Michigan, Caltech, or Harvard. All these contributions from the Foundation represent only a small part of the deep and widespread American influence on contemporary scientific development in China. The department's connections with its counterparts in Britain also helped create opportunities for its students to receive advanced training there. W. Y. Chang and Y. K. Hsü, two of Band's graduate students, for example, did research with Ernest Rutherford at the University of Cambridge and James Chadwick at the University of Liverpool, respectively.

One of the striking features of Yenching's physics study was its intensive attention to local or practical issues. Of forty-three BS and MS theses completed between 1930 and 1936, twenty (47%) dealt with local or practical problems. Several factors must have contributed to this trait. First, with its motto 'Freedom through Truth for Service,' Yenching actively encouraged its faculty and students to use their knowledge to conscientiously serve local society. Second, Y.M. Hsieh was a believer in John Dewey's pragmatist philosophy in scientific education. Third, the early 1930s coincided with the Rural Reconstruction Movement (RRM) which aimed at reconstructing rural culture, economy, health, and political awareness through education. Both Hsieh and Band clearly shared the ideals of the RRM and were enthusiastic in leading their students to participate in it. Fourth, since the Rockefeller Foundation, a main funding source for Yenching, had turned their attention away from pure sciences to 'practical fields' such as the RRM, it was also necessary for Yenching to take corresponding measures to accommodate its sponsor.

Another outstanding trait of Yenching's physics department was that it nurtured more female physics researchers than any of its contemporary counterparts in China. Yenching awarded a BS to its first female graduate in physics, WANG Ming-chen (hereafter M.C. Wang) as early as 1930. By Fall 1937, at least seven female students had earned their BS degrees at Yenching and two of them, M.C. Wang and WANG Cheng-shu (hereafter C.S. Wang) went on to earn their MS degrees.[55] In contrast, Tsinghua University, the most prestigious national university in the country, produced no female BS in physics until 1936. Merely four women graduated from Tsinghua's physics department before fall 1937, three in 1936 and one in 1937; no woman was ever admitted to that department's graduate

[55] C.S. Wang was known in the West as C.S. Wang Chang because she married W.Y. Chang, another prominent graduate from Yenching, who earned his BS and MS under Band's supervision in 1931 and 1932 respectively.

program before 1937.[56] At least three of the female graduates from Yenching went on to earn their doctorates at the University of Michigan, among whom were M.C. Wang and C.S. Wang, who studied and later collaborated with George Uhlenbeck, making significant contributions to statistical physics.[57]

Indeed, what Yenching's physics department had accomplished was even more striking if we compare it with its counterparts in China. By 1937, there had been established more than 30 college departments of physics in China,[58] of which only Yenching, Tsinghua, and Peking universities set up their MS program in physics before 1936.[59] It is therefore enlightening to juxtapose these three.

Peking, Tsinghua, and Yenching universities were all in the city of Beijing; while Peking University was situated in the city center, the other two were located in a northwest suburb neighboring each other. In the 1930s, the physics departments in these three schools all imitated their counterparts in America. After all, most of their leading faculty were trained in the United States and their daily work was mainly funded by either the refunded part of the American share of the Boxer Indemnity or private American sponsors such as the Rockefeller Foundation.[60] As shown in Table 13.2, Peking University, the oldest national university in the country, was the first to establish a physics department in 1913 and had produced more college graduates (BS) than the combined total number of BS from both Tsinghua

[56] For a complete list of college graduate (BS) in physics from Tsinghua University, see Qinghua daxue xiaoshi yanjiushi (Office for the study of Qinghua University history), *Qinghua daxue shiliao xuanbian* (Selected historical documents of Tsinghua University), 4 vols. (Beijing, 1991), ii.2, 784, 792, 799, 808, 819–20, 825–6, 833, 843–4, 856–7. According to HU Shenghua, there were only nine men earned their Master's degree in physics at Tsinghua before 1947 (adding J.S. Wang who Hu apparently missed). See HU Shenghua 胡升華, 'Ershi shiji shangbanye zhonguo wulixue shi' (A history of Chinese physics during the first half of the 20th century) (Dissertation, Chinese University of Science and Technology, Hefei, China, 1998), 63.

[57] Danian Hu, 'American Influence on Chinese Physics Study in the Early Twentieth Century', *Physics in Perspective* 17/4 (2016), 284–7; M. C. Wang and G. E. Uhlenbeck, 'On the Theory of the Brownian Motion-II', *Reviews of Modern Physics* 17/2-3 (1945); C. S. Wang Chang and G. E. Uhlenbeck, *Transport Phenomena in Polyatomic Molecules* (Ann Arbor, 1951); 'On the Propagation Sound in Monatomic Gases', in *Studies in Statistical Mechanics* (Amsterdam, 1970).

[58] LUO Bingxian 駱丙賢 (ed.), *Wuli jiaoyu shi* (A history of physics education) (Changsha, 2001), 138.

[59] SHEN Keqi 沈克琦 and ZHAO Kaihua 趙凱華 (eds.), *Beida wuli beinian* (Centenary of Physics at Peking University, Unofficial publication (Beijing, 2013), 20; Hu, 'A History of Chinese Physics' (note 53), 73. SUN Hong'an 孫宏安, *Zhongguo jinxiandai kexue jiaoyu shi* (A history of modern science education in China) (Shenyang: 2006), 476.

[60] For the history of the physics departments at Peking and Tsinghua, see Shen and Zhao, *Centenary of Physics at Peking University* (note 57), 17–32; HU Shenghua, 'History of Chinese Physics,' 60–78. For a discussion about the American refund of the Boxer Indemnity, see Danian Hu, 'American Influence on Chinese Physics Study', 275–7.

Table 13.2 The Physics Departments at Peking, Tsinghua, and Yenching before 1937[1]

Name of University	Start of the University	Start of the Department	First BS Graduate	Start of MS Program	First MS Graduate	Total		Senior Faculty in the 1930s
						BS	MS	
Peking	1898	1913	1916	1935	None	221	0	7
Tsinghua	1925	1926	1929	1929	1933	53	2	7
Yenching	1918	ca. 1918	1922	1927	1929	43	22	3

[1] The data on Peking and Tsinghua universities were drawn respectively from Shen Keqi 沈克琦 and 赵凯华, 17–30; Hu Shenghua 胡升华, 60–78; Qing hua da xue. Xiao shi yan jiu shi 清华大学校史研究室, 2 (Part II), 561, 646–647, 784, 792, 799, 808, 819–820, 825–826, 833, 843–844, 856–857.

and Yenching before 1937. However, Yenching was the first to set up a master of science program in physics in 1927. Both Peking and Tsinghua had more than twice as many senior faculty members as Yenching did, and yet it was Yenching that nurtured most MS in physics, i.e. physics researchers, domestically, far more than the other two prestigious national universities did.

It should be added that Yenching produced an additional 10 MS graduates before it was shut down by the Japanese in 1941; Tsinghua eventually awarded another 7 MS degrees, including the two earned by Chen-Ning YANG 楊振寧and Shou-lien CHANG 張守廉, during 1937–1949 while Peking gave out at least one to Kun HUANG 黃昆. It is remarkable that Chang transferred from Yenching to the National Southwest Associate University (NSAU) in Kunming and Huang graduated from Yenching (BS, 1941).

More than a dozen graduates from Yenching's physics department had gone on to earn their doctorates overseas (mostly in America) and grown into prominent physics researchers in China and in their own field. Among these distinguished graduates, eight were late elected CAS Academicians and two were awarded the State Preeminent Science and Technology Award, the highest scientific award issued in the country. Despite its small size, this department became an indispensable cradle that successfully nurtured many excellent researchers for China. Such a great contribution from an American missionary university is remarkable, and certainly worthy of note.

City University of New York

14

Science with Boundaries: Yang Zhongjian and Vertebrate Paleontology in Republican China, 1919–1950

Hsiao-Pei Yen

Introduction

One of the most exciting discoveries in the recent history of paleontology is that of the feathered dinosaur fossils: the Sinosauropteryx, or Chinese Dragon Bird. They were discovered in Liaoning, China by Chinese paleontologists in 1996. Their existence strongly suggests the evolutionary path from dinosaurs to birds. The rapid development of paleontology, especially vertebrate paleontology and dinosaurology, in China since then has made 'Chinese Paleontology' an important subfield of paleontology and China the powerhouse of paleontological research. Giving the fact that there was virtually no Chinese paleontologist at the turn of the 20th century, and that Chinese fossils at the time were discovered and studied solely by foreign scientists, the advancement and development of vertebrate paleontology as a scientific discipline in China over the last century is worth investigating.

YANG Zhongjiang 楊鍾健, also known as C.C. Young (1897–1979), is often praised by students of paleontology as the father of Chinese vertebrate paleontology. According to a dictionary of important scientists, Yang was '[a]lmost single-handedly responsible for generating research in the field of vertebrate paleontology through the century's central decades, [and] also named many of the most iconic dinosaurs from the Mesozoic formations of China'.[1] This chapter explores the formation of Chinese vertebrate paleontology through the lens of Yang's early academic training in China

[1] David Norman, 'Yang Zhongjian' in *Complete Dictionary of Scientific Biography*, 25 (Detroit, 2008), 383.

Hsiao-Pei Yen, *Science with Boundaries: Yang Zhongjian and Vertebrate Paleontology in Republican China, 1919–1950* In: *A Global History of Research Education: Disciplines, Institutions, and Nations, 1840–1950*. Edited by: Ku-ming (Kevin) Chang and Alan Rocke. *History of Universities* XXXIV/1, Oxford University Press (2021).
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and Germany during the 1920s, his field experience in China throughout the 1930s, his independent research during World War II, and his overseas networking. The making of a professional paleontologist in China in the first half of the 20th century provides a non-Western perspective on the entanglement between research training and disciplinary formation. Yang's experience shares a general picture of the establishment of higher education and disciplinary research based on the Euro-American model in non-Western societies, as described in the other chapters. But it also illuminates some specific local variations through factors that were intrinsic to the development of scientific disciplines in China during a time when the rise of Chinese nationalism intersected with scientific internationalism and imperialism. How did the academic practices of paleontology reflect geo-political realities? How were activities of fossil hunting and ownership of pre-historical objects tied to the modern concept of sovereignty and territoriality? How was paleontology seen as a 'local' scientific practice through which a trans-local system of the earth was built?

At Peking University, 1919–1923

Yang enrolled at Peking University in 1919 as a geology major. The geology department was first set up in 1909 when the university was still known as the Imperial University of Peking, China's modern national university founded by the Qing government. After the university was renamed National Peking University in 1912 with the fall of the Qing and the establishment of Republican China, the department, along with the entire college of sciences, was shut down the following year due to lack of funding. It was not until 1917 that the department was re-established.[2] By the time Yang entered the program, there were around 36 students at three different stages, with only two professors,[3] limited resources that students had to compete for, and a curriculum centering on textbooks and lectures without much fieldwork.[4]

As a result of the efforts made by the president of the university, CAI Yuanpai 蔡元培, one of the most influential intellectuals and educators in

[2] For more details of the establishment and development of geology in higher education in China during the time, see WANG Genyuan, 'Zhongguo dizhi jiaoyu shilue' (A brief history of the geological education in China), *Diqiu kexue, Zhongguo dizhi daxue xuebao* (Earth science: journal of China University of Geosciences) 11/2 (1986), 207–15. Also cited in Grace Shen, *Unearthing the Nation: Modern Geology and Nationalism in Republican China* (Chicago, 2013), 222n83.

[3] HE Jie, with a master degree in geology from Lehigh University, USA, and WANG Lie, a graduate from the Freiberg Mining Academy, Germany, taught mining and mineralogy in the department. See Shen, *Unearthing the Nation*, 219n61 and 222n82.

[4] Ibid, 64.

20th century China, two more professors were hired in 1920: LI Siguang 李四光 and Amadeus Grabau. Li was a geologist with a master's degree in geology from the University of Birmingham, and Grabau was an American geologist and paleontologist who was dismissed from teaching at Columbia University for his pro-German attitudes during World War I. While the previous curriculum of the geology program at Peking University focused on the studies of mineralogy and petrology, the new faculty brought in more vibrant dimensions. Besides introducing new courses, such as structural geology (taught by Li), historical geology and paleontology (both taught by Grabau), the newly expanded program was reoriented toward fieldwork as an essential part of geological training.[5] It soon became the best geology department in Asia.[6]

Like many contemporary Chinese students, Yang studied science primarily for the pragmatic benefits at a time when the development of science and technology was deemed to be the key to national prosperity. Yang's choice for geology was not out of any enthusiasm for the discipline. He picked geology among the four available departments in the college of sciences – mathematics, physics, chemistry and geology – due to his lack of interest in math and laboratory work. Moreover, as he later commented, 'geology is an interesting discipline because it keeps one close to nature'.[7] But his attitude toward geology, and later paleontology, would go through a more nationalistic turn when 'nature' became a representation of the 'nation'. Geology, as Grace Shen cogently describes, offered 'a coherent system that located their [the Chinese students] homeland and its material resources within a broader pattern of global history and causation'.[8] And geological, as was the case with paleontological, activities and practices were tied to the legitimate ownership of the land.

With Grabau's new courses, paleontology was introduced to students at Peking University for the first time.[9] He designed a curriculum that systematically familiarized students with paleontological knowledge and

[5] A 1927 course schedule shows that for first- and second-year students, a full day of fieldwork was required each week, in addition to several hours of surveying practice and lab time. Extensive field time was needed during vacations for upper-class students. See Ibid, 69.

[6] Ibid, 68.

[7] YANG Zhongjian, *Yang Zhongjian huiyi lu* (Yang Zhongjian's memoir) (Beijing, 1983), 26.

[8] Shen, *Unearthing the Nation*, 45.

[9] To be sure, paleontology was often taught in the department of geology or biology and did not become an independent discipline in many Euro-American universities until the late 19th and early 20th centuries. See David Polly and Rebecca Spang, 'History of Paleontology', in Brian S. Baigrie (ed.), *History of Modern Science and Mathematics*, 4 (New York, 2002), 69–97.

local variations. Through the 'Agassiz Method',[10] Grabau trained his Chinese students, who had relied too much on memorizing textbooks, to learn classification through close observation of fossils and specimens.[11] Besides teaching, Grabau also promoted the research of paleontology in China by launching the *Palentologia Sinica*, an English-language journal published by the National Geological Survey of China (*Zhongguo dizhi diaochasuo*).

In 1921, Grabau delivered a series of public lectures with the title 'Earth and Evolution' at Peking University. The 16 lectures that ran for an entire year were very popular and well-received.[12] Yang attended the lectures and participated in transcribing the contents for publication.[13] Undoubtedly, Yang was influenced by Grabau and decided to choose paleontology as his focus in the third year of his study. A measure of Grabau's impact is that three of the twenty-seven graduates of the class of 1923, Yang, TIAN Qiqiong 田奇瓗, and ZHAO Yazeng 趙亞曾, had later become important paleontologists.

Although paleontology was gradually taking root in China, research was limited to the study and collecting of invertebrate fossils. For Grabau, invertebrate fossils from the Paleozoic period were important to testify his theory that China, in the basin of the ancient Pacific, was the great center of marine life, and later during the time of dramatic geological, climatic, and evolutionary change, these marine faunas disseminated to Western America and Europe.[14] Notwithstanding Grabau's personal preference, the research on vertebrate paleontology in China then was however discouraged largely by technical obstacles. Vertebrate fossils, unlike invertebrate fossils, are fewer in quantity and much larger in size. The excavation and preservation of vertebrate fossils demand much more investment

[10] Louis Agassiz (1807–1873) was a Swiss-American biologist and geologist. His legacy is often tainted by his objection to evolutionism. However, being one of the greatest naturalists of his time, Agassiz was also known for his method of teaching natural sciences. He promoted close observation of specimen and phenomena and aimed at making legitimate comparison and classification.

[11] SUN Chengcheng, ' "Taxiang taoli fa xinzhi": Gelipu yu Beijing daxue dizhi xuexi' (The father of China's paleontology: Amadeus W. Grabau and the department of geology of Peking University), *Ziran kexueshi yanjiu* (Studies in the history of natural sciences), 35/3 (2016), 346.

[12] For more details of the lectures and their influence on the popularization of evolutionism in republican China, see Sun, ' "Taxiang taoli fa xinzhi": Gelipu yu Beijing daxue dizhi xuexi', 350–4.

[13] The contents of the lectures first appeared in the university bulletin and local newspapers. Later, they were organized into a book: Amadeus Grabau, *Diqiu yuqi shengwu zhi yanhua* (Earth and Evolution), transcribed by Yang Zhongjian and ZHAO Guobing (Shanghai, 1924).

[14] Amadeus Grabau, 'Paleontology', in Sophia H. Chen Zen (ed.), *Symposium on Chinese Culture* (Shanghai, 1931), 153–5.

of both money and manpower. It is no wonder that during the early period of the 20th century most vertebrate fossils in China were discovered by foreign explorers and shipped over to foreign museums and institutions for studying.[15]

In 1923, after the completion of his bachelor degree, Yang decided to pursue his graduate study in vertebrate paleontology, a virgin field for Chinese students to explore. And Germany would be the ideal place offering such an opportunity, since the deflation of the German currency after World War I made it relatively inexpensive to live in Germany, compared to other countries in Europe and North America.[16] Carrying with him three recommendation letters written by Grabau, Yang arrived in Germany in 1923 after a long trip across the globe.

At the University of Munich, 1923–1927

Grabau's three letters were addressed to Ferdinand Broili of the University of Munich, Johannas Walther of the University of Halle, and Josef Felix Pompeckj of the University of Berlin. All three were famous earth scientists.[17] Yang eventually decided to enter the Institute for Paleontology and Historical Geology at the University of Munich (Ludwig-Maximilians-Universität München), the leading research center for vertebrate paleontology in Germany, to study with Broili, who was also the director of the institute. Broili was the favorite student of the internationally renowned paleontologist Karl von Zittel, under whose guidance he received his doctorate in paleontology in 1898. After the death of Zittel, Broili became the director of the institute, specializing in Saurian fossils. The other incentive for Yang to choose the institute was Max Schlosser, an emeritus member who was a pioneer in the study of Tertiary vertebrate and mammal fossils of China.[18]

Yang majored in paleontology and minored in geography and zoology. The institute was located in the city center, very close to the Bavarian State Collection for Paleontology and Geology. Yang spent most of his daily life taking classes and identifying fossils in the lab. The lab was very well

[15] For example, between 1923 and 1932, there were around 330 articles on vertebrate fossils discovered in China published in foreign journals. See YANG Tsui-hua, 'Lishidizhixue zai Zhongguo de fazhan (1912–1937)' (The development of historical geology in China, 1912–1937), *Zhongyang yanjiuyuan jindaishi yanjiusuo jikan*, 15 (1985), 327.

[16] Yang Zhongjian, *Yang Zhongjian huiyi lu*, 31.

[17] Ibid, 32.

[18] Max Schlosser (1854–1932) was one of the first Westerners to study the so-called 'dragon bones' (mammalian fossils) discovered in China. He examined more than 95 species of mammal fossils purchased from drugstores in China and published his results in *Die Fossilen Säugethiere Chinas nebst einer Odontographie der recenten Antilopen* (München, 1903).

equipped. All the teaching materials were arranged according to Zittel's textbook, *Textbook of Paleontology*, perhaps the most authoritative textbook of paleontology available at the time.[19] Besides lab work, Yang also traveled throughout Bavaria for field work.

After 6 semesters of hard work, Yang took the qualifying examination in the subjects of paleontology, as well as zoology and geography on February 16, 1927. He received an overall grade of 3 (cum laude).[20] He also completed an 82-page manuscript in German for his dissertation, entitled *Fossile Nagetiere aus Nord-China* (Fossil Rodents from North China). Yang began to prepare for this work during his fourth semester upon Broili's approval. WENG Wenhao 翁文灝, who was the director of China's Geological Survey 地質調查所 at the time, suggested him to work on the vertebrate fossils collected in north China by the Survey's Swedish researcher Johann Gunnar Andersson. Lacking professional paleontologists to identify these fossils, Andersson, who was a geologist, had been sending the enormous number of fossils he had collected to paleontologist Carl Wiman at the University of Uppsala.[21] Upon Weng's request, Wiman agreed to ship three boxes of unexamined rodent fossils to Munich for Yang to study under the supervision of Schlosser, who had helped Wiman identify some of the fossils from Andersson's collections.[22] Yang had to repair the fragmented fossils and then classify and analyze them.[23] In *Fossile Nagetiere aus Nord-China*, Yang identified 31 species from the Cenozoic era, 13 of which were new discoveries. This work was immediately published in the *Palaeontologia Sinica*. Grabau later noted that this was not only a significant study of extinct rodents, but it was in fact the earliest monograph on vertebrate fossils by a Chinese paleontologist.[24] Yet, one cannot ignore the irony of the kind of 'international' collaboration functioning behind the completion of Yang's dissertation. A Chinese

[19] Yang, *Yang Zhongjian huiyi lu*, 34. The book was originally published in German as *Grundzüge der Paläontologie* (München, 1895) and translated to English as *Textbook of Paleontology* (London, 1900).

[20] According to the German grading system, grade 3 (cum laude) is considered as good and above average. The examination was conducted by his advisor Broili, Professor Enrich Kaiser from the Institute of General and Applied Geology, Professor Karl Ritter von Frisch from the Zoological Institute, and Professor Erich von Drygalski from the Geographical Institute. Protokoll (Chung-Chien Young), Universitätarchiv, Ludwig Maximilians-Universität München (OC-Np WS1926/27).

[21] The agreement was made between the Geological Survey and the University of Uppsala: all the materials were prepared and studied by Wiman and other European specialists while the research results had to be published in *Palentologia Sinica*. See Yang Zhongjian, *Yang Zhongjian huiyi lu*, 37.

[22] See Ferdinand Broili, Votum Informativum for the dissertation by Chung-Chien Young (Yang Zhongjian), Universitätarchiv, Ludwig-Maximilians-Universität München (OC-Np WS1926/27).

[23] Yang, *Yang Zhongjian huiyi lu*, 38.

[24] Grabau, 'Paleontology', 160.

student had to travel all the way to Germany to study the material objects collected by the Swedes from his homeland. This exhibited the unequal power relations between countries in the practice of science.

After completing his dissertation, Yang accepted Weng's offer to work for the Geological Survey of China. He did so in hopes of fulfilling his nationalistic dream to save China through science, a dream held by many contemporary Chinese intellectuals and overseas students.[25] When one of his foreign friends asked him why he chose to return to his impoverished country rather than staying in Germany, he replied, 'I cannot abandon China, no matter how backward and poor she is; just like a son can never abandon his mother'.[26] Right before Yang returned to China in 1928, Broili invited him to his house for a farewell dinner. Broili congratulated his young Chinese student for his success in completing the degree and wished him a bright future, 'All the rich paleontological materials of China are waiting for you to discover'.[27] At that moment, Yang made the firm determination to devote himself to Chinese paleontology.

The Cenozoic Research Laboratory in the Interwar Period

Upon Yang's return to China, he immediately participated in the excavation project of the Peking Man fossils in the Zhoukoudian area near Beijing and served as a technician. During the years when he was studying in Germany, north China and Mongolia had attracted many foreign scientists who advocated the Asiacentric hypothesis (the evolutionary theory that designates Asia, instead of Africa, as the cradle of humans and the center of outward human migration) to search for the remains of human ancestors.[28] Andersson's 1926 announcement of the discovery of

[25] 'Saving China through Science' (*kexue jiuguo*) was embraced at the turn of the 20th century by many of the Chinese overseas students to study Western science and technology in order to strengthen the wealth and power of China. The founding of *Zhongguo kexue she* (Science Society of China), China's first modern comprehensive scientific organization, together with the launch of the journal *Kexue* (Science) in 1915 by REN Hongjun, ZHU Kezhen and other Chinese students studying in the United States manifested such a determination. See Zuoyue WANG, 'Saving China Through Science: The Science Society of China, Scientific Nationalism, and Civil Society in Republican China', *Osiris*, 17 (2002), 291–322.

[26] WANG Guozhen, 'Yi wangshi: huannian qinren Yang Zhongjian' (In memory of my husband Yang Zhongjian) in QIN Huanzhong (ed.), *Zhongguo gujizhui dongwuxue de dianjiren: ji jiechu de dishi gushengwuxue jia Yang Zhongjian* (The founder of Chinese vertebrate paleontology: in memory of the geological paleontologist Yang Zhongjian) (Xi'an, 2008), 36.

[27] Yang, *Yang Zhongjian huiyi lu*, 43–4.

[28] For details of the Asiacentric hypothesis and the activities of foreign scientists in China during the 1920s, see Hsiao-pei YEN, 'From Paleoanthropology in China to Chinese Paleoanthropology: Science, Imperialism and Nationalism in North China, 1920–1939',

two hominid teeth in Zhoukoudian further promoted Beijing as the hub of international human paleontological research. When the Cenozoic Research Laboratory 新生代研究室, an institute staffed by an international crew under the Geological Survey to carry out the Zhoukoudian project, was established in 1929 with funding from the Rockefeller Foundation, Yang was promoted to deputy director, under the guidance of director Davidson Black, a Canadian anatomist who had worked in the Peking Union Medical College since 1919.[29]

Although the main project of the Cenozoic Research Lab was the excavation of the Peking Man fossils, it also promoted other paleontological and geological research related to China's Cenozoic deposits and formations. In 1929, Yang took his first long field trip with Pierre Teilhard de Chardin, a member of the crew: a three-month expedition to Shanxi and Shaanxi to examine the red and yellow soils of the late Tertiary and early Quaternary sediments.[30] Teilhard de Chardin was a French Jesuit priest who was a student of the famous French paleontologist Marcellin Boule. He arrived in China in the early 1920s to help Emile Licent, another French Jesuit, to collect specimens for the Musée Hoang Ho Pai Ho established by Licent in Tianjin. The two priests explored areas in Inner Mongolia on donkey-back and discovered the Paleolithic 'Ordos Man' in 1923.[31]

Teilhard was hired as a consultant for the Cenozoic Research Lab, and Yang took several field trips with him in the early 1930s.[32] The French priest not only had rich field experience, but also had broad interest in archaeology, anthropology, physiography and petrology, in addition to paleontology and stratigraphy. During their collaborations, Yang benefitted mostly from Teilhard's rich archaeological knowledge of the Paleolithic and Neolithic remains, which helped his own research and study of the fossils and relics discovered at the Zhoukoudian site.[33] With Teilhard's Christian connections, the two often received extensive support and help from the local churches along their research routes. However, Yang also noticed that when they worked together in the field, locals often mistook him for the servant of the French priest, because foreigners traveling in

History of Science, 53/1 (2015), 21–56, and 'Evolutionary Asiacentrism, Peking Man, and the Origin of Sinocentric Ethnonationalism', *Journal of the History of Biology*, 47/4 (2014), 585–625.

[29] Yang, *Yang Zhongjian huiyi lu*, 64. [30] Ibid, 67–8.

[31] For the activities of the Jesuit in Inner Mongolia, see Yen, 'From Paleoanthropology in China to Chinese Paleoanthropology: Science, Imperialism and Nationalism in North China, 1920–1939', 28–32.

[32] Yang Zhongjian, 'Huai dizhixuejia De Rijin xiansheng' (Thinking about geologist Mr. Teilhard de Chardin), *Zhenli zazhi*, 1/4 (1944), 463.

[33] Yang, *Yang Zhongjian huiyi lu*, 139.

China were often accompanied by Chinese servants or assistants. This made Yang self-conscious and uneasy.[34]

The Central Asiatic Expedition

To test the Asiacentric evolutionary theory, the American Museum of Natural History (AMNH) in New York City organized five major scientific expeditions to the Gobi Desert between 1922 and 1930. The AMNH Central Asiatic Expeditions team, led by the legendary Roy Chapman Andrews (said to be the prototype of the cinematic hero Indiana Jones), invested a huge budget in the equipment and personnel. In the case of the third expedition in 1925, the caravan was composed of 40 team members, 5 American-made cars, 2 trucks and 125 camels. Though the team failed in their effort to find remains of the earliest human ancestors, they collected numerous boxes of vertebrate fossils, including new species of dinosaurs and intact dinosaur eggs.[35] The scale and the accomplishment of the American team set new record in the history of scientific exploration.

When the Chinese Nationalist Party established the Nanjing government in 1927, anti-imperialist sentiment rose high and a strong anti-foreign nationalism reached its climax nationwide. The Central Asiatic Expeditions were seen in the eye of nationalistic Chinese as imperialistic aggression violating Chinese sovereignty. A group of professors and scholars formed the Chinese Association of Learned Societies 中國學術團體協會 to stop the activities of foreign explorers who 'infringe our sovereignty, plunder our research materials, and cause great loss to the future of Chinese academic development'.[36] Soon the non-official organization was integrated into the National Commission for the Preservation of Antiquities 中央古物保管委員會, which detained the collections of the American team's 1928 exploration.[37] After several negotiations, the Central Asiatic

[34] Ibid, 68.

[35] For the activities of the American Museum of Natural History in Mongolia, see Yen, 'From Paleoanthropology in China to Chinese Paleoanthropology: Science, Imperialism and Nationalism in North China, 1920–1939', 32–9. See also Lukas Rieppel, *Assembling the Dinosaur: Fossil Hunters, Tycoons, and the Making of a Spectacle* (Cambridge, 2019).

[36] 'Beijing xueshu tuanti fandui wairen caiqu guwu zhi xuanyan zuori yeyi fabiao' (The manifesto of the Association of Learned Societies in Beijing against foreigners collecting ancient relics was announced yesterday), *Chenbao* (Morning news), March 10, 1927, cited in WANG Chen (ed.), *Gaoshang zhe de muzhiming* (The epitaph of the nobles) (Beijing, 2005), 521–2.

[37] Guwu baoguan weiyuanhui (Commission for the Preservation of Antiquities), (ed.) *Guwu baoguan weiyuanhui gongzuo huibao* (The report of the Committee for the Preservation of Antiquities) (Beijing, 1935), 11–40.

Expeditions were allowed to proceed only if the Americans invited Chinese scientists to participate in their next venture into the Gobi.[38]

Yang, Pierre Teilhard de Chardin, and ZHANG Xiti 張席禔 (a professor of geology) were the three 'Chinese members' in the joint Sino-American expedition to Mongolia in 1930. Instead of cooperation, Andrews and his American team members intentionally isolated the three 'Chinese representatives' in order to prevent them from interfering with their fossil collecting activities. According to Yang, the three of them were only allowed to use the tools brought by the team and thus were involved in their own scattered geological surveying and fossil digging. All vertebrate fossils they discovered had to be handed over to the Americans. However, the participation in the American expedition provided the Chinese members ample opportunities to learn the most advanced field techniques. For example, Yang learned to use diluted shellac (a natural adhesive) to glue and stabilize huge but fragile vertebrate fossils like dinosaur bones, and to wrap them up with plaster and linen before removing them from the sediments.[39] After returning to Beijing from Mongolia, Yang summarized the collecting and preparation techniques of vertebrate fossils in a small handbook published by the Geological Survey.[40] Besides practical training, Yang also considered the two-month exploration the 'most interesting experience' because the state-of-the-art field equipment, the camping meals, and even the entertainment facilities (such as the phonograph) that the American team brought with them to the Gobi made camping and surveying in the desert a pleasant experience. As Yang later commented, 'To put it bluntly, the so-called "Sino-American collaboration" is how they take advantage of us, and how we take advantage of them.'[41]

Wartime Research

After the Second Sino-Japanese War broke out in 1937, a new stage of research on paleontology in China began. Most Chinese scientists left occupied Beijing for the southwestern region. Only a few staff stayed in

[38] The model of joint expedition was first implemented in the Sino-Swedish Scientific Exploration to Northwestern China (Zhong-Rui xibei kexue kaochatuan) led by Sven Hedin, the famous Swedish explorer, in 1927. Hedin was under the pressure of the Chinese Association of Learned Societies to make an agreement to include Chinese members in his team to Xinjiang.

[39] Yang Zhongjian, *Xibei de poumian* (The cross-section of the Northwest) (Beijing, 1932), 87.

[40] Yang Zhongjian, *Jizhui dongwu huashi zhi caiji yu xiuli* (The collection and preparation of vertebrate fossils) (Beijing, 1930).

[41] Yang, *Yang Zhongjian huiyi lu*, 69–71.

what was now the 'Peking branch' of the Geological Survey, while the main office had moved to Nanjing, Jiangsu and then Chongqing, Sichuan. The work of the Cenozoic Research Lab ceased and most of its foreign scientists left China for good. Yang and some of his colleagues migrated to Kunming, Yunnan and set up a local branch of the Geological Survey. It was a time of great difficulty for research due to scarcity of academic resources. However, the flocking of scientists to the southwestern frontier of the country prompted a 'paleontological renaissance' in the region.[42] Yang managed to carry out surprisingly successful research, the best example of which was the discovery and examination of the Lufeng fossiliferous formations.

In the winter of 1938, Yang's assistant and colleague BIAN Meinian 卞美年 discovered a massive amount of vertebrate fossils in Lufeng, Yunnan. The lower level contained remains of dinosaurs and the upper level some primitive mammals. These fossils, collected in more than 50 boxes, were then shipped to Kunming for Yang to investigate. Without access to reference books, Yang had to consult his foreign colleagues abroad. He mailed his preliminary study to four people for consultation: his old mentor Broili, German paleontologist Friedrich von Huene, British paleontologist David Watson, and South African paleontologist Robert Broom. Huene, a dinosaur expert, not only confirmed Yang's identification of these fossils, but also sent him a copy of his out-of-print monograph and a number of related journals, which greatly facilitated Yang's study of the new materials.[43]

Following Zittel's classification of sauropods, Yang believed that most of the fossils discovered in the lower level of the Lufeng formation belonged to a species that existed in the late Triassic period, which was confirmed by Huene. However, these bones did not match any specifications described by Zittel of known species.[44] In 1941, Yang reconstructed the bones and named the new genus *Lufengosaurus huenei* to honor Huene. This was the first complete dinosaur fossils discovered, studied, and reconstructed solely by the Chinese. During the war, the fossil dinosaur went on a tour exhibition in cities like Kunming, Beipei and Chongqing and created a sensation. In Chonqing, the exhibition even attracted more than ten thousand vistors daily.[45]

[42] Ronald Singer (ed.), *Encyclopedia of Paleontology*, 1 (Chicago, 1999), 261.

[43] Yang, *Yang Zhongjian huiyi lu*, 105.

[44] Yang Zhongjian, 'Lufeng konglong zhi chubu guancha' (Preliminary observations of the Lufeng dinosaur) in *Dizhi lunping* (Geological review), 4/2 (1939), 94.

[45] Yang Zhongjian, 'Long' (Dinosaur/Dragon), *Wenshi zazhi* (Journal of literature and history), 5/3:4 (1945), 3.

The other significant discovery of the Lufeng fossils was two nearly complete skulls of *Bienotherium*. This rodent-like animal was a new species of the tritylodont family, appearing in the late Triassic and early Jurassic period. Yang studied the fossils and named the species after Bien Meinian, the original discoverer of the Lufeng formation. Similar tritylodont fossils were discovered in South Africa in the 19th century, but in a relatively fragmented state; the *Bienotherium* was the first such fossils found in the Asian continent. According to Yang, the Lufeng fossils, including the oldest sauropods and the oldest mammals ever found in China,[46] represented one of the most significant paleontological discoveries in China because they offered invaluable information on the evolution of dinosaurs and mammals.[47] Until the early 1950s, Yang's research had been mainly focused on studying and analyzing the Lufeng fossils, on which he published more than 20 articles and 3 monographs.[48]

Teaching

After Yang returned to China with the completion of his graduate studies in Germany, he devoted himself to research while maintaining only a minimal teaching schedule. In 1929 he began to teach as a lecturer in the department of geology at Peking University, offering a course on vertebrate paleontology to seniors. It was the first time vertebrate paleontology was ever offered as a course in China. It also complemented Grabau's course focusing mainly on invertebrate fossils. His teaching was based on Zittel's textbook, supplemented by fossil specimens from the Cenozoic Research Lab.[49] Yang later offered another course for seniors on Cenozoic geology,

[46] It should be noted here that the classification of the tritylodont was controversial because it had both mammalian and reptilian characters. When Yang first studied the *Bienotherium* he identified it as the most primitive mammals, see C.C. Young, 'Preliminary Notes on the Mesozoic Mammals of Lufeng, Yunnan', *Bulletin of the Geological Survey of China*, 20/1 (1940), 93–111. However, during the early 1940s the tritylodontids were reclassified as the mammal-like cynodonts, a group of therapsids that gave rise to the ancestors of mammals. See G.G. Simpson, *The Principles of Classification and the Classification of Mammals*. *Bulletin of the American Museum of Natural History*, 85 (1945). In his later study, Yang followed the new classification and relabeled *Bienotherium* the 'mammal-like reptile'. See C. C. Young, 'Mammal-like reptiles from Lufeng, Yunnan, China', *Proceedings of the Zoological Society London*, 117 (1947), 537–97.

[47] The other two groundbreaking discoveries were the Peking Man fossils, the oldest hominid, and the Theromorpha reptiles, the most primitive reptiles discovered in China by YUAN Fuli during the Sino-Swedish expedition. See Yang Zhongjian, *Kangzhan zhong kan heshan* (Observations of rivers and mountains during the war) (1944), 140.

[48] ZHANG Junxiao, 'Yang Zhongjian de rensheng daolu' (The road of Yang Zhongjian) in *Zhongguo gujiezhui dongwuxue de dianjiren: ji jiechu de dishi gushengwuxue jia Yang Zhongjian*, 312.

[49] Yang, *Yang Zhongjian huiyi lu*, 169–70.

because the existing courses were limited to Paleozoic geology. The course was divided into 2 hours of lecture and 2 hours of lab work. Both courses were small, with between 2 and 20 students.[50]

During the war, Yang taught vertebrate paleontology briefly in the department of geology at Chongqing University. In order to keep up with the most updated scholarship, his course framework was built on Alfred Sherwood Romer's advanced textbook *Vertebrate Paleontology* (Chicago, 1933).[51] ZHOU Mingzhe周明鎮, who later became a famous paleomammalogist, took Yang's class while studying at Chongqing University.[52] However, due to lack of teaching resources, such as fossil specimens, no lab training was available. The course only lasted for a year.[53]

In 1947, two years after the end of the war, Yang came back to Beijing and resumed his teaching at Peking University. He again offered two courses: vertebrate paleontology and continental geology. Both were open to juniors and seniors. However, this time the course only lasted for a few months, until he took the position as the president of Northwest University 西北大學 in Xi'an.[54]

Although Yang Zhongjian was the only person who ever taught vertebrate paleontology at Chinese academic institutions from 1928 to 1949,[55] it cannot be said that Yang's influence in the field of Chinese paleontology was achieved through teaching in the classroom. It was rather through the field and the lab that he passed on his knowledge and experience and thus contributed to training future paleontologists. He once said that an accurate worldview and a sound foundation built the basis for scientific research. And for paleontology, the foundation meant diligent field work combined with theoretical knowledge. Moreover, maintaining an active role in the international academic circle, Yang also believed that it was necessary for Chinese scientists to master foreign languages, which formed the master tool of knowledge.[56]

[50] Ibid, 170.

[51] Romer sent Yang two of his publications in 1940, *Vertebrate Paleontology* and *Man and the Vertebrates* (Chicago, 1933), upon Yang's request. See YANG Xiaoxin, 'Yang Zhongjian yu Meiguo kexuejia de xueshu jiaoliu huodong' (The scholarly interactions between Yang Zhongjian and American scientists) in *Zhongguo gujizhui dongwuxue de dianjiren: ji jiechu de dishi gushengwuxue jia Yang Zhongjian*, 138.

[52] Yang Xiaoxin, 'Yang Zhongjian yu Meiguo kexuejia de xueshu jiaoliu huodong', 138–9.

[53] Yang Zhongjian, *Yang Zhongjian huiyi lu*, 171.

[54] Ibid, 172.

[55] Ibid, 173.

[56] ZHEN Shuonan, 'Chunfeng huayu hui houren' (To instruct the later generations with spring breeze and rain) in *Zhongguo gujizhui dongwuxue de dianjiren: ji jiechu de dishi gushengwuxue jia Yang Zhongjian*, 210.

Before 1949, Yang's main research was done at the Cenozoic Research Lab and the Geological Survey. At the Zhoukoudian site, PEI Wenzhong 裴文中, who just graduated from the geology department at Peking University, was Yang's first assistant. Without formal training in paleontology, Pei taught himself the details of the Cenozoic formation and related knowledge on fossils through studying Zittel's textbook at night.[57] Before Pei left for France to pursue his doctoral education in 1936, he worked closely with Yang as a team. The two often had extensive discussions in the lab in the afternoon after the excavation work of the day was over.[58] Later, Pei, Bian, and JIA Lanpo 賈蘭坡 worked as Yang's assistants at Zhoukoudian. Yang also trained a group of technicians to carry out the excavations, as well as the more meticulous repair and preparation of fossils.[59] Pei, Jia, Bian and those trained technicians played a crucial role in setting up the groundwork for the development of Chinese paleontology. From 1953 to 1979, Yang was both the director of the leading Institute of Vertebrate Paleontology and Paleoanthropology古脊椎動物與古人類研究所 (successor to the Cenozoic Research Laboratory) and the head of the Beijing Museum of Natural History. He helped train numerous professional vertebrate paleontologists, including LIU Dongsheng 劉東生 (environmental geologist), YE Xiangkui 葉祥奎 (vertebrate paleontologist specialized in fossil turtles), DONG Zhiming 董枝明(dinosaurologist), SUN Ailing 孫艾玲(vertebrate paleontologist specialized in Theromorpha reptiles), and ZHEN Shuonan 甄朔南 (vertebrate paleontologist and museologist).

International Networking

Between 1944 and 1946, Yang was among a group of scholars and engineers sent by the National Resources Commission, headed by Weng Wenhao, to visit America for more advanced training and study in industrial development.[60] Yang brought with him some fossils from the Lufeng formation and spent most of his time in New York's American Museum of Natural History repairing and studying them. He reunited with members of the Central Asiatic Expeditions, such as Roy Chapman Andrews, C. P. Berkey and F. K. Morris. He also traveled around the US and Canada

[57] Yang, *Yang Zhongjian huiyi lu*, 63. It might be Yang who recommended Zittel's textbook to Pei.

[58] Ibid, 84. [59] Ibid, 86–8.

[60] In fact, four scholars were chosen for the field of geology: Yang, and WANG Yu, an invertebrate paleontologist, and two experts of mineralogy. Yang was rather surprised that the NRC considered paleontology an important discipline for national development. See Ibid, 122.

to survey different geological formations and to visit major research institutions and museums. Among the renowned researchers in the field to whom Yang paid visits were Alfred Sherwood Romer of Harvard's Department of Zoology, Charles Gilmore of the National Museum of Natural History in Washington D.C., and Charles Camp of the University of California, Berkeley.[61]

As a consequence of the rapid westward expansion of the American frontier in the second half of the 19th century, the development of paleontology in North America accelerated with massive discoveries of fossils. It was fueled up by the 'bone wars' of dinosaur fossil hunts between the two leading paleontologists Othniel Marsh and Edward Cope.[62] The development of American capitalism and the rise of consumer culture further added market value to vertebrate fossils and made fossil hunting a profitable enterprise, which in turn helped promote the development of the new science of dinosaur and vertebrate paleontology.[63] As a result, the center of paleontological research gradually shifted from Europe to North America. This trend culminated during World War II, when many refugee scientists fled from the European battlefield and resettled in America. Yang's visit to America witnessed the coming of age of American paleontology. While Zittel's *Textbook of Paleontology* remained *the* monumental textbook for students of vertebrate paleontology since its English publication in 1900 until the 1930s, it was replaced by Romer's *Vertebrate Paleontology*, published in 1933. As mentioned, even Yang adopted Romer's book as the textbook when he taught at Chongqing University. When Yang met Romer in 1946, Romer was preparing his manuscript of the expanded second edition. Romer showed him the manuscript, which included the recent discoveries from the previous decade. Yang was contented to see that both the Peking Man and the *Bienotherium* were listed and their significance discussed.[64]

During the two years of his stay in America, Yang made many connections to American paleontologists and continued these friendships after he returned to China. When China was relatively isolated from the international scientific community during the Mao era, Yang maintained his connections with American academia through personal correspondence. Rachel Nichols, a scientific assistant in charge of the Osborn Library of Vertebrate Paleontology at the American Museum of Natural History,

[61] Yang Zhongjian, *Xin yanjie* (New perspective) (Shanghai, 1947), 64, 108, 148–9.
[62] Mark Jaffe, *The Gilded Dinosaur: The Fossil War between E. D. Cope and O. C. Marsh and the Rise of American Science* (New York, 2000).
[63] Lukas Rieppel, 'Prospecting for Dinosaurs on the Mining Frontier: The Value of Information in America's Gilded Age', *Social Studies of Science*, 45/2 (2015), 161–86.
[64] Yang, *Xin yanjie*, 156–7.

became a good friend of Yang during his stay in New York. Before he departed from New York, Yang left a small amount of money to Nichols and asked her to mail him some new journals and publications in the future. Nichols kept her promise. She also arranged exchanges of publications between Yang and the American scholars during the decades when official communication between China and America was halted.[65]

Conclusion

The history of the development of vertebrate paleontology in Republican China demonstrates the entangled relations of scientific internationalism and nationalism. Fundamentally, however, the accomplishment and success in the research on vertebrate paleontology reflect the power and wealth of the nation. When Yang studied at Peking University in the early 1920s, China was a fruitful field for scientific exploration by foreign scientists. For these foreigners, such as Roy Chapman Andrews and Henry Fairfield Osborn (the president of the AMNH during the Central Asiatic Expeditions), scientific research was an international endeavor; the Chinese had no right to claim what was dug up from their land, since earth had a common history.[66] However, for nationalistic Chinese, paleontological science was always attached to a territorial sensibility. It was never universal, but 'local'.

In 1926, while working on his dissertation, Yang wrote an article entitled, 'Sciences with Local Characters and the Duty of Scientists'.[67] He divided the sciences into two groups according to the material they processed: those of a universal nature, like physics and chemistry, and those with local characters, like biology, geology and paleontology. For scientists who studied the second kind, their duty was not only to understand basic knowledge of the discipline, but also to discover and study local varieties. He then questioned the validity of 'science without boundaries', arguing that such a statement was merely an excuse for powerful countries to do research and to fetch resources from the territories of weak countries.

[65] Yang Xiaoxin, 'Yang Zhongjian yu Meiguo kexuejia de xueshu jiaoliu huodong', 142–4.

[66] During the fossil dispute with the National Commission for the Preservation of Antiquities, both Andrews and Osborn condemned Chinese anti-foreign nationalism for thwarting scientific research. See Roy Chapman Andrews, *New Conquest of Central Asia* (The American Museum of Natural History, 1932), 418; Henry Fairfield Osborn, 'Interruption of Central Asiatic Exploration by the American Museum of Natural History', *Science*, 70/1813 (Sept. 27, 1929), 291–4.

[67] Yang Zhongjian, 'Daiyou difangxing de kexue yu yanjiu cixiang kexue zhe yingyou de zeren' (Science with local characters and the duty of scientists), *Shengwu kexue* (Biological science), 1 (1926), 31–5.

He pointed out that the Germans, the French, the Americans, the British, and even the Japanese had come to China to conduct geological expeditions, but no Chinese scientist ever did the same thing in those countries. He concluded that it was crucial for Chinese scientists to learn the principles of foreign methods and tools and systematically educate their fellow citizens with such knowledge and methodology, so they would be able to conduct research on their own land and discover what was hidden beneath their own soil. 'It is not only an obligation we have for our motherland, but an obligation we have to advance the discipline [of local science]'.[68]

What Yang described was the indigenization of paleontology. For him, paleontology was not only 'local', it had to be 'localized'. The localization of paleontology could only be achieved if the discovery, the excavation, the repair, the study, and even the reconstruction of the fossils were all done by local hands. As a Chinese, Yang never hesitated to return to China after the completion of his Ph.D. education in Germany, not only to fulfill his obligation to serve his country, but also because 'no matter how beautiful the mountains and rivers of Germany might be, this is not my land'.[69] Throughout his career, Yang kept a high international profile, and was eager to embrace foreign knowledge. Yet, science, at least for Yang, indeed had boundaries, and the boundary for paleontology was the boundary of the nation. His devotion to paleontology could not be separated from his deep identification with the place.

National Yang Ming Chiao Tung University, Taiwan

[68] Ibid, 34.

[69] Wang, 'Yi wangshi: huainian qinren Yang Zhongjian', 36.

15
Training Medical Researchers in Korea during the Japanese Colonial Period (1910–1945)

In-sok Yeo

Introduction

Contemporary medicine expects close interaction between practical and theoretical aspects. However, throughout the history of medicine, this has not always been the case. The Hellenistic period, for example, witnessed a confrontation between the so-called Empiricists, who valued the practical side of medicine, and the Rationalists, or Dogmatists, who placed more emphasis on theory.[1] Despite their confrontation, the main source of medical knowledge was at the patient's bedside. During the medieval period, new academic institutions, that is, universities, became important in preserving ancient medical knowledge and producing new knowledge. From the middle of the nineteenth century, a third locus for the production of medical knowledge was added: the laboratory. With the rise of the laboratory, the goals of medical education changed significantly. While the traditional goal of educating practitioners remained, there appeared a new requirement of modern medical education to train 'medical scientists' for laboratory work. The rise of the laboratory gave rise to 'scientific medicine.' Indeed, by the late nineteenth century, medical scientists had begun to lead academic medicine, even though they were not necessarily physicians or surgeons. The chemist Louis Pasteur (1822–1895), for example, made an epochal contribution to bacteriology, the archetypical field of modern medicine, which was born in the laboratory. The emergence of medical scientists marks the historical integration of laboratory science into modern medicine.

[1] Galen, *Three Treatises on the Nature of Science* (Indianapolis, 1985). Michael Frede's *introduction* provides a good summary of the medical scene of the Hellenistic period.

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As Western medicine grew to be widely accepted in the nineteenth century, a similar process of integration took place in the non-Western world. In fact, the non-Western world repeated this process in a much faster, and thus condensed, manner, though with differences derived from specific historical and social contexts. This article describes this process in Korea, where Western medicine first arrived in the 1880s, and formal medical education shortly thereafter. Thirty to forty years passed between the beginning of medical education in Korea and the appearance of the country's first generation of medical researchers. Over this time Japan annexed Korea in 1910, producing a dramatic shift on the country's medical development. Previous studies on medical education during the colonial period in Korea have mostly focused on institutional aspects of medical education or on biographical studies of medical researchers. This paper aims to combine both: to examine the first appearance of the country's medical research and to position them in the topography of colonial medicine.

Western Medicine Comes to Korea

Western medicine came to Korea relatively late in comparison with its neighbors Japan and China. Before the opening of the treaty ports in 1876, Korean intellectuals had had contacts with Western medicine only via books imported from China. Chinese translations of the work of the Jesuit Johann Adam Schall von Bell (湯若望, 1591–1666) and other Western authors were imported into Korea during the 17th and 18th centuries. Unlike China, Korea was very hostile towards Christianity in the early modern period, allowing no entry to Jesuits. Therefore, Koreans of that time could only learn indirectly about Western science from those Chinese books known as Books on Western Learning (西學書) that circulated among progressive Korean Confucian literati such as YI Ik (李瀷, 1681–1763). Yi was the first to introduce Western medicine in Korean publications. The medical doctrines he discussed were mainly taken from the work of Schall von Bell, though he did more than simply reproduce the latter's thinking. Indeed, his writings show the effort both to understanding Western medicine and to reconciling it with traditional practice.[2] Such engagement with Western medicine did not represent anything more than an intellectual interest. Furthermore, the knowledge received in the country was outdated medieval medicine. It took until the late nineteenth century for Koreans to truly experience Western medical practice.

[2] In-sok Yeo, '*Zhuzhiqunzheng* (主制群徵), the Jesuit Translation of Western Medicine and its Influence on Korean and Chinese Intellectuals', *Korean Journal of Medical History*, 21/2 (2012), 251–278.

Since modern medicine is practiced and often taught in hospitals, the establishment of a Western-style hospital can best mark the introduction of Western medicine. The first Western-style hospital in Korea was established by an unexpected accident. Korea opened itself to the outer world in 1876. In December of 1884, Horace N. Allen (1858–1932) of the North American Presbyterian Church, the first medical missionary in Korea, was summoned to treat a close relative of the Korean queen. His successful treatment gained him a great deal of credit from the royal family.[3] He eventually proposed the establishment of a hospital, and offered to work without pay if the Korean government would provide the building.[4] His proposal was accepted. Sponsored by King Kojong, the Royal Hospital *Kwang Hye Won* (廣惠院), or, 'House of Extended Grace', was founded in 1885. The hospital was soon renamed *Che Jung Won* (濟衆院) 'Universal Helpfulness', and Allen was appointed head of the hospital by the king. From here, Allen and his colleague J. W Heron further established a medical school affiliated with the hospital in 1886, which marked the dawn of modern medical education in Korea.[5] They recruited 16 medical students and began education in English and science. However, this first attempt turned out to be unsuccessful, as none of the 16 medical students completed their study to become a doctor.

After Allen's departure from *Che Jung Won*, O. R. Avison (1860–1956) of Canada took charge of the hospital. Unlike Allen and other predecessors, Avison had significant experience in medical education, having taught at the University of Toronto before becoming a missionary in Korea. Medical education began soon after he took over the hospital in 1894. Avison's first task was to prepare medical textbooks in Korean.[6] Lack of adequate medical textbooks was one among many failures of Allen's first attempt to begin medical education in the country. With the help of his student-assistants, Avison began translating Henry Gray's textbook of anatomy, and then prepared textbooks for nearly all fields of medicine, along with a medical dictionary.[7] These medical textbooks and references were published from 1905 to 1910. Publication was halted when the country was

[3] Horace N. Allen and John W. Heron, *First Annual Report of the Korean Government Hospital, Seoul* (Yokohama, 1886).

[4] *H. N. Allen's Diary* (Seoul, 1991), 428–9.

[5] A more detailed description of the process can be found in the following article. In-Sok Yeo. 'Severance Hospital: Bringing Modern Medicine to Korea'. *Yonsei Medical Journal*, 56/3 (2015), 593–7.

[6] Oliver R. Avison, 'Some High Spots in Medical Mission Work in Korea. Part IV. A Medical School', *Korea Mission Field*, 35/5 (1939), 104.

[7] PARK Junhyoung and PARK Hyoungwoo, 'Jejungwoneseo yakmulhak bunyoukkwa ke uimi (The Translation and its Meaning of Materia Medica Part I in the Jejungwon)', *Korean Journal of Medical History*, 20/2 (2011), 327–54.

annexed by Japan in 1910, when no textbooks in the Korean language were permitted in school education.

Meanwhile, the Korean government had also set up a school for education in Western medicine. In 1899, a medical school that provided a three-year program opened its door in 1899. It produced 19 of its first graduates in 1902.

Medical Education Policy in Colonial Korea

Japan revised its educational policies over the course of its colonial rule. The main concern of the colonial government was elementary and middle-school education for colonial subjects. It did not want to provide higher education to the Korean people, as it feared that such education could make the people critical of the colonial system. Nonetheless, demand among the Korean people for higher education was such that they launched a movement for the establishment of a university in the early 1920s. The Government-General sought to neutralize this movement by establishing Keijo Imperial University in 1924. In order to limit colonial higher education only to practical or technical disciplines, the university included only the faculty of law and the faculty of medicine. During the early colonial period, however, the Japanese were resistant to even allowing Koreans to pursue higher education in medicine. The policy became clear when they re-categorized the aforementioned government medical school (established in 1899) as an occupational school. This re-categorization was symbolic in expressing the notion that Korea deserved occupational training instead of high-achieving academic education.

Such reluctance toward medical education is thought to have been due to the widely shared opinion among the colonial officials that Koreans were not qualified to take on positions in the medical profession that demanded considerable responsibility.[8] Furthermore, the lack of financial resources hampered the colonial government's investment in medical education. Before the annexation, education in the government medical school was free, and the school even provided scholarships to all students. Following the annexation, financial support for students gradually decreased. By 1915 all medical school students had to support themselves.[9] The colonial government was also concerned about possible competition between Japanese and Korean medical practitioners, as some Japanese medical practitioners moved to Korea after the annexation.

[8] SATO Gojo 佐藤剛藏, *Chōsen Iyukusi* 朝鮮醫育史 (Kyoto, 1956), 29.

[9] PARK Yunjae, *Hankuk Keundaeuihakui Kiwon* (The Origin of Korean Modern Medical System) (Seoul, 2005), 280.

The colonial government's medical education policy was clearly defined in the guiding principles of the 'medical training school' in Korea. First, the courses, all of which were on Western medicine, were to be taught in Japanese; second, students were to acquire basic knowledge for the study of medicine before entering the school; third, students were to have clinical experience during their education. This third principle, which is commonplace today, requires further discussion. Before the annexation, Korea's government medical school had no proper teaching hospital. During their three years of education, students studied medicine only in a classroom. Most students graduated with virtually no clinical experience. As a result, beginning in 1904, some of its graduates entered Severance Hospital Medical School (discussed below), where proper clinical training in Western medicine was provided. The Japanese mandate to acquire clinical experience during medical training spoke to the desire to produce capable medical practitioners in colonial Korea.

In the 1910s, there were only two medical schools in Korea: Severance Hospital Medical School, run by a missionary board, and the government medical school. Severance Hospital Medical School was the heir to the Che Jung Won Medical School that was founded by Allen. In the beginning, the Che Jung Won and its medical school were under the control of the Korean government. In 1894 the mission of the American North Presbyterian Church took over their operation. Then in 1900, the American philanthropist Louis Henry Severance (1838–1913) made a donation to build a new Che Jung Won.[10] The new hospital was called Severance Hospital after its donor.[11] Immediately after the Japanese annexation, the total number of graduates from these two medical schools was less than one hundred. While a sizable number of Japanese doctors came to Korea to open their own private practice or work in public hospitals, the available medical practitioners throughout the colonial period did not meet the medical demands of the population. To facilitate and accelerate the production of medical practitioners, the colonial Government-General implemented a provisional scheme. Individuals could receive a license to practice medicine by passing a medical license examination, even if they had never studied in a medical school. In fact, Japan itself had the same scheme in place for medical practitioners up to the early 20th century. Thereafter it was no longer possible in Japan to become a medical doctor without formal medical education.

[10] 'Historical Sketch', *Catalogue of Severance Union Medical College 1917* (Seoul 1917), 6–10.

[11] In-Sok Yeo, 'Severance Hospital: Bringing Modern Medicine to Korea', *Yonsei Medical Journal,* 56/3 (2015), 593–7.

The public health conditions in Korea, especially in the 1910s, required an immediate supply of medical practitioners. This was tasked to the government medical training school and Severance Medical College. It is difficult to expect scientific research to grow when there is an emphasis on the urgent supply of medical practice. The school was equipped with minimum facilities for medical education and virtually none for experimental research. The situation is expressed well in the lament of Inamoto Kamegoro (稲本龜五郎), who came to the medical training school as a professor of pathology: 'Although I heard that there was nothing in the school, the real situation was beyond my imagination.'[12]

In 1916, the government medical training school became Keijo [Japanese name for Seoul] Medical College, which adhered to the regulations for occupational schools promulgated by the Government General. Institutions of medical education in Japan proper were divided into two levels: medical colleges (*igaku senmon gakko*, 醫學專門學校, literally professional medical schools), and faculties of medicine at universities. The educational goals in these two institutions were different. The medical college was expected to train practitioners for the general public, whereas the university's medical faculty was academically oriented. The lengths of these two programs were also different. It was four years for the medical college, and six years, including two years of pre-med courses, for medical study in the universities. Severance Union Medical College and Keijo Medical College were like medical colleges in Japan: they produced medical practitioners, not academically-minded physicians. The statutes of Keijo Medical College specified the duty of professors as follows: 'Professors should, whether in basic medical science or clinical medicine, teach not complicated theoretical knowledge of medicine, but brief, simple and practical knowledge.'[13]

Although the main goal of Korean medical colleges at the time was to produce medical practitioners, education in basic medical science became more pronounced than before. Severance Union Medical College, though established and run by Western missionaries, shared the same goals and requirements as Keijo Medical College, a state school. It had to implement basic medical science departments in order to meet the colonial government's requirement for medical colleges in spite of its stated goal for practical medicine. As a result, the undergraduate curriculum of both medical colleges and the medical faculty of Keijo Imperial University

[12] Sato, *Chōsen Iyukusi*, 53.

[13] *Keijo Igaku Senmongakko Kitē* 京城醫學專門學校規程 (Regulations of Keijo Medical School), *Chōsen Chodokufu Kanpō* 朝鮮總督府官報 (Official Gazette of Government-General in Korea) (Seoul, 1916), iv. 1.

became similar. They were standardized according to the colonial government's requirements. During the first two years, basic medical science such as anatomy, physiology, bacteriology, biochemistry, and pathology was taught.[14] The third and fourth years were for clinical education. One great difference between Severance and other governmental medical institutions consisted of its integration of clinical education, as opposed to only teaching basic medical science. Beside lectures on clinical medicine, which were common in both institutions, the Severance College had an Outpatient Department Rotating Service for students during the third and fourth years with 12 hours per week, totaling 912 hours.[15] This meant that the medical students of Severance spent much more time in the hospital than the students of the governmental medical institutions. This time spent working with patients reflects the difference between the clinically oriented Anglo-American medicine and the more theoretically oriented German-Japanese medicine.

Medical Research in the Early 1910s

While the supply of medical practitioners was an urgent issue in Korea in the early 1900s, a few significant attempts were made to promote medical research during the colonial period. For example, the Chosen Igakukai (Korean Association of Medicine) was founded soon after the annexation, for which a journal, *Chōsen Igakukai Zashi* 朝鮮醫學會雜誌 (*The Journal of the Korean Medical Association*), began to be published in 1911. Most of the association's members were Japanese doctors in Korea, though a few Korean doctors were included as well. The articles published by the association's journal during the 1910s mostly concerned clinical subjects, though the results of laboratory work and basic research can also be found. This journal would eventually become the major academic journal in medicine in Korea. From the 1930s forward, it was divided into two parts: one for clinical medicine and the other for basic medical science.

Another significant event in medical research during this period was the establishment of the Research Department at Severance Union Medical College (SUMC) in 1914 by R. G. Mills, J. D. Van Buskirk, and A. I. Ludlow. Severance Hospital Medical College became the medical education institution that united American North Presbyterian Church and the other missionary boards in Korea, thus the word 'union' was

[14] *Keijo Igaku Senmongako Ichiran* 京城醫學專門學校一覽 (Bulletin of Keijo Medical School), (Seoul, 1930), 35–7; *Keijo Teikoku Daigaku Ichiran* 京城帝國大學一覽 (Bulletin of Keijo Imperial University) (Seoul, 1930), 83.

[15] *Catalogue of Severance Union Medical College Seoul, Korea 1925–26* (Seoul, 1925), 21.

inserted into the name of the school. In the implementation of this department, Dr. Mills was particularly concerned about the establishment of a research department within a missionary institution such as SUMC and the criticism it might draw. Upon proposing his plan to open the research department, he stated: 'Well, that's fine from the scientific standpoint, but I doubt whether any Mission Board would consider it a missionary enterprise.'[16] Therefore, in order to justify the research department in a missionary institution, the goals of its research were carefully set to solve practical problems, such as medical issues of Koreans related to local diet, customs, and habits.

The main areas of research within the department included traditional medicine, the Korean diet, and local diseases in Korea.[17] Regarding research on traditional medicine, Mills conducted extensive investigations on drugs mentioned in the pharmacopeia of traditional medical texts. He translated Korean medical texts into English (which unfortunately went unpublished) and collected thousands of traditional drugs and botanical specimens. Concerning the Korean diet, Van Buskirk investigated various issues of diet, and made recommendations for a balanced diet.[18] Parasitic diseases were among the local diseases that the department collectively studied.[19]

At first, the research department served as a laboratory where experimental work was carried out. Its nature eventually changed as each area of the department became a center of research activities. The research department grew to become a research-promoting institution that provided funding to different areas of study and individual researchers. The founding of this department marked an important point in the history of SUMC in its turn to scientific research. In the early 1910s, the key medical researchers remained foreign missionary doctors. Another decade would pass before witnessing Korean graduates of SUMC go on to pursue research careers.

Medical research was also carried out in the 1910s at Keijo Medical College despite its occupational orientation. Some research was conducted in the college for colonial interests. Japanese anatomy professor Kubo Takeshi (久保武, 1879–1921), a specialist in physical anthropology,

[16] Ralph G. Mills, 'The Research Department of the Severance Union Medical College', *The Korea Mission Field*, 12/1 (1916), 22–5.

[17] *Catalogue of Severance Union Medical College Seoul, Korea* (Seoul, 1917), 37.

[18] James D. Van Burskirk, 'Some Common Korean Foods', *Transactions of the Korea Branch of the Royal Asiatic Society*, 14/2 (1923).

[19] For the more detailed activities of the research department, see the following article: In-sok Yeo, 'Severance Uijeon Younkubuui Uihakyounku Hwaltong (A History of the Research Department of the Severance Union Medical College)', *Korean Journal of Medical History*, 13/2 (2004), 233–250.

gathered a vast collection of data on the physical traits of Koreans. He concluded that Koreans were inferior to the Japanese.[20] Such racially inclined anthropological studies were a quite popular research theme of the time. It could be done without costly experimental apparatus, thus affordable for the poorly equipped Keijo Medical School. In summary, medical research in 1910s Korea was carried out by Japanese doctors and Western missionaries. While the research of the former was racially oriented, that of the latter was focused on solving local medical problems.

The First Generation of Korean Medical Researchers

As mentioned above, the goal of medical education in colonial Korea was to produce medical practitioners instead of academic physicians. Therefore, the first generation of Korean medical researchers were educated outside of Korea. After graduation from medical colleges in colonial Korea, some individuals went abroad to receive proper training in medical research, particularly in the United States, Germany, and Japan.

Since the nineteenth century, it became an irresistible trend that medicine integrated modern science to empirical knowledge. Each country had its own way to join this trend. Germany started the trend by actively supporting scientific medical research in university laboratories, giving rise to the golden age of German medicine from the late nineteenth to the early twentieth century. The United States by and large followed the German model. The reform of American medical education that was proposed in Abraham Flexner's famous report was an attempt to integrate science-oriented German medicine into the more clinically oriented Anglo-American medical education.[21] Although the scientific aspect of medicine was underlined, American medical schools remained clinically oriented compared with their German counterparts. Japan also followed the German model.

In the 1910s and 1920s, the United States and Germany were the preferred countries for Koreans seeking advanced medical education, while from the 1930s onwards Japan became the destination of choice. Institutional or cultural ties influenced their choice. For example, graduates of Severance Union Medical College, run as it was by Anglo-American medical missionaries, tended to go to the United States. By contrast,

[20] KUBO Takeshi 久保武, 'Kaibogakuniokeru Nisenjinno Higakugenkyu 解剖學的に見たる日鮮人の比較研究' (Anatomic Discoveries of a Comparative Study of the Japanese and the Korean Peoples), *Chōsentomanchu* 朝鮮及滿洲 (Korea and Manchuria), October (1918).

[21] Abraham Flexner, *Medical Education in the United States and Canada* (New York, 1910).

graduates of Keijo Medical College typically chose Japan or Germany. Japanese universities were close and their degrees were accredited in the Japanese Empire, thus good for a medical career. Germany was also a logical choice, first because Japanese medical education followed the German model, and second because study in Germany had become a coveted experience, for Japanese as well as Korean students.[22] The following discussion will examine some of the first generation of Korean medical researchers who studied in the United States and Germany.

KIM Chang-sei (金昌世, 1893–1934) graduated from Severance Union Medical College in 1916. Upon graduation, he went to Shanghai to work as a medical missionary in an Adventist hospital. There he joined the Korean Provisional Government (in exile) and took part in the independence movement. While taking on the task of educating nurses for the future independence movement, Kim came to believe that the health of the Korean people was of utmost importance in order to achieve political independence. He then went to America in 1920, where five years later he became the first Korean to receive a Ph.D. degree in Public Health, from the Johns Hopkins School of Hygiene and Public Health. After earning his degree, he returned to Korea and founded the Department of Preventive Medicine within Severance Union Medical College. Public health and preventive medicine is a field that was not confined to a laboratory. To contribute to the progress of public health in a society, findings or proposals had to be adopted into governmental policies. Therefore, unless Kim were to become a government official, it was almost impossible to make his knowledge applicable in a meaningful way. As a Korean, he could not attain a high position in the colonial government. Presumably frustrated by this situation, Kim left SUMC for the United States to promote the Korean independence movement.[23]

In the early 1920s, two Koreans went to Germany to pursue advanced study in medicine. Upon graduating from Keijo Medical College in 1918, YU Il-joon (兪日濬, 1895–1932) spent a year in the Department of Pathology and Internal Medicine in the Faculty of Medicine at the Imperial University of Kyoto. In 1921, he went to Germany and studied bacteriology at the University of Freiburg, earning his doctorate in 1923.[24] After one year of post-doctoral study in Japan, he acquired his second doctorate of medicine from Keio University in Minato, Tokyo. According to the school

22 Hoi-Eun Kim, *Doctors of Empire* (Toronto, 2014).

23 PARK Yunjae, 'Kim Chang Seiui Saengaewa Kongjung Wisaeng Hwaltong (Chang Sei Kim's Activities on Public Health in Colonial Korea)', *Korean Journal of Medical History*, 15/2 (2006), 211–26.

24 LEE Gyu-Sik, 'Yu Il Chunui Saengaewa Hwaltong (A Study about Il Chun Yu [兪日濬])', *Korean Journal of Medical History*, 12/1 (2003), 1–12.

regulations, a Japanese doctorate was required to become a professor in a medical school. No foreign doctorates, whether from the United States or Germany, were deemed acceptable for this purpose. Returning to Korea in 1924 with a Japanese degree, Yu was appointed professor at Keijo Medical College. It was exceptional for a Korean to be appointed to the college at a time when almost all of its teaching staff was Japanese. There were only two Korean professors throughout the entire history of Keijo Medical College.

A second Korean medical scholar, LEE Suk-shin (李錫申, 1897–1944), graduated from Keijo Medical College in 1921. Upon graduation, he went to study at the Department of Pathology at Tokyo Imperial University for one year. He left for Germany the following year and entered the Faculty of Medicine at Berlin, where he specialized in biochemistry and won his doctorate in 1926. On returning to Korea, he worked as an assistant researcher at the Department of Biochemistry in the Faculty of Medicine at Keijo Imperial University. He moved to Severance Union Medical College in 1928, as he found out that it was impossible for a Korean to be a professor at the university. At Severance Union Medical College, Lee was appointed as an assistant professor of biochemistry in 1931. As a Japanese doctorate was required for appointment as a professor, he acquired a second doctorate at Kyoto in the same year.

Aside from Yu and Lee, five additional Koreans studied medicine in Germany. All seven were all graduates of Keijo Medical College. Though they all succeeded in being appointed as professors, they constituted only a very small number, for a German doctorate was deemed invalid for professorial appointments. It is also noteworthy that the study periods of these individuals were limited to the early 1920s, when no university existed in Korea. From 1926 onward, no Korean went to Germany to study medicine.

While graduates of Keijo Medical College headed to Japan or Germany for advanced study, graduates of SUMC preferred the United States. This choice seems natural considering that SUMC was established and run by Anglo-American missionaries. Unlike those who went to Germany and returned with no clear career future, graduates of SUMC who travelled to the United States enjoyed a much more certain career trajectory. Not only did SUMC fund its graduates' studies, it also ensured their appointment as professors following their studies in America. While early faculty members of SUMC were all foreign missionaries, it was the basic policy of Avison, the principal of SUMC, that its faculty members should eventually be replaced by Koreans. He thus selected graduates who worked as assistants at SUMC after graduation and supported their study abroad.

Seven graduates of SUMC studied medicine in the United States during Korea's colonial period, and all of them were appointed as professors at their alma mater. Three studied basic medical science, such as physiology, parasitology, or public health, while the others studied clinical medicine. KIM Myung-sun (金鳴善, 1897–1982), for example, graduated from SUMC in 1925 and went to the United States after working for a few years as an assistant in the Department of Physiology. He studied physiology at Northwestern University and earned his Ph.D. in 1932. Paul CHOI (崔棟, 1896–1973) graduated from SUMC in 1921 and went to China to study parasitology at Peking Union Medical College (PUMC) in Beijing.[25] Although PUMC began as a missionary institution much like SUMC, it became a more secular institution when the Rockefeller Foundation transformed it into a kind of Johns Hopkins University in China.[26] World class researchers and scientists were invited to the faculty at PUMC.

Beginning with Choi, a number of SUMC graduates went to PUMC for further study due to its high academic standing and shared identity as a missionary institution. SUMC and PUMC were close enough that not only SUMC graduates but also certain faculty members moved to PUMC as professors. For example, Ralph Garfield Mills (1884–1944), a professor of pathology at SUMC, moved to PUMC in 1918. Choi studied at PUMC for two years before coming back to Korea in 1925. The following year he again left Korea, this time to Canada to study in the Department of Pathology at the University of Toronto. On his return to Korea, he published several papers on parasitology and surveys on cancer cases in Korea. As a Japanese doctorate was required for professorship, Kim and Choi also received doctorates from Japanese imperial universities.

To earn a Japanese doctorate, medical aspirants could only go to Japan until Keijo Imperial University was opened in Seoul as the sixth imperial university in 1924. The opening of Keijo Imperial University reflected a change of policy for higher education in Korea. As mentioned above, the colonial government did not want Koreans to receive higher education, thus establishing only professional colleges, including Keijo Medical College, in colonial Korea. The new university was established in order to suppress civilian requests for a university. For example, Avison, a medical missionary in charge of both Severance Union Medical College and Yonhee College, proposed to open a university by merging the two colleges. In addition, a fundraising movement to establish a university had begun among Koreans. The Japanese Government General would not accept any university that was not under their direct control. It instead

[25] LEE Gyu-Sik, YANG Jeong-Pil, YEO In-Sok, 'Choy Tongui Saenaewa Hwaltong' (Paul D. Choy: A Life for Learning), *Korean Journal of Medical History*, 13/2 (2004), 284–97.

[26] Mary Bullock, *An American Transplant: The Rockefeller Foundation and Peking Union Medical College* (Berkeley, 1980).

established the Keijo Imperial University in Korea.[27] It started with only two faculties, a faculty of law and a faculty of medicine, and appointed highly qualified Japanese scholars to its teaching staff.

Japanese Doctoral System and Medical Research

Medical research during the colonial period in Korea can be said to have largely been promoted by the Igaku Hakase (醫學博士 or Doctor of Medicine) system. The German 'Doctor of Medicine' system of accreditation that was adopted in Japan had nothing to do with practicing as a physician. Rather, it served as a kind of honorary title of academic excellence. Those who wanted the title had to spend a certain number of years in a laboratory and present a dissertation on the result of their experimental work. As mentioned above, anyone who wished to be appointed as a professor in Korea had to attain a doctoral degree at a Japanese university. The title was sought not only by those who pursued academic careers but also by the clinicians who wanted the honor and prestige associated with the degree. Throughout the colonial period, more than 300 Koreans acquired MDs. Roughly half of them received their degrees at the Keijo Imperial University and the other half at other imperial universities. The doctoral degree was such an honor that newspapers of the time often reported their conferrals. At the same time, oddly enough, the degree did not guarantee the clinical capability of its possessor but only his or her laboratory experience. Nevertheless, the general public had so high a respect for such a title that clinicians wanted it for their businesses, a tradition that persists in Korea to this day.

There were two paths to the Doctor of Medicine degree in Japan. One, much like today, was to do dissertation research at an imperial university and receive a degree there. In this case, a student would spend several years in residence at the university. The other way was for a candidate to conduct dissertation research in a non-university laboratory and then submit the dissertation to a Japanese university. In this case, a university committee would evaluate the qualification of the candidate regardless of his residence.

Because only Japanese universities could award the doctoral degrees that qualified for teaching positions in universities and colleges in the empire, medical colleges such as Severance Union Medical College or Keijo Medical College were not entitled to award the degree. This of course meant that all supervisors of a dissertation were Japanese, as there were no Korean professors in the Japanese Imperial universities. Under

[27] KEE Chang-duk 奇昌德, *Hankuk Kundae Euihak Kyoyuksa* (A History of Medical Education in Korea) (Seoul, 1995), 222–3.

this system, the training of Korean researchers was completely controlled by Japanese professors.

The Korean pathologist YUN Il-sun (尹日善, 1896–1987), however, famously succeeded in shaking up this scheme of Japanese supervisors and Korean doctoral candidates. Yun completed the undergraduate education in the Faculty of Medicine at Kyoto Imperial University in 1923, specialized in pathology at the graduate school, and received the Doctor of Medicine degree in 1929. His academic career was thus exceptional, for the majority of Koreans who earned a Doctor of Medicine were graduates of medical colleges in Korea. When Yun was appointed Assistant Professor at Keijo Imperial University in 1928, he was the only Korean on its teaching staff.[28]

When Yun moved to SUMC in 1930, the college was facing two contradictory demands. The Western missionaries demanded it maintain its identity as a missionary institution. However, the colonial authorities wanted to position the school under their complete control. Avison, the principal of the college, sought to find a compromise for this situation. His solution was that the college would not only be a missionary institution but also an academic one. The college thus was making various efforts to improve its academic quality when Yun arrived. As mentioned, Avison was transferring the management and professorships of the college to Koreans. He thus aggressively recruited to the college Korean medical scientists, like Yun, who were qualified as university professors, or outstanding medical scholars who were not eligible for professorships in academic institutions in Japan or colonial Korea.

Yun was an excellent researcher and the first Korean to begin training medical researchers. Once at SUMC, he began to establish a system for research and training. Under his supervision, a considerable number of Korean students were trained in research and actively published their findings. One of his salient achievements was the training of LEE Young-chun (李永春, 1903–1980).[29] Lee did a series of experiments on sexual hormones at SUMC under Yun's supervision and submitted a dissertation to Kyoto Imperial University for the doctoral degree. Lee's degree was the first doctorate awarded to a dissertation directed by a Korean supervisor, thus representing a significant achievement in colonial Korea. A Korean researcher could then train another Korean. Korean society celebrated this

[28] HONG Jong-wook, 'Sikminjiki Yun Il-sunui Ilbon Yuhakkwa Uihak Younku (Yun Il-sun's Studies in Japan and Medical Research during the Colonial Period)', *Korean Journal of Medical History*, 27/2 (2018), 185–254.

[29] Young C. Lee, 'Experimental Studies on the Relation between Nicotine and Sexual Hormone'. *The Journal of Severance Union Medical College*, 2/ 2 (1935), 80–158; PARK Yun-jae, 'Hankuk Nongchon Wisaengkwa Lee Young Choon (Lee Young Choon, the Pioneer in Rural Health in Korea)', *Yonsei Journal of Medical History*, 7/1 (2003), 1–21.

achievement.[30] After Lee earned his degree, Yun continued to supervise other Korean candidates, the majority of whom received doctoral degrees from Kyoto.

Yun's laboratory was not big. He led the department of pathology, which consisted of himself and a few assistants for experimental pathology. Most of the research was designed to reveal pathological effects caused by certain pathogens or physiological changes. Yun placed importance on animal experimentation, and he himself taught experimental techniques and principles to his students.

Although it is generally agreed that the *Igaku Hakase* system greatly promoted medical research during the colonial period, it was difficult for MD holders to continue their research. Many of them did not pursue academic careers due to limited posts in SUMC and the near impossibility of a Korean's appointment as a professor in a Japanese college or university. The doctoral system nonetheless contributed to medical research by requiring laboratory work for almost all applications for the MD degree.

Although the doctoral system encouraged and rewarded medical research, its most serious problem was probably the dissociation of laboratory research from clinical medicine. A criticism was that most laboratory work produced nothing of clinical or practical value. This criticism was not only leveled at the doctoral system, but also at Japanese higher education in medicine in general. As a result, certain Japanese medical scholars, such as SHIGA Kiyoshi (志賀潔, 1871–1957), deliberately sought the introduction of Anglo-American medicine in Korea, which was considered more practical and more clinically oriented.[31] Many of the research projects for the MD did not consider clinical applications. For example, LEE Jung-chul, a pioneer psychiatrist in Korea, earned his doctorate from the Imperial University of Kyushu in 1935.[32] Though a psychiatrist, he did his dissertation research on the methods of staining brain cells.[33] After him, two other Korean psychiatrists, both SUMC graduates like Lee, earned doctorates from the same university on experimental subjects (in their cases histological studies on brain tissues).

[30] *Dong-A Ilbo* 東亞日報 (East Asia Daily), 18 June 1935.

[31] SHIGA Kiyoshi 志賀潔, *Aru Sēkingakushano Kais*ō 或る細菌学者の回想 (Memoirs of a Bacteriologist) (Tokyo, 1997).

[32] In-sok Yeo, 'Severance Jeongsinkwaui Seolipkwajeongwa Indojuijek Chiryo Jeontongui Hyungseng' (The Establishment of Severance Union Medical College Psychiatry Department and the Formation of Humanistic Tradition)', *Korean Journal of Medical History*, 17/1 (2008), 57–74.

[33] LEE Joongchul 李重澈, 'Mahisēchibōniokeru Shōnōno Byorisosikidekinogenkyu' 痲痺性癡呆ニ於ケル小腦ノ病理組織學的研究 (Histo-pathological Study of Cerebellum in Paralytic Dementia), *Fukuoka Igaku Zashi* 福岡醫學雜誌 (Fukuoka Medical Journal), 28/11(1935), 2567–634.

They performed their work in the laboratory of SHIMADA Kojo (下田光造) in neuropathology, which produced dissertations on neuropathological subjects.[34]

The choice of the laboratory was strongly affected by personal relations. Once chosen, the laboratory determined the subject of the dissertation. The lead professor of the laboratory often assigned dissertation subjects to his supervisees. We do not know exactly what led Lee to choose his laboratory at Kyushu. It is quite certain, however, that the choice of two other Koreans was made under Lee's strong influence.

The situation was almost the same at Keijo Imperial University. All students of the medical faculty had to enroll in a department. Some enrolled in clinical departments and others in basic science departments. For their dissertation research, however, even those who enrolled in clinical departments had to go to basic science departments, since the doctoral degree was awarded on the basis of laboratory work. Mere collection of clinical data was not acceptable for the doctoral degree. As a result, even if a student's specialty was in clinical medicine, his dissertation research could not be clinical. In fact, the method or orientation of the research was determined by the laboratory one chose for his dissertation. For example, if a student of the Gynecology Department had chosen the anatomy department for his research, his work was very often an anatomical study of a gynecological subject.

The results of research were published in medical journals in Korea, Japan, and other foreign countries. As mentioned, *the Journal of the Chosen Medical Association* was the first medical journal in Korea, thus enjoying the widest readership in the country. In addition, each medical school published its own medical journal. For example, SUMC published the *Journal of Severance Medical College*, and Keijo Medical College and Keijo Imperial University published *the Journal of Medical College in Keijo* and the *Keijo Journal of Medicine*, respectively. Medical journals of related fields in Japan also published the results of dissertation research by Korean physicians.

Conclusion

Following the introduction of Western medicine in Korea in the late nineteenth century, a medical education system was gradually established. The main objective of medical education during this period was to produce medical practitioners for primary care. Up to the 1910s, this objective was

[34] *Gojunensi* 五十年史 (History of Fifty Years of Medical Faculty of Kyushu University) (Kyushu, 1953), 317.

shared by medical missionaries and the Korean government (royal and later colonial). During the 1920s, some graduates of medical colleges in Korea pursued careers in medical research. As the conditions for medical research in the country were not favorable, most of them went abroad, mostly to the United States, Germany, and Japan. This situation changed during the 1930s, when better laboratory facilities and more capable supervisors became available as a result of the stabilization of colonial higher education in the 1930s. One could say that 'colonial modernization' reached its peak during this period. The situation began to deteriorate after the Japanese invaded China in 1937. It became even worse when Japan declared war on America in 1941. As the resources of Korean society were mobilized to support the war, little remained for higher education. At this time, medical college students were mobilized to build military constructions, such as airstrips. The main objective of medical education was then to secure medical officers for the battlefield rather than training medical researchers. The situation regressed back to the beginning of the colonial period, when the main objective of medical education was to secure the supply of primary physicians. Thanks to the Doctor of Medicine system, many, even those who did not wish to pursue an academic career, went to laboratories to do dissertation research. Though the doctoral system promoted research in colonial Korea, virtually no permanent positions for medical research were available to Koreans except at SUMC. Competent Korean researchers were only able to secure permanent positions to a significant degree after the Japanese staff of the medical institutions left Korea following the defeat of Japan in 1945.

Yonsei University, Korea

16

Training Historians and Ethnologists in Taiwan, 1928–1949

Wei-Chi Chen, Wan-yao Chou, and Ku-ming (Kevin) Chang

Introduction

The first university in Taiwan was founded in 1928 by the Japanese colonial rulers in Taipei as Taihoku Imperial University (台北帝國大學, hereafter Taihoku). Literally, the name meant the Japanese empire's university in Taipei, though the city's name was pronounced and transliterated in Japanese as Taihoku. As the first institution of higher education in Taiwan, Taihoku not only provided teaching but also generously supported academic research. Especially relevant to this volume, it also institutionalized research education for its students.

Scientific or academic research had been done in Taiwan before the founding of Taihoku. TORII Ryūzō (鳥居龍藏, 1870–1953) and INŌ Kanori (伊能嘉矩, 1867–1925) did ethnographical studies of Taiwanese aboriginals in the 1890s and 1900s. Neither of them had a university education. Torii taught himself anthropology after he had dropped out of elementary school. His knowledge won him a position as the curator of anthropological specimens at Tokyo Imperial University. He then served as the university's commissioned fieldworker from 1896 to 1900 to explore several territories on the margins of the Japanese empire, including Taiwan, then a newly acquired colony.[1] Inō went to a teacher's school and worked as a news editor first. His interest in anthropology led him to join the Tokyo Anthropological Society, of which Torii was also a member. Inō was recruited by the Governor-General's Office of Taiwan from 1895 to 1906 to investigate aboriginals on the island and then conducted cultural and

[1] Torii Ryūzō Torii, *Tanxian Taiwan: Niaoju Longzang de renleixue zhilu* (Exploring Taiwan: Torii Ryūzō's journey to the anthropology of Taiwan), trans. Nan-chun Yang (Taipei City, 1986), 426–7.

Wei-Chi Chen,Wan-yao Chou, and Ku-ming (Kevin) Chang, *Training Historians and Ethnologists in Taiwan: 1928–1949* In: *A Global History of Research Education: Disciplines, Institutions, and Nations, 1840–1950.* Edited by: Ku-ming (Kevin) Chang and Alan Rocke. *History of Universities* XXXIV/1, Oxford University Press (2021).
 DOI: 10.1093/oso/9780192844774.003.0017

historical surveys for the governance of the new colony.[2] Though neither man received a university education and Inō never held a university position, their publications from the 1890s to the 1920s have been hailed as monuments in the history and anthropology of Taiwan.

A generation later, things changed considerably. The previous generation of Japanese scholars could still achieve fame in history and anthropology without an academic position, and even without university education. In the interwar period and later, accomplished historians and anthropologists in Japan and its colonies were based in academia. They received a foundational education for academic research at the university; some even pursued advanced study abroad and doctorates. These are all signs of the professionalization of academic scholars and the institutionalization of research education—even though the junior scholars never stopped informal research training, either on their jobs at the university or by themselves outside it.

This chapter investigates the education for academic research that took shape in colonial Taiwan and the informal training that was available to junior scholars. It first briefly introduces the context of the founding of the only university in the colony in 1928, then examines the teaching of the two fields of Southeast Asian history and ethnology, in which the colonial government of Taiwan invested heavily, and draws a pattern from the careers of the faculty. This is followed by an analysis of the four modes of research training available at the time, and a description of the foundational education available to the first generation of Taiwanese academics in ethnology in a few years after Japan's handover of Taiwan to China. The findings of this survey are of great significance for the history of science and the humanities in Taiwan and to a large extent applicable to the history of research education in the humanities and social sciences in Japanese universities during the interwar decades.

The Foundation and Organization of Taihoku Imperial University

The idea of establishing a university in the colony of Taiwan had been discussed for several years in Taiwan and Japan before it was proposed to the cabinet of the empire.[3] The arguments for its establishment, as presented in the proposal, can be summarized in three points. The first

[2] Wei-Chi Chen, *Yineng Jiaju: Taiwan lishi minzuzhi de zhankai* (Inō Kanori and the emergence of historical ethnography of Taiwan) (Taipei City, 2014), 17–26.

[3] Suying Ou, *Chuancheng yu chuangxin: zhanhou chuqi Taiwan Daxue de zaichufa, 1945–1950* (Continuation and innovation: the relaunch of Taiwan University in the early postwar period, 1945–1950*)*, 2nd ed. (Taipei City, 2012), 12–17.

justified the selection of Taiwan for a new imperial university. The colony of Taiwan, located at the southern end of the Japanese Empire and between continental China and Southeast Asian islands, occupied a strategic position that could facilitate the spread of Japanese civilization to the south (which in general meant Southeast Asia from Thailand to Indonesia), aid the empire's advance into East Asia (which generally meant China and Korea), and contribute to the world's civilization. The second argument concerned the practical value of the university. Taiwan was an excellent stepping-stone for Japanese nationals to advance south. A research university that produced studies of southern civilizations would prepare the necessary knowledge for southbound advances. The university would host students from southern China and Southeast Asia, give them facilities for study and research, show them the true value of the Japanese civilization, induce mutual understanding between nations, and open new opportunities for East Asian civilizations.[4] These two arguments also led to the university's heavy investment in Southeast Asian history and the ethnology of Taiwan.

The third argument concerned the educational needs of the residents in Taiwan. The university was mainly to serve children of ethnic Japanese. It was hoped that they, a valuable source for replenishing manpower, would stay in Taiwan for higher education and then take up the responsibility of invigorating the colony. The islanders (the local Taiwanese) also had an educational need. Up to that point, most Taiwanese students had been attending private universities in Japan's homeland. They were able to see the dark side of the country. They then returned home influenced by improper (that is, seditious) thought, creating obstacles to the governance of the colony. If they went to China for university education, they were infected by the increasing anti-Japanese sentiment and communism. A university in Taiwan would spread healthy thought, impart proper knowledge, and open a path to study that was in the firm control of the colonial authority.[5]

There were four organizational units—faculty, chair, department, and major—in the imperial universities in Japan, including the one in Taiwan. A university consisted of several faculties (學部 *gakubu*). The first and foremost imperial university, Tokyo Imperial University, had seven (letters, sciences, law, medicine, engineering, agriculture, and economics) in the interwar period. The new imperial university in Taiwan opened with two,

[4] Chou Wan-yao, 'Taibei diguodaxue nanyangshi jiangzuo, zhuangong jiqi zhanhou yixu, 1928–1960' (Nanyō-shih as a chair and as a major at Taihoku Imperial University and its postwar development, 1928–1960), *Taida lishi xuebao* (Historical Inquiry of the Department of History, National Taiwan University), 61 (2018), 28–9.

[5] Chou, 'Taibei diguodaxue nanyangshi jiangzuo', 29–30.

the Faculty of Letters and 'State Sciences' (after the German term *Staatswissenschaften*, which included law, political, and economic sciences that served the governance of the state) and the Faculty of Physical and Agricultural Sciences. A chair was essentially a unit for research. In the Faculty of Letters and State Sciences there were twenty chairs in, for example, national language and literature, Western literature, national history (that is, Japanese history), East Asian history (東洋史), Southeast Asian history (南洋史), and ethnology (土俗人種學).[6] A complete chair came with positions for a professor (the chair occupant), an assistant professor, a lecturer, an assistant (especially for laboratory sciences), and sometimes a teaching assistant, although few chairs were equipped with a complete staff. The chair had at its disposal a library, and, in the case of the chair of ethnology, a specimen room, a laboratory, a darkroom, and an exhibit room (sometimes known as a museum) in addition. Thus a chair in its entirety was a small research institute. Indeed, the professor of ethnology identified to his international colleagues the complete organization of his chair as the Institute of Ethnology,[7] which will be followed in the discussion below. An institute did not correspond to a department (學科, *gakka*), which was essentially a unit for teaching at the university. There were only four departments in the Faculty of Letters and State Sciences: philosophy, history, literature, and state sciences. Each offered a few majors or concentrations (專攻). The history department, for example, offered majors in national history (Japanese history), East Asian history (mainly Chinese history), and Southeast Asian history. Thus Southeast Asian history was both a major and an institute. In contrast, ethnology, though claiming a chair, was not a major, admitting no undergraduate students. The institute was responsible for one course in ethnology that was required for all three majors in the Department of History. In this sense, and only in this sense, was the Institute of Ethnology a part of the history department.

Academic Careers at Japanese Universities

The careers of the teaching staff of the Institutes of Southeast Asian History and of Ethnology give a good idea of the formation of junior scholars in

[6] There are no exact equivalents of 東洋, 南洋, and 土俗人種 in English. Since the first two terms for the most part meant East Asia (especially China) and Southeast Asia, they are translated as such in this chapter for the sake of simplicity. The last could mean folklore, ethnology, and anthropology. It is translated as 'ethnology', as the founding president of Taihoku Imperial University understood it. For his understanding, see Nobuhito Miyamoto, *Wo de Taiwan jixing* (Recollections of my time in Taiwan), trans. Wen-hsun Sung and Chao-mei Lien (Taipei City, 1998), 48.

[7] Ibid, 48.

colonial Taiwan, and by extension across Japan. The professor, that is, the chairholder, in Southeast Asian history was MURAKAMI Naojiro (村上直次郎, 1868–1966). He had an assistant professor, IWAO Seiichi (岩生成一, 1900–1988), and an assistant, YANAI Kenji (箭內健次, 1910-?). The chair of ethnology was UTSURIKAWA Nenozō (移川子之藏, 1884–1947). He had an assistant, MIYAMOTO Nobuhito (宮本延人, 1901–1987), and a commissioned fieldworker, Mabuchi Tōichi (馬淵東一, 1909–1988), a history graduate of Taihoku who was later promoted to assistant professor.

Murakami was already a senior scholar when he was recruited by the university in Taipei. He studied history at Tokyo from 1892 to 1895 and was admitted to graduate school (大學院) immediately thereafter. Leaving graduate school without an advanced degree, Murakami then studied Southeast Asian languages and historical geography in Spain, Italy, and the Netherlands for three years on a government scholarship. He returned to Japan in 1902 to take up a senior position (as a professor) at Tokyo Foreign Language School, and was later co-appointed as a lecturer at Tokyo Imperial University. He became the president of the Tokyo Foreign Language School in 1908 and continued his co-appointment at Tokyo. He was awarded the Doctor of Letters degree in 1921 for his work on Japan-Mexico trade in the seventeenth century.[8] From the 1890s to the 1920s Murakami was three times commissioned by Japan's Ministry of Colonies or Taiwan's Governor-General's Office to collect documents on Taiwan (written in Dutch, Spanish, Portuguese, Chinese, Japanese, or even a transliterated indigenous language) or to cowrite a history of Taiwan. With his accomplishments he seemed a perfect candidate for the chair of Southeast Asian history at the new university in Taipei, the first in the empire. With the university's support he again went on a tour of advanced study to the Netherlands, Britain, Spain, Portugal, and Java before his arrival in Taiwan in 1929.

Professor of Ethnology Utsurikawa had a somewhat unusual career for a Japanese academic. He was not a graduate of one of the best imperial universities, such as Tokyo or Kyoto. He finished high school, university (at Chicago), and doctoral education (at Harvard) all in the United States. He received his PhD in anthropology in 1917 with a dissertation on Indonesian art.[9] An outsider to Japanese academia, he at first could only find a job as an English teacher at Keio University, a leading private institution.

[8] Pi-Ling Yeh, 'Cunshang Zhicilang de Taiwan shi yanjiu' (Murakami Naojirō's study of Taiwan history), *Guoshiguan xueshu jikan* (The journal of Academia Historica) 17 (2008), 8–9.

[9] The title of Utsurikawa's dissertation is 'Some Aspects of the Decorative Art of Indonesia: A Study in Ethnographic Relations' His supervisors included Roland Dixon and

He then became a professor at Tokyo Commerce School, and then a professor at Taipei Senior High School (which was essentially the preparatory program for university students). Appointed as the chair of ethnology at Taihoku, he, like the other appointees, was given an overseas-study scholarship. He first secured in Japan the abovementioned Inō's *Nachlasse* for his library, then spent close to two years in Europe before assuming his position at the university in 1928.

The junior scholars under the chair of Southeast Asian history, Iwao and Yanai, both received their academic positions shortly after finishing their BA. Iwao graduated from the Department of National History at Tokyo in 1925. He was then appointed compiler of historical materials at Tokyo, collecting and editing historical materials in European languages. He developed a specialty in studies of Japanese communities in Southeast Asia, using in particular materials in Dutch and Spanish. He was appointed assistant professor at Taihoku in 1929 under Murakami. In 1930–1932 he took a tour of advanced study to the Netherlands, Britain, the Dutch Indies, Italy, Spain, and Portugal. He succeeded Murakami as professor of Southeast Asian history upon the latter's resignation (for health reasons) in 1935.[10] Iwao was awarded the Doctor of Letters in 1951, after his departure from Taiwan. Yanai was also a history graduate of Tokyo, receiving his BA in 1935 with a thesis on Japan-Spain relations in the early modern period. He was first admitted to the graduate school at Tokyo, then appointed as a lecturer in Southeast Asian history at Taipei in 1936, shortly after Iwao's promotion to professor. Yanai was promoted to assistant professor in 1938.

The junior scholars in the Institute of Ethnology followed a similar pattern. Miyamoto was a history graduate (1928) of Keio, where he took courses and did fieldwork with Utsurikawa, a lecturer there. Aware of his new appointment at Taihoku, Utsurikawa invited Miyamoto to be his assistant there. Miyamoto was promoted to lecturer in 1940 and to assistant professor in 1943. He stayed in Taipei after World War II and became associate and then full professor. Mabuchi was in Utsurikawa's first class at Taihoku. A history major, he took part in anthropological fieldwork every summer. After his graduation in 1931, Utsurikawa commissioned him to do fieldwork for his island-wide aboriginal survey. From 1935 to 1943, Mabuchi worked for Japan's Imperial Academy of Sciences as a commissioned editor on aboriginal customary laws, and then for the East Asian Economic Investigation Bureau of the South Manchurian

Earnest Hooton. David L. Browman and Stephen Williams, *Anthropology at Harvard: A Biographical History, 1790–1940* (Cambridge, MA, 2013), 353–4.

[10] Yeh, 'Cunshang Zhicilang', 105–6.

Railroad Company, which, like the British East India Company in the previous century, employed scholars to do scientific surveys and investigations of Japan's colonial interests in Manchu, Korea, Taiwan, and elsewhere.[11] Continuing to publish on Taiwan's aboriginals in the best anthropological journals in Japan, Mabuchi was appointed assistant professor at Taihoku in 1943.

Their careers are summarized in Table 1.

This survey, expandable to the teaching staff in national history and East Asian history for a similar result, is sufficient to show the career path for academic humanists and anthropologists at Taipei (and in other imperial universities in general). This pattern, very different from those in other countries, can be summarized with a number of features.

Table 16.1 Careers of the teaching staff in East Asian History and Ethnology at Taihoku, 1928–1945

	Murakami	**Utsurikawa**	**Iwao**	**Yani**	**Miyamoto**	**Mabuchi**
Career	BA, Tokyo	PhD, Chicago	BA, Tokyo	BA, Tokyo	BA, Keio	BA, Taihoku
	Grad. Sch.			Grad. Sch.		
	SUT	SUT	NTUP			NTUP
	Lecturer			Lecturer	Assistant Lecturer	NUR
	DLitt 1921		Ass. Prof.	Ass. Prof.	Gov. Pos.	
	Stud. Abr.	Stud. Abr.	Stud. Abr.		Ass. Prof.	Ass. Prof.
	Prof. 1929	Prof. 1928	Prof. 1935			
			DLitt 1951			

Keys to Table 16.1:
Grad. Sch.: Graduate School
D.Litt: Doctor of Letters, followed by the date of receipt
Stud. Abr.: Advanced study abroad
SUT: Sub-university teaching at institutions such as foreign language schools, high schools, teachers' colleges, and commerce schools
NTPU.: Non-teaching positions at the university
Ass. Prof.: Assistant Professor
Gov. Pos.: Government positions, such as Miyamoto's position in the colonial government of Taiwan on affairs of local religion
NUR: Non-university research position

[11] For the East Asian Economic Investigation Bureau of the South Manchurian Railroad Company, see, for example, Ito Takeo and Joshua A. Fogel, *Life Along the South Manchurian Railroad* (London, 2016).

1. Undergraduate education was the last formal education a scholar was able to receive.
2. Study in graduate school, though available, was not required for an academic career. A new university graduate might be appointed as an assistant (or teaching assistant, or lecturer) at the university without spending any time in graduate school. In fact, graduate school often provided no formal training. A graduate student did whatever the supervisor asked him to do, which might be collecting and deciphering primary material, wide reading of literature, writing, or participation in a seminar that the supervisor led. The attraction of graduate school was the included scholarship, which enabled a student to dedicate himself to study without being distracted by material needs.[12]
3. The doctorate was not a requirement for a professorship, and even less for any academic rank below it, although it gave candidates for professorial chairs a strong advantage.[13] Although in principle a graduate student could apply for a doctoral degree with a thesis after two years in graduate school, few humanists bothered. A doctorate thus granted was known as *katei hakushi* (課程博士, program doctorate). This was quite well received by natural scientists and physicians, who often relied on university facilities such as a laboratory for dissertation research. The humanists preferred the other kind of doctorate, known as *ronbun hakushi* (論文博士, thesis doctorate). For this degree, which was very selective, the applicant submitted as his thesis a magnum opus that represented perhaps two or three decades of scholarship. This degree, granted usually quite late in a scholar's career, carried great prestige and real weight for the humanists, whereas the program doctorate meant very little to them.[14]

[12] Kozo Iwata, *Kindai Nihon no daigaku kyōjushoku: akademikku purofesshon no kyaria keisei* (The academic profession in modern Japan: the career path of the professoriate) (Machida-shi, 2011), 109–20.

[13] In the interwar period, the great majority of the professors in the humanities at the best imperial universities, Tokyo and Kyoto, received the Doctor of Letters degree before their promotion to professor. They usually earned the doctorate in their position as assistant professor, and sometimes before then. This did not apply to the other imperial universities, let alone private universities. Ibid, 93–107. For the university in Taiwan, the colonial government was very serious about its professorial appointments, selecting senior scholars who had established themselves in the field and had received the Doctor of Letters or the PhD degree. Murakami, Utsurikawa, and the Chair of East Asian History, FUJITA Toyohachi, are examples. After the university's opening, however, promotions, not as selective as at Tokyo and Kyoto, required no doctorate.

[14] William K. Cummings, *The Changing Academic Marketplace and University Reform in Japan* (Cambridge, MA, 1971), 198–9.

4. An overseas tour to Europe for advanced study and to relevant countries for research, fieldwork, or primary materials was a regular part of the formation of a scholar for a chair-professorship before World War II. Japan's Ministry of Education and individual universities regularly provided scholarships for study abroad. The colonial government of Taiwan reserved a special fund for all of Taihoku's professor appointees, available even before the opening of the university.[15]
5. Since graduate school and the doctorate were not required for an academic career and offered no formal training, the junior scholars in the university basically learned to do advanced research on the job, essentially by watching their seniors. They may be seen as apprentices in this sense.
6. At Taihoku and elsewhere, when a professor left a position open, his assistant professor usually succeeded him. And those under him were promoted through the ranks in sequence. Promotions therefore favored in-house candidates. There were cases (see one below), however, in which a junior scholar lost the competition for promotion and then left the university.
7. As will be seen below, junior scholars might begin teaching at a high school, occupational school, teacher's college, or other non-university educational institution. Sometime during their career, some worked at research institutions, such as the Investigation Bureau of the South Manchurian Railroad Company.[16] Others might be employed by the colonial government for the investigation of local customs, culture, or religions.
8. Publication was crucial for career advancement. This applied to in-house promotions but was even more important for new appointments in universities. For those who followed non-university tracks, accumulation of impressive publications was the key to their return to academia.[17]

Research Training

Research training at Japanese universities in this period existed in four modes: undergraduate education, which constituted the only formal academic training; apprenticeship at the university; self-training outside

[15] Chou, 'Taibei diguodaxue nanyangshi jiangzuo', 27–8.

[16] Takeo and Fogel, *Life Along the South Manchurian Railroad*.

[17] An academic career in interwar Japan was of course more complicated than the brief review here. For an broad and in-depth study, see Iwata, *Kindai Nihon no daigaku kyōjushoku*.

the university; and advanced study abroad. The survey below examines these modes of training for scholars and students in Southeast Asian history and ethnology at Taihoku University.

Though today we usually associate graduate education with research training, elements of research were prominent in undergraduate education at Taihoku—in its insistence on the learning of multiple foreign languages, on primary research, and on the preparation of a thesis, based on primary and secondary research, for the BA degree. This is not to suggest that all university graduates moved on to an academic career, however.

The language requirement for the Southeast Asian history major was demanding. Students were expected to have studied English and German in high school. The Faculty of Letters and State Sciences required all entering students to have had two years of French. The major in South Asian history, in addition, required Spanish and Dutch. As students were anticipated to use Spanish in their second year, Professor of Southeast Asian History Murakami taught them Spanish on lunch breaks during their first year. They then began Dutch in the second year.[18] An education that required so many foreign languages was more than just general education.

These languages were needed for primary readings. Every student was required to take a primary reading course for Southeast Asian history and the associated exercise course (which in German universities would be called *Übungen*, exercises, as described in the chapter by Kasper Risbjerg Eskildsen). At every meeting a student was chosen to read and translate assigned material in Dutch or Spanish. The material was handed out four or five days before the meeting, and the person in charge often stayed up all night before the meeting to prepare for his presentation. The material, usually six or seven pages long, took two hours to discuss. It was therefore close reading of primary material.[19] This trained students for primary research.

Every student in the major was required to prepare a research paper as their BA thesis. From 1933 to 1943, fifteen theses in Southeast Asian history were submitted. Each worked on various dimensions (trade, missionary, Japanese communities, foreign powers, etc.) of the history of the Philippines or the Dutch Indies. They were written in Japanese, each about 100,000 Japanese characters long (perhaps comparable to English of equal length). Most of the foreign-language references consulted were in English. Some of the theses in addition consulted Spanish and Chinese

[18] Chou, 'Taibei diguodaxue nanyangshi jiangzuo', 20.

[19] Pi-Ling Yeh, 'Taibei diguodaxue yu Jingcheng diguodaxue shixueke zhi bijiao, 1926–1945' (The history departments at Taihoku Imperial University and Keijō Imperial University, a comparison, 1926–1945), *Taiwan shi yanjiu* (Taiwan historical research), 16/3 (2009), 97, 119–20.

literature.[20] It might be fair to say that, although such theses might not qualify one for a faculty position today, their quality would exceed the requirement for a college honor thesis and might be even equal to, if not greater than, that for an MA thesis. This showed the seriousness of undergraduate research training at Taihoku.

Students also learned to present their theses in something comparable to the research seminar. The exercise course discussed above does not seem to have required presentations of research papers. The history department, however, organized seminars (讀書會, literally meetings of study) in which students were required to participate. At each meeting a member of the teaching staff and or a student presented a research paper and received critiques from the participants and the presiding professor. Drafts of the BA theses especially were presented in the seminar.[21] Through their observation and personal participation, students learned the norms, etiquette, and skills for academic writing and presentation.

As can be seen from the number of submitted theses, majors in history were few. Though the Southeast Asian history major was already the most popular of the three in the history department, it only had fifteen graduates by the end of World War II. During this period the Department of History had thirty-three graduates in total, among whom only two were Taiwanese.[22] At the time many more Taiwanese students still chose to pursue higher education in Japan, either for the prestige of Japanese institutions or for the relative ease of admission.

Informal training or apprenticeship on the job included study in graduate school and work in junior positions in the university. Graduate study qualified as training on the job, for the student received no formal training. He simply learned to do research on his supervisor's assignment. Sometimes even assistant professors felt that they were receiving training like students, by the side of chair professors. Assistant Professor of Southeast Asian History Iwao, for example, recalled that he felt as if he were also a student when he joined the students for Professor Murakami's lunch-break language study sessions—which he always did.[23] That also means that he learned Murakami's teaching method and style by watching them in person.

What happened to Utsurikawa's assistant and student serves as a good example of apprenticeship. Starting in 1930, Utsurikawa took Miyamoto and his student (and later commissioned fieldworker) Mabuchi with him

[20] Chou, 'Taibei diguodaxue nanyangshi jiangzuo', 43–5.
[21] Ou, *Chuancheng yu chuangxin*, 223.
[22] Chou, 'Taibei diguodaxue nanyangshi jiangzuo', 41–3.
[23] Yeh, 'Taibei Diguodaxue yu Jingcheng diguodaxue shixueke zhi bijiao, 1926–1945', 97.

to do three years of fieldwork on the aboriginal peoples across Taiwan and two years of organization and editing of the material for publication. The end result was the two-volume *Formosan Native Tribes: A Genealogical and Classificatory Study* (臺灣高砂族系統所屬の研究, 1935). Without graduate study, the two junior scholars first followed the professor to the field, observed him selecting fields and informants, and watched him interviewing them. Then gradually they took over part of the fieldwork. They also followed the professor's example of transcribing oral history and photographing and even filming figures and rituals in the field. At the end Mabuchi spent 425 days in the field, Miyamoto 129 days, and Utsurikawa 88 days.[24] Meanwhile Utsutikawa also embarked on archeological excavations across Taiwan, with Miyamoto in his company. For archeological work, they often worked with the professor of anatomy at Taihoku, KANASEKI Takeo (金關丈夫, 1897–1983). Utsurikawa also directed Miyamoto to study the religions of the Taiwanese population.[25] The chair of ethnology thus trained its staff in the ethnology of aboriginals, archaeology, and anthropology of contemporary culture.

The Institute of Ethnology had other resources at its disposal for the training of junior scholars. Its library was equipped with updated international journals, books acquired from Japan, China, Europe, and the United States, and archival materials that had been collected by Inō. As stated above, it also had a specimen room, a darkroom, a laboratory, and an exhibit space. All these were accessible to, and in fact operated by, Utsutikawa's staff. The institute also had its seminar. Compared with the history seminar, the Seminar on the Ethnology of the South (南方土俗) gathered a much wider community that included scholars from the university's Faculty of Letters and State Sciences, Faculty of Physical and Agricultural Sciences, and Faculty of Medicine (which was added to the university in 1936); academically minded officials in Taiwan's colonial government; and teachers from various educational institutions in Taipei and surrounding areas. They met regularly, and presented works and heard presentations on the anthropology of local culture, ethnology of aboriginals, and archaeology. They also established the journal *Nanpo Dozoku* (literally Ethnology of the South; the founders gave it the English title *Ethnology of Southeast Asia and Oceania*) (南方土俗) in 1940.[26] The junior scholars of the chair participated in all these activities, and continued to publish with the professor or in their own names.

[24] Katsumi Nakao, 'Taihoku teikoku daigaku dozoku-jinruigaku kenkyushitsu no kenkyu katsudo (Research activities of the Institute of Ethnology at Taihoku Imperial University)', *Teikoku to koto kyoiku: Higashiajia no bunmyaku kara* (Empire and higher education in East Asia), 42 (March 29, 2013), 117.

[25] Miyamoto, *Wo de Taiwan jixing*, 184–90.

[26] Ou, *Chuancheng yu chuangxin*, 223.

The last mode of research education was self-training. A good example is KOKUBU Naoichi (國分直一, 1908–2005), a Japanese who grew up in Taiwan. He finished high school in Taiwan and then studied as a national history major at Kyoto Imperial University. Thereafter he returned to Taiwan and taught at Tainan Girls' High School (1933–43) and was appointed professor at Taipei Teacher's College in 1943. He stayed in Taiwan after China's takeover as a retained scholar, and became associate professor in the ethnology program at the reorganized university in 1947. He left for Japan when the scholar retention policy was terminated in 1949.

A history major at Kyoto, Kokubu attended seminars in modern archaeology and ethnology. Once teaching at Tainan Girls' High School, he began to investigate historical remains and monuments in the region and gradually expanded his interest to ethnology and archaeology. For example, he surveyed the pot-worship culture of aboriginal Siraya villages and conducted fieldwork in the south and east of Taiwan and on offshore islands. He published his findings in scholarly journals in Taiwan and Japan.[27] This was the phase of Kokubu's self-training, since he had no university position and worked under no mentor.

Strictly speaking, Kokubu did not do his work alone but with a support group around him. This group consisted of Taiwanese literati and several Japanese high school teachers in Tainan. Among the teachers, MAEJIMA Shinji (前嶋信次, 1903–1983) of Tainan First High School was a history graduate of Tokyo Imperial University, and KANEKO Sueo (金子壽衛男, 1913–2001) of Tainan Second High School was a biology graduate of Tokyo Teachers' College. Maejima was first an assistant to the chair of East Asian history at Taihoku. After losing a promotion contest, he relocated to a high school in Tainan. There he began publications on local religion and geography, while continuing his interest in Arabic history that had started at Tokyo. After a few years in the 1940s working at the Investigation Bureau of the South Manchurian Railroad Company, he returned to academia, teaching at Keio University from 1950 until his retirement. He was awarded the Doctor of Letters for his work on Islamic history in 1953.[28] Interested in shell fossils and earth sciences, Kaneko made quite a few notable archeological discoveries while teaching in Tainan, often partnering with Kokubu. Kaneko is also known for taking interested high

[27] Kumamoto Daigaku Bungakubu Kōkogaku Kenkyū Shitsu (ed.), *Kokubu Naoichi sensei nenpu* (The chronology of Professor Kokubu Naoichi) (Kumamoto, 1966), 18.

[28] Chen Jung-sheng, 'Qiandao xinci qiren qishi, II (Maejima Shinjin: who he was and what he did, part II)', *Taiwan yu haiyang Yazhou* (Taiwan and Oceanic Asia) (blog), December 24, 2008, https://bit.ly/2NpU8P5.

school students to do collections and small-scale excavations on the field.[29] Kaneko was later called to Taihoku to serve as a teaching assistant in geology, and was kept by the reorganized university after the war.[30]

The cases of Maejima and Kaneko (and Kokubu as well) serve to make two points about the academic path of junior scholars in Japanese academia. First, some continued to do research on their own (or luckily with a support group) while they taught in high schools in regions with no university nearby. Though on their own, they had the research training from their undergraduate education to rely on. They published their findings in local or national venues. Second, the best of them won academic recognition with their publications and eventually gained (or regained) positions at universities, even rising to professorships.

Later, Kokubu was integrated into the research community in ethnology in Taipei. In 1939, he took part in excavations of shell mounds with Utsurikawa, Miyamoto, and the above-mentioned professor of anatomy, Kanaseki. When Kanaseki initiated a folklore study circle in Taipei and established the monthly journal *Minzoku Taiwan* (民俗台灣, Folklore Taiwan), Kokubu was one of the first contributors.[31] In April 1943, Kokubu was appointed professor at Taipei Teachers' College and then became closely associated with Utsurikawa's institute. He was recruited to the reorganized university in Taipei after the war and continued his academic career in Japan after his repatriation.

The last mode of training, study abroad, was important for strengthening the junior scholar's foreign languages, broadening his international outlook, and expanding his intellectual network. It has been a tradition since the nineteenth century that junior Japanese academics studied abroad for a few years on government scholarships. In the first half of the twentieth century, the Ministry of Education regularly sent more than 50, and at one point more than 200, junior scholars abroad every year. Most of them received the scholarship when they were assistant professors.[32] The humanists among them usually took courses with prominent

[29] Yao-kun He, 'Jinzi Shouweinan dui Taiwan ziran wenhuashi de gongxian (Kaneko Sueo's contribution to the natural history of Tainan)', *Tainan wenhua* (Tainan culture) 54 (2003), 144–51.

[30] Wei-Chi Chen, 'Zhishi de jieshou: Guofen zhiyi yu zhanhou chuqi de Taiwan yanjiu (Knowledge Retrieval: Kokubu Naoichi and Taiwanese studies in the early postwar era)', *Taida lishi xuebao* (Historical inquiry of the Department of History, National Taiwan University), 61 (2018), 103.

[31] Kokubu published his ethnological studies on Taiwanese spirit medium beliefs and practices in southern Taiwan in 'Tankino kenkyu (Studies on the spirit medium)', *Minzoku Taiwan* (Ethnology of Taiwan), 1 (1941).

[32] Naoto Tsuji, *Kindai Nihon kaigai ryūgaku no mokuteki hen'yō: Monbushō ryūgakusei no haken jittai nitsuite* (The Transformation of the Objectives of Overseas Study in Modern Japan: The Dispatches of Students Abroad by the Ministry of Education) (Tōkyō, 2010), 32–6.

professors or did library and archival research, often moving from one institution or country to another during the years of his scholarship. The scientists and physicians, in contrast, usually worked in a particular professor's laboratory throughout the time. Though few of them studied for a degree, their foreign experience was taken seriously as an important part of their academic portfolio if they wished to advance and become full professors at imperial universities. Taihoku replicated this model and secured the funding of Taiwan's Government-General for Murakami's and Iwao's tours of advanced study abroad, for example.

Two more points are important. First, a mature scholar did not necessarily complete all four modes of training. Only undergraduate education and apprenticeship were necessary. A lucky (and good) student might get a junior teaching position right after receiving his BA and then step by step reach the top academic echelon, without working outside the university. There were a small number who became professors without advanced study abroad. Second, the four modes did not constitute a specific sequence. The only certain element of all possible sequences was that undergraduate education came first. High school (or any other sub-university teaching) usually preceded university positions (if one could not get a university appointment directly out of school). But Maejima's case shows that junior university teaching might precede high school teaching, even though he later returned to the university. In some cases, study abroad might interrupt junior university teaching or come after the appointment to professorship.

The War and the Handover

Scholarly research was never an intellectual pursuit for its own sake in colonial Taiwan. As seen above, the founding of Taihoku Imperial University in general, and teaching and research in Southeast Asian history and ethnology of Taiwan specifically, were closely tied to Japan's colonial enterprise. As wars broke out, the university faculty was soon mobilized to help with the war effort. For example, Japan seized the eastern half of China shortly after the outbreak of the Sino-Japanese War in 1937. The faculty of Taihoku was quickly enlisted, often by the military, to investigate the culture and natural resources in southeastern China, sometimes even to help restore the teaching and museum collections at Xiamen and Guangzhou universities.[33]

[33] Miyamoto, *Wo de Taiwan jixing*, 169–76, 191–3.

Japan's political, military, and economic advances into Southeast Asia ensued. Taihoku created the Research Institute of Tropical Medicine in 1939 by upgrading the manpower and laboratory of an institute that had been previously placed under the Governor-General's Office. The need for medical, hygienic, and therapeutic knowledge for fighting tropical disease had been constant throughout Japan's rule of Taiwan. The new institute had an additional mission to apply its knowledge to Southeast Asia and to extend medical care for new plantation immigrants in the region. After the opening of the Pacific War in late 1941, Japan rapidly seized vast lands (including islands) in Southeast Asia. The economic development and governance of these lands became an urgent issue. This led to the creation of two more research institutes at Taihoku in 1943: the Research Institute on the Humanities of the South and the Scientific Institute on the Resources of the South. Utsurikawa headed the former, and promoted Miyamoto and Mabuchi to assistant professorships with new positions allocated to his institute. The increased resources and the political agenda behind them supported these scholars' expanding their ethnological work from Taiwan to southeastern China, the Philippines, Vietnam, and Indonesia.

While research and material investment seemed to expand, teaching at the university was interrupted, especially when the conditions on the Pacific fronts deteriorated. All male students were drafted into the military in 1944 and 1945. Only women students, who were very few, were able to stay. Even their study was disrupted by the university's closure in March 1925 as bombing by the US Air Force intensified.[34]

A new, and at first chaotic, phase of Taiwanese history opened after Japan ceded Taiwan to China in August 1945 as a result of its defeat in World War II. At least three factors caused chaos for the university, which was reorganized and renamed National Taiwan University in January 1946. First, bombings during the war had destroyed many facilities. Shortage of building materials after the war made reconstruction difficult. Runaway inflation further crippled the reconstruction efforts.[35] Second, thousands of Taiwanese students who had studied in Japanese universities and high schools during the war returned to Taiwan after losing their legal residence (since Taiwan was no longer part of Japan). They requested access to the university—when there was only one in Taiwan. The situation further worsened with the arrival of Chinese students, also in thousands, who fled home for Taiwan when the Nationalist government seemed on the verge of losing the country to the Communist rebels. They

[34] Chou, 'Taibei diguodaxue nanyangshi jiangzuo', 53–4, 58.
[35] Ou, *Chuancheng yu chuangxin*, 29–32.

likewise requested admission to the university. As a result, the university accepted thousands of students, whereas the colonial university, elitist in nature, had only accommodated hundreds. Short of teaching resources, students even had to organize courses on their own.[36] Third, although the reorganized university hired to the faculty some Taiwanese who had been educated at prestigious Japanese institutions, there were not enough of them to fill the vacancies left by the Japanese faculty. Taiwanese rarely had academic ambition in the colonial period, knowing that racial discrimination gave them little chance for academic advancement. The vacancies at first could not be filled by scholars from China, either. Overjoyed by the victory after a long war, Chinese scholars hoped to return from where they were evacuated to their previous institutions and took part in national rebuilding. Few of them saw Taiwan, a remote and unfamiliar island, as their first choice. The shortage of faculty forced the university to adopt a policy of retention, keeping eighty-nine Japanese professors and instructors of various ranks.[37]

Beyond the practical need of manpower, a Taiwanese intellectual, YANG Yun-Ping (楊雲萍, 1906–2000), justified this policy with what he called the takeover of historical materials and the takeover of history. He argued that taking over power from Japan was not sufficient. The Taiwanese should also take over the historical materials of Taiwan that the Japanese faculty had collected, ideally before their possible destruction and with full cooperation of the Japanese faculty. He also proposed to take over the power of historical interpretation, reevaluating the colonial experience.[38]

Somewhat ironically, a stabilizing force in the chaotic university was the remaining Japanese faculty, who offered teaching that was consistent with the prewar quality and even continued to give research training to students, almost all of whom were Chinese and Taiwanese instead of Japanese in this postwar period. Miyamoto, one of the retained Japanese faculty, was joined by Kokubu of Taipei Teacher's College, who was appointed associate professor in the Department of History in 1947.[39] They both taught on the archaeology and ethnology of Taiwan, a specialty that no Chinese scholars were qualified to teach. In addition to teaching, Kokubu was put in charge of the reconstruction of the archaeological and ethnological museum from the prewar Institute of Ethnology. He restored the specimen

[36] Ibid, 103–25.

[37] Taihoku Imperial University at the time of the handover had 1,416 employees, including 114 chair professors. Chou, 'Taibei diguodaxue nanyangshi jiangzuo', 60–1.

[38] Yang's proposal was made in 1945, just months after Japan's surrender. Cited in Chen, 'Knowledge Retrieval', 99.

[39] The Japanese rank of assistant professor was replaced by that of associate professor in the reorganized university.

collections that had been badly damaged during the war, built up an inventory, and added captions for collected objects.[40] Kokubu used these specimens for his publications on indigenous material culture and prehistoric culture in Taiwan and for his lecture courses. Together, Miyamoto and Kokubu trained the first generation of Taiwanese archeologists and anthropologies who stayed in academia.

A Taiwanese student recalled his study with Miyamoto and Kokubu:

> [When] I was admitted to the Department of History, I seldom went to freshman-year classes. Instead I was keen to audit Professor Kokubu's 'Introduction to Archaeology' and 'Introduction to Taiwan's Prehistory' courses as well as Professor Miyamoto's 'Ethnography of Taiwanese Aboriginals' course. The two professors were so-called 'retained Japanese professors'. Because there were only two students at the senior level in the Department of History, Professors Kokubu and Miyamoto allowed me to join them. I told Professor Kokubu that in the future I would dedicate myself to archaeology. I felt that his lectures were given especially for me, which filled me with enthusiasm and joy.[41]

A student's lecture notes help reconstruct Kokubu's teaching. In his class Kokubu often compared history and archaeology. Both disciplines studied the history of human life. For him, the text of a letter concerned historians, while the physical letter, and traces on it (such as the kiss of the sender placed on the envelope) were artifacts that concerned archeologists.[42] Historical studies were based on writing, whereas archeological work depended on analyses of excavation sites and physical artifacts. Besides the comparison of history and archaeology, he covered the history, methods, subfields, and periodization of archaeology. He demonstrated what he considered the objects of archaeology with the specimens in his museum, including stoneware, boneware, objects made of shell, pottery, plant remains, metal tools, and natural substances related to prehistoric food culture. He also related local culture and Stone Age culture by examining

[40] Chi-lu Chen, 'Tusu Yanjiu Zai Taiwan—Wei Taida Minzuxue Yanjiushi Biaoben Chenlieshi Xie (Ethnological Studies in Taiwan: The Story of the Museum of the Institute of Ethnology of the History Department)', *Gonglunpao* (Public Opinion Newspaper) (31 May 1948), 4 ed. Chen, 'The Takeover of Knowledge', 108.

[41] Wen-Hsun Sung, 'Qianbei Fengfan (Exemplar forerunner)', in Nanjun Yang (ed.), *Taiwan bainian shuguang: Xueshu kaichuang shidai diaocha shilu* (The dawn of Taiwan in the past 100 years: a record of scholarly investigations in the time of academic expeditions) (Taipei City, 2005), ix–x.

[42] Kanaseki once produced a series of drawings of Kokubu's everyday life in postwar Taipei, including Figure 16.1. See Takeo Kanaseki, *Kōgi tosuru Kokubu sensei, gakuseiwa futari (Professor Kokubu in class, with two students)*, 1948, National Taiwan University Library, Papers of Professor Kanaseki Takeo <https://www.lib.ntu.edu.tw/events/2013_kanasekitakeo/painting.html>.

16.1 A Pictorial Depiction of Kokubu's Class. This picture shows the small size and intimacy of Kokubu's class. This apparently took place in a seminar room, in which a seminar table was placed in the middle, and bookshelves surrounded the space by the walls. (Digital Images of the KANASEKI Takeo Collection, Courtesy of National Taiwan University Library).

unearthed items—for example, shell bracelets—side by side with those still used in fishing villages in southern Taiwan.[43]

Kokubu advocated comparative methods from several perspectives. He called the comparison of contemporary local culture with excavated artifacts the 'ethnographical method of archaeological research'. He also compared artifacts from one site with those from surrounding archaeological sites. This mapped out their geographical distribution and also sorted out their genealogy. These ethnographical, geographical, and genealogical comparisons, he asserted, held the key to Taiwan's prehistorical culture as well as all other prehistorical cultures in Southeast Asia.[44] Thus his courses were an introduction not just to the subjects of archaeology but also to its methods.

[43] Notes of Kokubu's archaeology course; see Wen-Hsun Sung, 'Transcription of Kokubu lecture on archaeology', 1947, Sung Wen-hsun Papers, National Taiwan University Library.

[44] Sung, 'Transcription of Kokubu lecture on archaeology', 16, 34. After his return to Japan, Kokubu developed a theory of ethno-archaeology in the 1960s by integrating his previous empirical work in archaeology and ethnology. See Naoichi Kokubu, *Kan shinakai minzoku bunka kō* (Studies of ethnic cultures around the China Sea) (Tokyo, 1976), 8–18.

Kokubu's 'Overview of Taiwan's Prehistory' course introduced prehistorical life in Taiwan by applying theories to excavated objects. Kokubu advocated the idea that Taiwan had been the center of Greater East Asia since the Stone Age. It was at the crossroads of northbound, southbound, and continent-to-the-Pacific routes. The history of Taiwan did not begin with the first Chinese immigrants, but with Stone Age peoples who lived either on the coast or on hills near rivers. The culture of Taiwan resulted from the convergence of southern, continental, and northern cultures.[45]

Continuing archaeological work after the war, Kokubu trained his students in the field. As he did with students in high school and teachers' college, Kokubu took university students to several excavations in central and northern Taiwan during winter and summer vacations in 1948 and 1949.[46] Some of these sites had been discovered during Japanese rule, while others were first excavated by his team.[47] His teaching thus trained students in both intellectual and practical skills in archaeology.

The new authorities in Taiwan became increasingly intolerant, or suspicious, of the Japanese retainees, particularly after the violent confrontations between the Taiwanese population and the new Chinese authority that led to a bloody massacre in 1947. Feeling insecure, the new authorities tried their best to keep all resources, including faculty positions at the university, for their Chinese confidantes. Then the civil war between the Nationalist government and the Communist rebels intensified in the Chinese mainland, eventually resulting in the retreat of the Nationalist government and its army to Taiwan. Along with them came a considerable number of academics who chose the Nationalists over the Communists. Their arrivals left no more room for the retention policy. All but a very few number of exceptions among the remaining Japanese faculty were forced to leave Taiwan in 1949, closing a chapter of research education in Taiwanese history.

[45] See Wen-Hsun Sung, 'Transcription of "Xianshi shidai de Taiwan gaishuo" (Overview of Taiwan prehistory)', 153–61, Sung Wen-hsun Papers, National Taiwan University Library.

[46] The sites Kokubu and his students surveyed were mostly near Taipei and Taiwan's northern coastal areas. For his archaeological journals and field notes concerning these small-scale investigations see Naoichi Kokubu, 'Saishuki (Notes on Collection)', n.d., Kokubu Papers, National Taiwan University Library; Naoichi Kokubu, 'Archeology', n.d., Kokubu Papers, National Taiwan University Library.

[47] Kokubu coauthored with Kanaseki Takeo a paper for the Japanese Society of Ethnology in 1950 that described the archaeological surveys in Taiwan from 1945 to 1949. See Takeo Kanaseki and Naoichi Kokubu, 'Taiwan senshi kōkogaku niokeru kinnen no Kōsaku (Recent studies in prehistoric archaeology of Formosa)', *Minzokugaku Kenkyu* (Japanese journal of ethnology), 18 (1950), 67–80.

Conclusion

This chapter has analyzed research education in colonial Taiwan during the interwar period, based on a survey of the context of the founding and organization of Taihoku Imperial University and on a selective review of the careers of its teaching staff. The analysis identifies four modes of research training at work. The first mode was undergraduate training, the only formal research education that Japanese universities, including Taihoku, offered. The students majoring in Southeast Asian history at Taihoku, for example, studied multiple languages, learned primary research using the languages, and applied their research to a degree thesis. The second mode was apprenticeship. All junior members of the teaching staff helped professors with teaching and research. They learned their trade by completing assignments under the professor's direction and close supervision. The third mode was self-training, applicable to scholars who taught at non-university institutions, especially in a region with no university. They used their time after teaching to collect historical material, do fieldwork, make small-scale excavations, and write and publish their findings. Some of them gained junior university positions with their active research and publications. The fourth mode was study abroad, available to a select few who went overseas, often on government scholarships. A portion of the Japanese professors were kept to provide teaching after Taiwan's handover to China; they continued to train Taiwanese students in their undergraduate classes and in the field during the transitional period of 1945–48.

The efficacy or success of the research training at Taihoku can be judged by the career development of the junior members of its teaching staff. Apprenticeship worked to the degree that most of the junior members moved up in the ranks when openings became available (with the exception of Maejima). More significantly, some of them acquired chairs at the foremost Japanese universities. Iwao became a professor at Tokyo, the flagship university of Japan, and Yani had a chair at Kyushu University, also a respectable institution that was once an imperial university, and after the war one of the 'Seven National Universities'. The first lecturer in national history, KOBATA Atsushi (小葉田淳, 1905–2001), ended up as a professor at Kyoto, the rival to Tokyo. The first assistant professor of East Asian history, KUWATA Rokuto (桑田六郎, 1894–1987), became a professor at Osaka, also one of the Seven National Universities.

Some of those who trained themselves in sub-university teaching positions also made good career advancements. As seen above, Kaneko was appointed at Taihoku as assistant and then lecturer before the war. Kokubu became an associate professor after the war. Maejima became a professor at Keio.

The success of Taihoku's undergraduate training for academic careers in Japan is harder to judge. The most successful academic among Taihoku's history graduates was probably Mabuchi. He was in the first class of Taihoku students and became an assistant professor at Taihoku in 1943. He retired from Tokyo Metropolitan University as a professor. Another success story was NAKAMURA Takashi (中村孝志, 1910–1994). A Japanese born in Taiwan, Nakamura graduated as a Southeast Asian history major from Taihoku in 1935, was employed by the Investigation Bureau of the South Manchurian Railroad Company before the war, and retired as a professor at Tenri University, a private university in Japan, after the war.[48] Thus, Taihoku's history department produced two professors out of a total of thirty-three graduates—not a bad rate.

On the other hand, none of the Taihoku history graduates landed a position at any of the foremost universities in metropolitan Japan, even after the war. This may have had less to do with the quality of Taihoku's research training than with Japanese academia's preoccupation with intellectual pedigree. To be a professor at one of the top universities, a junior scholar had to have graduated first or at least second in his class at one of those universities. In fact, all the junior members of Taihoku's teaching staff who later gained professorships at leading Japanese institutions were Tokyo or at least Kyoto graduates. In spite of Taihoku's great resources and solid undergraduate education, the university in the colony still did not belong to Japan's 'Ivy League', so to speak. Its graduates had virtually no access to faculty positions in that league.

The case for Taiwanese students after the war was very different. Before the war, it was very difficult for colonial subjects to become university instructors, even though a very small number of them overcame the difficulty. This explains why the only two Taiwanese history graduates in the colonial period did not venture an academic career. Things changed dramatically after the war, especially after the Nationalist government fled to Taiwan. Taipei was no longer the periphery. Instead, it had become the metropole. At that time, the university in Taipei was the only one in Taiwan, and it has remained the foremost academic institution even up to today. The students it trained became the elite of Taiwanese academia. Wen-Hsun SUNG (1924–2016), Bing-Hsiung LIU (1925–2004), and Ting-Jui HO (1923–2014), Taiwanese students who entered the university immediately following the war, gained teaching positions at National Taiwan University and at Academia Sinica, the leading research institution in Taiwan. Though trained by the retained Japanese Miyamoto and Kokubu, they formed the first generation of Taiwanese who had successful

[48] Chou, 'Nanyō-shi as Research Chair and as a Major', 47, 49.

academic careers at the foremost institutions in Taiwan.[49] They based their work very much on the material and methods that their Japanese teachers imparted to them. Their specialty in the ethnology of Taiwan was still indispensable even to the new rulers for governing the aboriginals, making these scholars irreplaceable by their Chinese teachers or peers in the first decades after the war.

This is not to say that their Chinese teachers were not important in their intellectual formation. The junior Taiwanese scholars also benefited from the teaching of the Chinese faculty who had just retreated to Taiwan. Some of them were the most accomplished historians, anthropologists, and archeologists of their generation. Nonetheless, they came with their political, cultural, and linguistic preferences, creating delicate and often unspoken tensions between them and their Taiwanese students (and the Taiwanese population at large). They preferred Chinese history to Taiwanese history and Southeast Asian history, for instance, at a time when their minds were set on reacquiring China. Therefore, the first postwar Taiwanese graduates of the university did not advance on the academic path in the history department as well as their peers did in the program that became the Department of Archaeology and Anthropology. The new generation of academic historians in Taiwan, however, belongs to another study.

Academia Sinica, Taiwan
National Taiwan University
Academia Sinica, Taiwan

[49] They were joined by Taiwanese who were educated in Japan or China and returned to Taiwan as junior scholars or students at the reorganized university, such as Yun-Ping Yang, Chi-Lu Chen (1923–2014), and Chih-wan Liu (1923–2018).

Conclusion

Ku-ming (Kevin) Chang and Alan Rocke

University reforms that institutionalized research education in the principal European countries and in the United States have been well studied; the remainder of this paragraph offers a quick summary of the received wisdom. The so-called Humboldtian reforms made Prussian universities, and Berlin in particular, leaders in higher education from the early nineteenth century onward. The Prussian university reformers, including Wilhelm von Humboldt, established original research and the training of students in research into important objectives for the university, and this research ethos quickly spread across German states in the next few decades. The reception of the research ethos was late and slow in France. The Napoleonic reforms at the beginning of the nineteenth century radically reorganized the *Université de France* and hollowed out its function in advanced studies. By the 1850s and 1860s, French scholars began to advocate the German model of academic training after seeing its strength, and used their country's defeat in the Franco-Prussian War of 1870–71 as their battle cry for a systematic reform of French higher education. Reform measures were rolled out gradually over two decades from the mid-1870s. Britain accepted the research ethos even more slowly. Colleges had usurped most functions of the university at Oxford and Cambridge in the early modern period, and many of them resisted attempts to implement curricula and degrees for advanced research until the late nineteenth century. Oxford and Cambridge thus often accepted changes later than other British universities—those in London, the other industrial cities, and Scotland. As part of the national rebuilding after the Civil War, leading American colleges upgraded to universities by adding graduate and professional schools, while new universities such as Johns Hopkins, Clark, and Chicago deliberately fashioned themselves as research universities. All of them bypassed the tradition-bound college and placed research education in graduate schools. Once begun, university reforms

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after the German model of research education were pursued with enthusiasm in the United States.

This volume focuses on the education that prepares students (or junior scholars) for advanced research. Research education is of great importance for the history of higher education and the history of science, for over the course of the century that this volume examines, the ability to do advanced scientific research came to be seen as the entry qualification for the academic profession. The training for this ability became the definitive education for academics. The history of research education is in this sense a story of the modern academic profession.

The chapters in this special issue/volume substantiate and fruitfully complicate the common understanding of the history of higher education in the dimensions that are discussed in the preface. These chapters examine representative disciplines that rely on different instruments and methods of research. Some chapters study cases of disciplinary education in individual countries, while others compare disciplinary practices across several countries. Reaching beyond the Eurocentrism that is embedded in the received wisdom summarized in the first paragraph of this conclusion, this volume expands its attention to major countries in South Asia, East Asia, and Latin America. This coverage includes not only sovereign countries that were more or less free to choose their academic systems, but also colonized societies or regions upon which external systems were imposed. This volume also pays attention to women researchers, whose entrance to academia was late and slow, but monumentally important. Instead of comparisons of national systems that are common in the international studies of higher education, this volume deliberately investigates concrete cases in which institutional culture and disciplinary practice shaped research education.

Together, the authors of this volume approach the history of research education across several axes: the foundation of research education in the university; the instruments of research education and their multiplication; expansion of higher education and proliferation of disciplines; the emergence of women researchers; and the roles of state, nation, imperialism and globalization. Below we summarize prominent findings in individual chapters, and weave together themes that are visible only by comparing or digesting several or all of them.

The Foundation of Research Education in the University

Most of the chapters in this country study the research education at universities, either comparatively or in individual countries. Indeed, one of the most significant changes in higher education in the last two centuries is the very fact that universities, at least select ones, took over the function of training in advanced research. It was pointed out in the introduction to this volume that the most advanced scientists or scholars, such as members of scientific academies, often received their training outside universities in the eighteenth century.[1] In the twentieth century, none would be elected to the national academy without university education, not to mention graduate training. When new forms of research institutions appeared in the nineteenth century or later—the Robert Koch Institute, the Pasteur Institute, the Kaiser Wilhelm Gesellschaft, the CNRS (*Centre National de la Recherche Scientifique*)—they recruited researchers who had received university and often doctoral education. This trend has only intensified today, when industry, as well, recruits university-educated scientists or PhDs into its research and development departments.

German universities, and those that shared a similar model in the Austro-Hungarian Empire, differed from their counterparts in other Western countries in that they offered research education following graduation from Gymnasium, which meant that in the German-speaking lands the doctoral degree (in theology, law, medicine, and 'philosophy', i.e., the various sciences) was the first degree that a student received after secondary education.[2] In this sense, doctoral education that taught advanced research was technically 'undergraduate'. The challenge, then, was that these universities were still obliged to provide education to those who had no interest in an academic career. Kasper Risbjerg Eskildsen points out in Chapter 2 that German professors were made acutely aware that they could not train all students as researchers, especially in an age of rapid expansion of higher education. They either selected only a very few research-minded students for their seminars,[3] or, like Waitz, opened two seminars, one for students who were research-minded, and the other of more practical nature for those who were not. German universities thus accommodated this difference by diversifying their curricular offerings.

[1] For an analysis of the career of the members of the Royal Academy of Sciences in Paris, see Ku-ming (Kevin) Chang, in Matthew D. Eddy, Seymour H. Mauskopf, and William R. Newman (eds.), 'Communications of Chemical Knowledge: Georg Ernst Stahl and the Chemists at the French Academy in the First Half of the Eighteenth Century', in *Chemical Knowledge in the Early Modern World*, Osiris, 2nd Series (Chicago, 2014), 149.

[2] Among all German universities, Jena preserved the bachelor of theology degree, Leipzig the bachelor of law, and Bonn the Master of Arts. These were the few exceptions that were degrees awarded after secondary education and before the doctorate. Max Baumgart, *Grundsätze und Bedingungen zur Erlangung der Doctorwürde bei allen Facultäten der Universitäten des deutschen Reichs* (Berlin, 1884), 45, 93, 161–2, 165–6.

[3] This was Leopold von Ranke's solution. He reserved the seminar only for gifted students, and thought that lecture courses were enough for ordinary students. Leopold Ranke, 'Vorrede', in *Jahrbücher des deutschen Reiches unter dem sächsischen Hause*, i (Berlin, 1837), viii–ix.

They only granted the doctoral degree to a very small percentage of students.[4]

To further select their teaching staffs, German universities introduced the *Habilitation*, a postdoctoral qualification requiring, among other elements, a second major research project. In the nineteenth century, starting with Berlin, the habilitation was institutionalized as the qualification or license that gave the recipient the *venia legendi*, the privilege to teach at the university, although the preparation for the habilitation involved little formal training.[5] All aspirants to an academic career, even in the professional faculties, needed the habilitation before they were admitted to teach at the university. This in fact distinguished the German academic profession from the traditional learned professions of theology, law, and medicine.[6]

Other countries accommodated students' different career goals by relegating research training to postgraduate levels. Throughout the first two thirds of the nineteenth century, students in France and Britain received higher education in arts or sciences that had limited specialization. Most training in specialized research was available only after university education, hence 'post-graduate'. Often this postgraduate training was quite informal. In English universities, postgraduate research fellowships, certificates, and degrees (such as the Bachelor of Science, Doctor of Letters, and Doctor of Science) appeared in the late nineteenth century for university graduates to pursue. Some required limited coursework; others required the submission of published works as proof of scholarly achievements (Chapter 1). In France, the *doctorat d'état* was a degree available to those who had completed university study and thus had been granted the *licence* degree. A university graduate usually taught at a secondary school. To become a professor, they needed to work on a major

[4] At Berlin, the rate of students who receive their doctorate was constantly below 2 percent in the 1900s and barely 3.6 percent in 1923/24. Siegfried Wollgast, *Zur Geschichte des Promotionswesens in Deutschland* (Bergisch Gladbach, 2001), 206. Through the nineteenth century, the faculties of traditional professions—theology, law and medicine—continued to train students for practical roles, generally shunning over-specialized focus. The faculty of philosophy meanwhile educated students who sought a teaching career in the Gymnasium. Many students skipped the doctoral degree and took state examinations instead. If they passed, they entered these professions.

[5] The habilitation was essentially an apprenticeship in the university that stipulated little formal training. It required a doctoral degree, certain years of residence, a research paper that could not be the candidate's dissertation, and a public lecture in front of the faculty to which the candidate belonged. No habilitation-level coursework was offered. Paul Daude, *Die Rechtsverhältnisse der Privatdozenten: Zusammenstellung der an den Universitäten Deutschlands und Oesterreichs*... (Berlin, 1896), 7–8.

[6] Martin Schmeiser, *Akademischer Hasard: das Berufsschicksal des Professors und das Schicksal der deutschen Universität 1870–1920: eine verstehend soziologische Untersuchung* (Stuttgart, 1994), 31.

thesis for the *doctorat d'état*, a postgraduate degree while they were teaching in secondary education. After the French defeat in the Franco-Prussian War, the reforms that ensued expected this thesis to be a very substantive work, often hundreds of pages long, based on original research. While laboratory training was provided for doctoral work in experimental sciences, little residential study and little professorial supervision was required or offered for candidates in the humanities (Chapter 6). In the United States, the Doctor of Philosophy degree, though modelled on the German degree, was postgraduate, for it was awarded to college graduates. Pursued essentially by those who wished to pursue an academic career, the American PhD demanded residential study, a set coursework, and a dissertation that presented the results of advanced research.

When non-Western societies—India, Japan, China, Korea, and Taiwan, those reviewed in this book—introduced universities, they first implemented its function of teaching. At least in this early stage, the university was expected to produce personnel that their traditional institutions could not provide, such as civil servants, lawyers, and judiciaries for modern statecraft; scientists and engineers for the material and economic infrastructure of the society (geologists to explore mineral resources, for example); doctors of Western medicine; and teachers for modern secondary and tertiary education. During this period, original research was not demanded from the teaching staff of the university, nor was it provided for. The training of its students for advanced research was likewise scarcely addressed. When research education was finally offered, it was at first available at the postgraduate level only.

Once postgraduate research training was put in place, it began to infiltrate into undergraduate education. This was especially true in the societies where no formal graduate education was available, such as Britain and Japan. In these countries, even if doctoral degrees were available (and sometimes graduate schools or programs were opened), there was no set curriculum and no formal training (Chapter 5). The only way to give students serious training in research (after it had become desirable) was to offer it in the undergraduate curriculum, at least to select students. As Wei-chi Chen, Wan-yao Chou, and Ku-ming (Kevin) Chang show in Chapter 16, this was also the case for Japan's colonies, such as Taiwan.

A pattern that the cases in this special issue seem to suggest is that leading universities in all countries eventually became, or at least aspired to be, research universities. Although in Germany every university was meant to be a research university, the leading city of the German Empire, Berlin, had to maintain its status as the site of the best of all research universities by keeping a constellation of the greatest scholars in almost all disciplines (though in the field of language studies Leipzig was paramount).

Elsewhere in Europe and North America, only selected universities were equipped to support advanced research. Again, it was the leading national universities—such as Paris, Oxford, Cambridge, Harvard, Yale, Johns Hopkins, and Chicago—that received this equipment. This trend also applied to latecomers in higher education in the non-Western world. The universities that stood out—Calcutta, Tokyo, São Paulo, and Peking—eventually took upon themselves the task of original research and the teaching of research, despite material and cultural constraints.

What might explain this almost universal phenomenon? Local factors may have varied from one place or society to another, but a common factor is that by the late nineteenth century, or at least by the early twentieth, it had become the norm that the goal of scholarly work was to seek the advance or progress of knowledge. In Max Weber's words, for academics 'to be superseded scientifically is not simply our fate but our goal'.[7] This mentality was already deeply rooted in Western societies by the time Weber gave his famous lecture 'Science as a Vocation' in 1917. In non-Western countries or societies, this research ethos was first brought home by the students or scholars who studied in Western countries. The result was the same perception: A respectable university could only win and sustain its status by conducting and supporting original research that received the approval of its peers. This pressure was greatest for the leading universities of the country, for they produced the majority of the academic elite of their home society, and often received the most resources.

The establishment of research education coincided with the secularization of the university. In the Middle Ages, theological teaching dominated the university curriculum; the university saw its core mission to train clergy. This began to change already in the early modern period, and was radically altered in the nineteenth century. The faculty of philosophy (or the faculties of letters and sciences in France) became the core of the university, supporting an ever increasing number of disciplines. Local contexts varied from one country or society to another. In Germany, it was Kantian, idealist, and neohumanist currents of thought that elevated the faculty of philosophy, a base for disinterested learning, over the professional faculties. It France, it was the French Revolution and the following Napoleonic reforms in higher education that removed the domination of religion over the faculties of letters and sciences (which were split from the faculty of philosophy of the pre-Revolutionary university). In both countries, reforms in the early nineteenth century secured employment in secondary schools for the students of philosophy (or letters and sciences),

[7] Max Weber, 'Science as a Vocation', in David Owen and Tracy B. Strong (eds.), *The Vocation Lectures*, trans. Rodney Livingstone (Indianapolis, 2004), 11.

thus strengthening these faculties' practical attraction to students. In Britain, a career in the Anglican Church had traditionally been the favorite choice for the graduates of Oxford and Cambridge, but through much of the nineteenth century students spent most of their college years in these two leading universities learning and preparing for the examination subjects in mathematics (at Cambridge) and classics (at Oxford). Meanwhile, more 'modern' universities, such as the University of London, were created. After the American Civil World, leading American colleges deliberately worked to upgrade themselves to universities by introducing graduate schools. In all these countries, the studies in natural sciences and the humanities served as the model for all learning in the university, thanks to their original contributions to human knowledge.

The secularization of university education also reflected the general trend of European society. Barberis provides a telling example in Chapter 6. Just as Christianity was losing its function of unifying the society in France, the Minister of Public Instruction of the Third Republic created a position in 'Science Sociale et Pédagogie', with the goal of providing a secular morality based on science to replace what the Catholic Church had offered.

In non-Western societies, university teaching and research arrived as an alien institution. The university had no relation to the indigenous religion; in fact, it may even have competed with institutions that imparted the learning of traditional religion. In general, the appeal of Western higher education was rather its promise of material developments for the country, although colleges of Western missionaries intended otherwise. University education thus largely served to instill science or Western modernity to these societies, promoting secularization.

Instruments of Research and their Multiplication

Before the nineteenth century, the lecture and the disputation were two chief forms of teaching in European universities, although the latter was losing its dominance in the early modern period.[8] Philologist Friedrich August Wolf was the first to develop the seminar as an instrument to train junior scholars in methods for philological research. His academic heir

[8] William Clark points out that philology had its roots in rotational disputation that had been used since at least the early modern period: 'On the Dialectical Origins of the Research Seminar', *History of Science*, 27 (1989), 111–54. See also Friedrich August Wolf's integration of disputation into his seminar: Carlos Spoerhase and Mark-Georg Dehrmann, 'Die Idee der Universität: Friedrich August Wolf und die Praxis des Seminars', *Zeitschrift für Ideengeschichte*, 5 (2011), 111.

August Boeckh carried on the philological seminar at Berlin into the 1860s. It is well known that the philological seminar served as the model for seminars in history and in the faculties of theology and law.[9]

Eskildsen's chapter, examining Georg Waitz's seminar at Göttingen in the 1860s, shows the multiplication of the seminar as an instrument of historical research. Waitz had modelled his seminar on his professor Leopold von Ranke's 'seminar of all history seminars' that was started at Berlin in the 1830s. It in turn became the model for many more. Instead of methodical training, Waitz emphasizes the character-transforming power of the seminar. As Eskildsen points out, the seminar was thought to shape the junior historian's relationship to his object, his discipline, and his community. As students became professors, they duplicated the historian's identity that formed in the seminar, and multiplied the seminar to educate the next generation of historians.

Historical research multiplied not just on the personal and local levels, as in Waitz's seminar, but also on a large, and even transnational, scale. In the second half of the nineteenth century, a considerable number of historians—including Paul Fredericq, a Belgian, Kristian Erslev, a Dane, and G. Stanley Hall, an American—investigated methods and instruments of historical teaching in Germany and sometimes other countries (Chapter 2). They published reports in their languages (sometimes also translated into other languages), disseminating the methods of distinctive historical training impersonally in their countries and even abroad.

John Joseph and Daniela Barberis describe the ways in which French humanists and social scientists dealt with the lack of formal programs for research training in their country. A product of the German university, Ferdinand de Saussure was hired to teach comparative Indo-European philology at the *École Pratique des Hautes Études*, a new institution that was created in 1868 as an experiment to provide research training with lectures and especially seminars. His job was, in a strong sense, to replicate at *École Pratique* what he had learned in Germany. Indeed, Saussure trained some of the best French language scholars, and 'set the agenda for French doctoral training in linguistics and adjacent areas at least through the

[9] On the importance and working of the seminar, see the classical and recent studies of Friedrich Paulsen, *The German Universities and University Study* (New York, 1906), 212–15; R. Steven Turner, 'Historicism, Kritik, and the Prussian Professoriate, 1790–1840', in Mayotte Bollack and Heinz Wismann (eds.), *Philologie und Hermeneutik im 19. Jahrhundert* (Göttingen, 1983); William Clark, *Academic Charisma and the Origins of the Research University* (Chicago, 2006), 141–82; Spoerhase and Dehrmann, 'Die Idee der Universität: Friedrich August Wolf und die Praxis des Seminars'; Carlos Spoerhase, 'Das "Laboratorium" der Philologie? Das philologische Seminar als Raum der Vermittlung von Praxiswissen', in Andrea Albrecht et al. (eds.), *Theorien, Methoden und Praktiken des Interpretierens* (Berlin, 2015), 53–80.

1960s' (Chapter 8). Barberis's chapter shows how French sociologists, led by Émile Durkheim, offered his supervision to junior scholars who usually taught in secondary schools or provincial universities far away. Using his journal *Année sociologique* as a base, Durkheim trained junior scholars by instructing them to write book reviews and working closely with them on their original writings. They did this through extensive and frequent correspondence, when regular meetings were impossible.

Also short of formal programs of research education, British universities likewise turned to instruments that were less formal, and that were often not exclusive to research or post-graduate education. Seminar teaching, as Janet Howarth shows in Chapter 5, was rare and in fact unpopular at Oxford and Cambridge even at the turn of the twentieth century. British academics preferred conversations in the college dining hall, or Socratic dialogues in the classroom. Examinations for the Bachelor of Arts degree and honors gradually accommodated certain degrees of specialization and accepted non-standard answers to the essay questions. Some tutorials switched the focus to essay-writing, and university prizes and college fellowships were increasingly won by 'dissertations', which were research papers in the English sense. Howarth summarizes the British culture as one 'that valued quality over quantity of scholarship, collegiality and individual insights over hierarchy and the research school, literary merit and readability over mere originality'.

Training in the experimental sciences was very different from its counterpart in the humanities. At least on the rhetorical level, the neohumanist and idealist reformers who placed Berlin at the forefront of research universities favored pure, disinterested *Wissenschaft* or scholarly pursuits such as philology, history, philosophy, and mathematics, and some of them denigrated the experimental sciences as involving material interests and manual work. The experimental sciences were given significant impetus after Justus Liebig and colleagues influenced by him publicized their value. In Chapter 3, Alan Rocke analyzes the factors that contributed to the phenomenal success of Liebig's chemical laboratory in Giessen. These included personal, material, institutional, and disciplinary factors. This constellation of factors made the success of the Giessen model difficult to reproduce at first. Liebig's success, however, motivated German principalities, competing with one another, to support chemical laboratories. For similar reasons foreign universities, governments, and even individual scientists also tried to reproduce the Giessen model, or at least the research laboratory, from the 1840s on, with varying degrees of success.

Research education gradually became a core mission for theoretical scientists such as mathematicians in the middle third of the nineteenth century, again first in Germany. Like philologists, mathematicians also took advantage of the seminar as their instrument of research training. As seen in Karen Parshall's chapter, starting with Carl Jacobi at Königsberg, the seminar was the space in which students mastered and presented the most recent mathematical literature, learned to show calculations or analyses on paper, and worked out the solution or the proof of a mathematical problem under the supervision of a professor or his assistant.[10] In the second half of the century, mathematicians responded to the rapid growth of new fields by providing a growing number of specialized lecture courses and thematic seminars. They organized mathematics clubs on campus as support groups for interested students, and established specialized journals and professional organizations to serve specific fields or the discipline at large.

As for the humanities, France played a catch-up game for both theoretical and experimental sciences. In the early nineteenth century, France was the obvious European leader in both theoretical and experimental sciences (mathematics, chemistry and physics). Beginning in the 1830s, the ambitious and capable chemist Jean-Baptiste Dumas expressed fears that Germany was moving ahead of his country. By mid-century, the lead of Germany was becoming obvious to many observers. Unable to find state support for their chemical laboratories, French chemists set up private ones where junior chemists found suitable training in experimentation. All but one of them soon failed, and the one that survived did not prosper until the higher education reforms of the Third Republic finally provided support. For theoretical sciences like mathematics, the reforms increased the size and funding of the faculty of sciences and the number of lectures and seminars. They accommodated doctoral studies, and made it possible for good young scholars to teach specialized courses full-time as *maîtres de conférences* (newly created positions that were lower than professors in rank) in the faculties of sciences. Paid in these positions, junior scientists would not be distracted by teaching in secondary school.

Britain presented a different case for experimental and theoretical sciences. The young University of London forged ahead of Oxford and Cambridge in constructing a purpose-built academic laboratory (the Birkbeck Laboratory) in 1845. For the rest of the century, chemical laboratories, chairs, or professorships slowly appeared in England (in Manchester, for example) or Scotland (e.g. Edinburgh), almost all filled by chemists who received experimental training in Germany (Chapter 3). For

[10] Gert Schubring, 'Das mathematische Seminar der Universität Münster, 1831/1875 bis 1951', *Sudhoffs Archiv*, 69/2 (1985), 165, 171, 172, 177.

mathematics, as shown in Parshall's chapter, Cambridge had an advantage over other British institutions in its Mathematics Tripos, an honours examination. This advantage waned as the Tripos tested students on increasingly antiquated questions and memorization. Systematic teaching in mathematical research was still largely absent in British universities through the nineteenth century.

Over the course of that century, medicine became a vast terrain of teaching, practice, and research that was based on clinical work. The medical faculty at the Prussian University of Halle at the turn of the eighteenth century consisted of only two chairs—one in theoretical medicine and the other in practical medicine. In contrast, around 1900 the medical faculty at Berlin, which replaced Halle as the leading Prussian university, consisted of no less than 36 professors (and many more unpaid lecturers or *Privatdozenten*), five research institutes, a university hospital (the *Charité*), and at least ten clinical departments.[11] By the mid-nineteenth century, teaching at the sickbed had become a staple of the medical curriculum in major Western countries, while laboratory training in the basic sciences competed for time. In fact, as In-sok Yeo points out, following the example in Europe and the US, Japanese and Korean universities in the 1920s and 1930s favored basic science over clinical work as the choice of doctoral research in medicine. Most doctoral projects, however, were experimental research on phenomena found in clinical observations. As Theodore Porter explicates in Chapter 7, statistical studies of clinical phenomena also grew.

Fieldwork as an instrument of research training began to be accepted toward the end of the nineteenth century. Up to that point, humanistic studies were largely based on texts, for which personal presence at the site of investigation was not required. For example, Sanskrit philology, a respectable field by the 1870s, was still very much a so-called armchair study that required no visit to India.[12] Fieldwork was valued in, for example, archaeology, ethnology/anthropology (Chapter 1), language studies (Chapters 8 and 9), geology, and paleontology (Chapter 15). Though all valued experience in the field, these disciplines relied on different technologies to tackle different materials. Archeologists looked for artifacts by excavation, while anthropologists studied 'primitive' culture or society by living amongst aboriginal peoples. Fieldwork had become a requirement for advanced degrees in these two disciplines by the

[11] *Verzeichnis der Vorlesungen, welche auf der Friedrich-Wilhelms-Universität zu Berlin im Sommer-Semester 1900 gehalten werden* (Berlin, 1900), 33.

[12] Pascale Rabault-Feuerhahn, *Archives of Origins: Sanskrit, Philology, Anthropology in 19th-Century Germany* (Wiesbaden, 2013), 233–7.

turn of the twentieth century. Language studies followed later. In the 1880s, Saussure had to urge his students in Paris, chief among them Antoine Meillet, to study the language where it was spoken (Chapter 8). Without training in advance, Meillet was on his own in the field. In the 1920s, Edward Sapir took his student Fang-Kuei Li to a Native American tribe, demonstrating to the junior scholar the process of selecting and interviewing informants (Chapter 9).

Another important mode of training may be characterized as apprenticeship. The German *Habilitation* can serve as an example. Most training available to the candidate at this stage was the observation of professors and *Privadozenten* at work. In German universities there were also positions like *Assistent*, who helped a professor with his teaching or laboratory. The junior scholar essentially accumulated training as an apprentice when he worked on the *Habilitation* or as an assistant. As Chen, Chou, and Chang show in Chapter 16, in Japan and its colonies a promising university graduate either studied in graduate school, which provided no formal education except a scholarship, or worked as assistant, teaching assistant, or lecturer. He apprenticed as a junior member of the teaching staff, observing his master teach and perform research.

Chen, Chou, and Chang's chapter also presents the mode of self-training that was available in Japan and its colonies (and elsewhere). When an academically-minded university graduate taught high school in a region where no university was nearby, they studied local history, archaeology, or geology by investigating monuments or primary materials in the city, or took their students to do small-scale field surveys or excavations. They thus trained themselves by applying to their new material the research training that they had received from undergraduate education. If their publications won recognition, they returned to academia and even ascended to its top.

The case of Japan and those of India and China show that research training could take place outside universities. Before a research university was in place in Bombay, museums and scientific societies supported scientific research, though such research might have been more curatorial in nature than original (Chapter 12). In China, it was the Chinese Geological Survey that funded the first academic journal for the discipline and fostered the first generation of geologists, paleontologists, and even archeologists in the country (Chapter 14). Also, as Porter indicates in Chapter 7, many figures who were seen as professional statisticians learned on their jobs and improved statistical tools and theories by meeting the needs of their practical work.

Based on the comparative analyses in this volume, five modes of research education can be identified: formal education (which may be graduate or undergraduate) that could include training in the seminar, the laboratory, or fieldwork; informal immersion in school life (such as conversations in the college dining hall); apprenticeship in junior academic positions; self-training without the resources of a nearby university (or universities); and advanced study abroad (see below). Depending on the junior scholar's institution or country, he may experience just one mode of training, or multiple at the same time or different points in time.

Disciplinary Identity and Proliferation amid the Expansion of Higher Education

As noted above, Germany experienced an expansion of higher education in the 1860s and 1870s. Although the modern research university was taking root across German states during the *Vormärz* period (the decades preceding the March revolution of 1848 in Germany), the size of universities remained relatively small until the 1860s. A result of industrialization and its consequent prosperity, this expansion also occurred in other European countries.[13]

Some academics experienced this expansion with complaints. An example discussed above was the Göttingen historian Waitz, for whom this expansion meant a decrease in the quality of students. He complained about the qualification of the majority of students. In addition to the seminar that he led for academically-minded students, he coped with this reality by opening a second seminar for students who were not interested in original historical research.

Complaints apart, positive consequences also derived from the expansion of higher education. Mathematicians were happy to see enrollment in their courses grow to 250 at times in a single German university (Chapter 4). Material investment also grew. Before the 1860s, support for chemical laboratories could be seen as individual experiments among competing German universities (and their states). The completion in 1868 of a lavish laboratory at Berlin, which a generation prior Liebig had characterized as reactionary toward experimental sciences, marked the beginning of a new norm that was replicated rapidly and widely across Germany. Indeed, the decades after 1870 saw more investments in new institutes and professorships in the unified German Empire, including the newly annexed University of Strasbourg. The increases of the student

[13] Konrad H. Jarausch, 'Higher Education and Social Change: Some Comparative Perspectives', in Konrad H. Jarausch (ed.), *The Transformation of Higher Learning, 1860–1930: Expansion, Diversification, Social Opening, and Professionalization in England, Germany, Russia, and the United States*, (Chicago, 1983), 9–36.

body, the teaching staff, and material investments were also evident in France, Britain, and the United States.

Concurrent with the expansion of higher education was the proliferation of disciplines. The increase of scholars, students, and resources encouraged and supported specialization, then as well as now. James Turner has shown the many disciplines that developed out of philology in the second half of the nineteenth and the twentieth centuries.[14] His chapter in this volume also illustrates the diversification of classical studies into comparative literature, classics, anthropology, and archaeology, among other fields. Language studies were also drifting from text-oriented philology to becoming linguistics and phonetics (Chapters 8 and 9). In France, Durkheim, as Barberis shows (Chapter 6), worked to assert the independence of sociology from philosophy (in which he had been trained) or education (which was the subject of his first professorship). Earth sciences also diversified into geology, paleontology, and archaeology (Chapter 14).

The chapters by Turner and Porter remind us that as late as the turn of the twentieth century, there were still areas of studies that could not be easily defined as a discipline. Turner's chapter investigates 'common erudition'. The first example is John Linton Myres, who taught and published in classical literature and history, did archaeology by actual excavations, founded the Royal Anthropological Institute's journal *Man*, and became the institute's president. The other examples are Charles Eliot Norton of Harvard, who taught art history, Dante and organized the Archeological Institute of America, Andrew Lang, classical scholar, historian of Scotland, and anthropologist, and the Canadian-American Simon Newcomb, astronomer, mathematician, and economist. Their work covered a wide range of today's disciplines. Instead of specialists, they are better seen as generalists.

Common erudition was supported at particular places and in a particular age. Myres, Lang, and Norton were educated at Oxford or at Harvard, where colleges preferred general, classics-based learning to specialized knowledge. Their appointments at their alma maters were essentially to provide the same education to students, even though they were free to publish in areas rooted in classical studies that were splitting into different disciplines. Without previous formal education, Newcomb taught himself mathematics until he enrolled at the Lawrence Scientific School of Harvard. His broad expertise in astronomy, mathematics, and economy were the result of his practical works in nautical sciences

[14] James Turner, *Philology: The Forgotten Origins of the Modern Humanities* (Princeton, 2014).

(including planetary observation) and later at Harvard's observatory, which eventually won him the appointment as the Professor of Mathematics at Johns Hopkins. Economics may be seen as an extension of his previous work in mathematics. None of these four scholars had a PhD, which required specialized research for the dissertation. Without a doctorate their appointments would have been very difficult, if not impossible, in Germany or France at the time or thirty years later in the US.

New disciplines may grow out of a common root, while a discipline may also claim different roots. In Britain, from classics grew philology, archaeology, and to some extent anthropology (Turner). In Japan and colonial Taiwan, archaeology, aboriginal ethnology, and anthropology of contemporary society were joined in the Institute of Ethnology (Chapters 16). In Europe, philology gave birth to language sciences, while linguistics and phonetics competed, in France and England at least, to be *the* science of language. The American tradition, however, saw linguistics as part of anthropology (Chapter 9). As seen above, archaeology may have its roots in classical studies and ethnology. But those were not the only influences. As Yen shows in her chapter, geologists also expanded their reach to archaeology (and paleontology) in the early twentieth century. Thus classics, ethnology, and geology may all claim to be the origin of archaeology.

Porter points out in his chapter that an academic subject like statistics was more than just the discipline of mathematical statistics that gradually received chairs or departments in Western institutions. Statistics was 'highly heterogeneous, resisting any neat classification'. It served as a method in many disciplines and industries, such as agriculture, medicine, psychology, and ecology, as well as economics, insurance, industrial quality control, and regressions. Statistics was therefore both a field and a method with many applications. Its practitioners continued to be trained on their jobs or in disciplines outside of mathematical statistics, even after the advanced degree in statistics appeared in the early twentieth century.

Turner investigates the possible causal relationship between disciplinary training and the formation of a discipline. The instruments or methods of research training, such as the seminar and the laboratory, indeed instill a disciplinary identity in students (Chapters 2, 3, 4, etc.); that is, they shape the discipline. This does not necessarily mean that a particular instrument of research generates a discipline, for an instrument of training is often shared by several disciplines. Though the seminar was first adopted to train students in philology, for example, it was then used in history, mathematics, and other disciplines. Likewise, fieldwork first served as the method of research and training for anthropology, and was consequently used by Sapir, first trained as an anthropologist, to prepare his students in linguistics. The instrument of research training, like the seminar, thus is not discipline-specific. It may serve several disciplines at a time, or it may sustain a discipline while also generating a new one.

On the other hand, several instruments of training may have been available to a discipline. Language scholars had fieldwork, auditory training, and the phonetic laboratory at their disposal, though they did not employ them equally. Scholars at Chicago and Yale preferred fieldwork, the phoneticians at University College London preferred ear training, and the scholars of African languages at Hamburg placed greatest emphasis on instrumental analyses in the laboratory (Chapter 9). Or a junior scholar may have received his training in a combination of several research instruments. An anthropologist may have been trained in the seminar and also in the field. A physician might have been trained at the bedside as well as in the laboratory. A chemist might have started in the laboratory and then served as an assistant to a professor, like an apprentice. Hence, disciplines may not have been training-specific.

The Role of Women in Research

To pursue a career of academic research, women faced two major hurdles. They first had to be admitted to the university, and they subsequently needed a formal position in the university or a research institution. The former was hard to come by until the nineteenth century, and even later in some societies. The latter came much later.

The openness to women's higher education is not correlated to a country's research standing. Germany, the leader in research education, formally admitted women to universities only after 1900, the last major Western country to do so. France admitted women gradually, beginning in the 1870s and 1880s. The first colleges for women were established at Oxford and Cambridge also in the 1860s and 1870s, although full degrees were not available for women until the 1920s and 1940s, respectively. The University of London granted its first degrees to women in 1878.[15] The United States, hardly a leader in higher education otherwise, forged ahead of European countries in opening colleges to women in the 1830s, though at first the number was small. By the 1870s there were a considerable number of private co-educational or women's colleges. Boston University was the first to confer the PhD to a woman, Helen Magill White, in 1877, and Bryn Mawr College, for example, set up a

[15] Richard J. Evans, *The Feminists: Women's Emancipation Movements in Europe, America and Australasia 1840–1920* (London, 2012), 66, 111, 128.

doctoral program in mathematics for women in the 1890s.[16] In Japan, women's colleges opened in the 1900s, though women were not admitted to national universities until decades later.[17] Women were admitted to Chinese state universities and women's colleges in 1919, following the small missionary colleges established in the previous decade.[18] Though China fell behind Japan in many aspects of higher education, it appointed the first women to Peking University, its flagship state university, in 1920, much earlier than Japan did.[19]

Several chapters in this volume pay attention to women who received research education in the first half of the twentieth century. Their careers can be generalized into three types. First, they did not obtain academic appointments even after receipt of the doctorate. The reason may have been partly personal or familial; for instance, Maria von Tilling, who received her PhD in language studies at Hamburg in 1924, gave up her teaching position there to relocate with her husband for his appointment at Leipzig (Chapter 9). Or in many cases jobs were not available: Barbara Freire-Marreco, with a certificate of a largely postgraduate program in anthropology at Oxford and a college scholarship at Somerville College, Oxford, never acquired a full-time appointment, although she continued to write, edit and publish in anthropology (Chapter 1).

The second type consists of women who taught and did research in low-rank positions in an academic laboratory or department. These included Karl Pearson's women students in his Laboratory of Eugenics (Chapter 7) and the female staff of Daniel Jones' Department of Phonetics (Chapter 9), both at University College London. Mary Haas was supported by postdoctoral fellowships at Yale in the 1930s and 1940s (Chapter 9).

A third category was those women who received professorships at women's colleges or co-educational universities. Jeanne M. Vidon-Varney, for example, received a university doctorate (lower than the state doctorate) in phonetics at the Sorbonne, and then found a teaching position at Barnard College, a women's college affiliated with Columbia University;

[16] Margaret W Rossiter, *Women Scientists in America: Struggles and Strategies to 1940* (Baltimore, 1982), Chapters 1 & 2; 'Helen Magill White', in *Encyclopedia Britannica*, 2018, https://www.britannica.com/biography/Helen-Magill-White; Karen Hunger Parshall, 'Training Women in Mathematical Research: The First Fifty Years of Bryn Mawr College (1885–1935)', *The Mathematical Intelligencer*, 37/ 2 (2015), 71–83.

[17] Barbara Sato, *The New Japanese Woman: Modernity, Media, and Women in Interwar Japan* (2003), 26.

[18] Ruth Hayhoe, *China's Universities, 1895–1995: A Century of Cultural Conflict* (New York, 1996), 38, 46.

[19] For the Chinese case, see Denise Gimpel, *Chen Hengzhe: A Life between Orthodoxies* (2015), 1–2, 22–3. For Japan's conservatism in providing higher education and opening university positions to women, see Anne M. Harrington, 'Women and Higher Education in the Japanese Empire (1895–1945)', *Journal of Asian History* 21 (1987), 178–86.

she finally became a professor of French at Columbia in 1958. Another Sorbonne graduate in phonetics became a lecturer at Wellesley College in 1935 and later at the College of William and Mary (Chapter 9). Indeed, women's colleges were usually women's best hope for a teaching and research career, although some co-educational institutions began to hire women.

The fact that French women scholars found jobs in the United States suggests that it was harder for women to pursue an academic career in France (and likewise Germany) than in the US. The interwar decades constituted a period of transition for women's academic employment. Though the earliest appointment of women in academics took place before World War I, a small but signficant number of women received research education or doctorates between the wars. The number of them who found teaching or research positions also ticked up. Jones' lecturer Ida Ward received a professorship at SOAS in 1944, Haas a faculty position at Berkeley in 1948, and Vidon-Varney a full professorship at Columbia in 1958 (Chapter 9). These dates indicate that it was only after World War II that academic appointments of women opened substantially; even then, gender discrimination was a reality of life for female scholars.

Nations, States, Colonies, and Scientific Globalization

An important reason for the success of Berlin (and Prussian universities in general) as a leader of European higher education was the state's support and investments towards research, which were extraordinary in comparison to the other European countries. Already in the lead, German universities celebrated a further boom after the unification of Germany, as the country was enriched by industrialization. France and Britain, though wealthy and powerful, did not sufficiently recognize the value of research, much to the chagrin of their intellectuals who saw German academia charge ahead in Europe. France started seriously spending on academic research only after the Third Republic was established in the 1870s. As Howarth shows, in England it was the college culture of Oxbridge that resisted change. Thus Parliament, representing state power, had to impose reforms on these two ancient universities with national legislation. In the US, the land grants of the federal government after the Civil War helped jump-start some fine state universities. This factor should not eclipse the US-specific phenomenon that private universities relied on philanthropy that was generous to an extent envied by their European peers.

Some of the most important initiatives in the history of higher education were motivated by nationalism. The foundation of the University of Berlin was partly a result of a nationalistic reaction to Prussia's defeat by

Napoleon. The reason why the other German states were relatively quick to accept the Prussian higher education reform was a result of nationalism, both particularist and pan-German. During the Vormärz period, German intellectuals called loudly for a unified country. Powerful German princes had to work hard to show their mandate as the unifier, while small ones endeavored not to be overshadowed by their larger peers. Each looked to strengthen his cultural capital by elevating the standing of his state's university, through staffing it with famous scholars and building appropriate infrastructure when necessary. Systematic higher education reform gained momentum in France only after the country suffered a humiliating loss to Prussia in 1870–71. Britain sensed little urgency for reform in part because the nation experienced no survival crisis. Leading American institutions began or accelerated their reorganizations after the Civil War, in part in the image of Germany. In the eyes of Americans, Germany, like their own country, was working for unification after a series of wars, and experiencing similar industrial and social developments. Americans were the most enthusiastic followers of German academia until the First World War.[20]

A foreign institution for non-Western societies, the university was often accepted at moments of national crisis. Some of these societies had had institutions of learning that educated their traditional elite. In imperial China and Korea, it was the centuries-old Civil Service Examinations and the associated web of private schools and state programs that prepared their intellectual, political, and cultural elite. In Muslim societies, it was the madrassa. Few of these societies voluntarily gave up their institutions for the Western educational system that was topped by the university. Japan and China accepted the university as the Western powers' aggregation made it clear that their survival was in serious danger. In India, Korea and Taiwan, it was the colonial rulers who made the decision. For all these societies, the university was at the heart of Westernization, serving as the institution that trained the country's new elite to staff the modern state machine. For the countries that managed to keep their sovereignty, the university also promised to strengthen them with science, technology, and economic growth against aggressive powers. In many societies—Japan, China, and India, for example—within a few decades the newly introduced university (or college) became the exclusive institution where the new elite received their education.[21]

[20] Jurgen Herbst, *The German Historical School in American Scholarship: A Study in the Transfer of Culture* (Ithaca, NY, 1965), 9–10.

[21] In contrast, Egypt, chief among Arabic countries in terms of Muslim institutions of learning, has kept the great Madrassa Al-Azhar open along with universities.

Political stability and economic prosperity were often the preconditions for the development of higher education in non-Western and Western societies alike. This was clear for Latin American countries. As Ana Alfonso-Goldfarb, Márcia Ferraz, and Silvia Waisse show in their chapter, independence did not bring peace and prosperity to Latin American countries. Most of them were mired in frequent border conflicts, civil wars, coups, dictatorships, and economic troubles thereafter. Peru was able to introduce a university reform in the 1850s and 1860s thanks to its economic boom from the guano trade. It introduced doctoral programs that addressed research in the 1870s. Argentina likewise began its higher education renewal at the turn of the twentieth century and set up sustained doctoral training thanks to its prosperous agricultural export. Doctoral programs that supported research also began in Mexico when the country recovered from political turmoil in the 1920s. Likewise, the university in Rio de Janeiro, the capital of Brazil, was reorganized as the industrialization after World War I generated an economic boost to the relatively peaceful republic. When the central government became repressive, Brazilian intellectuals found shelter at the University of São Paulo under the auspice of the autonomous state government. As Danian Hu and Hsiao-pei Yen note in their chapters, it was difficult for universities that were opened (or reopened) after the founding of the Chinese Republic to support research, for they were plagued by financial shortage, a result of endless civil wars. By comparison, the United States and Japan enjoyed a relatively unbroken growth of higher education until the Great Depression (which affected almost all countries worldwide), thanks to continuous political and economic stability.

A common theme in the early phase of university education in non-Western societies was the presence of foreign instructors. This of course was not exclusive to these societies. Saussure, who was Swiss, taught in Paris, for instance. The French case, however, was not comparable with their non-Western counterparts in scale. The staffing of foreign instructors was common, or even inevitable, for societies that started university education on their own, especially at a time when all university disciplines were new to them. This had been the case in Japan and China before they were able to recruit enough properly trained domestic scholars for their universities (Chapters 11, 13 and 14). In Latin America, university teaching and research likewise often depended on foreign professors who received training in Europe (Chapter 10). In India, Taiwan, and Korea, colonial rulers imposed a new system of education upon local societies, filled the teaching staff, first exclusively and then dominantly, with instructors from the metropole (Chapters 12, 15, and 16). This transition often took decades to complete.

Overseas study was another common theme for Western and non-Western countries alike. European students constantly studied at universities of foreign countries from the earliest time of universities in the Middle Ages through the early modern period. Russian and Muslim students joined the study tours beginning in the eighteenth century. The transatlantic flow of students started in the sixteenth century with the ambitious Latin American elite, who sought a degree or study experience at Salamanca, Coimbra, or other prestigious universities in the Iberian Peninsula. Starting in the nineteenth century, the number of international students increased dramatically while the countries of their origins diversified. The Latin American transatlantic flow was outnumbered by North American students. More than ten thousand Americans travelled to German universities for the PhD, pre-doctoral or post-doctoral study before World War I. Japan sent dozens of students to Europe and the United States for advanced education every year in the late nineteenth century, and the number grew to hundreds in the first half of the twentieth century. Chinese students followed Japan's lead to travel westward for advanced education. Their favorite destination country was in fact Japan, which was much closer and more inexpensive than Western countries, and had a written language containing many Chinese characters. Japanese and Chinese, never formally colonized, were free to study at a country of their own choice (or that of their funding agency). For the Japanese, Germany was a regular destination for law, medicine, and the humanities, although for chemistry or natural sciences in general, Britain and the United States were major destinations thanks to the ties of the first generation of foreign instructors (Chapter 11). While wealthy students made international study tours at their own expense, the others went on scholarships from national, local, and even colonial governments. Indeed, government scholarships for study abroad were a phenomenon common to almost all countries.

Latecomer countries in research education often tried to replicate back home the hardware and software that they were familiar with abroad, though with local adaptations. Sometimes the incentive to do research was imposed or adopted by foreign instructors, and sometimes it was proposed by returnees from Western universities. The seminar, the laboratory, statistics, fieldwork, and so forth, were accepted as instruments for training junior scholars, though adapted to meet local realities. As Yoshiyuki Kikuchi and Chen, Chou and Chang point out, in Japan and Taiwan (then ruled by Japan), the seminar was not just a class in which a professor and his own students met. It was instead an organization that interested scholars and students in all universities and colleges (and sometimes academically-minded high school teachers) in the region to gather and study the latest literature published in foreign languages, and to present their works in progress. Kikuchi also shows that professors of chemistry at Tokyo reorganized their laboratories to adapt to different groups' power structures and preferred teaching styles.

The opening of universities cannot be equated, then or now, with support for research or doctoral programs. There were at least three obstacles to the founding of the research university. First, universities were very elite when first introduced, accepting only a tiny number of students. The state and its clientele had little interest in a still higher degree as long as the university fulfilled its primary function to train qualified personnel for modern bureaucracy, professions, and businesses. The second obstacle was associated with the first. The role of researcher was non-existent in Japan at first,[22] and in fact in many other societies. It generally took societies a long time to appreciate the value of research and then to support it. The early success of chemistry in gaining a doctoral program in Argentina, for instance, was not due to the country's recognition of scientific research for its own sake, but to the wide applications of chemistry to industry, agriculture, and public health (Chapter 10). Third, the previous development in the nineteenth century in Europe had upped the ante for funding scientific research. The lavish chemical laboratories in Germany that were constructed in the 1860s and later each cost hundreds of thousands of marks (Chapter 3). The collection and the international postage of specialized journals in each discipline, proliferating in major Western countries, also demanded extra funds. The expenditure for raw material and accessories was another issue. Fortunate to have teaching laboratories early on in Tokyo, professors of chemistry had no funding for research. As a result they diverted funding from teaching to pay for research. Funding for university research, or the establishment of research institutions, became available only at the turn of the twentieth century and especially after World War I (Chapter 11). In China, state universities lacked funding for research. It was a missionary institution, Yenching University, that first offered steady support for research in physics, thanks to the generous endowment of the United States-based Harvard-Yenching Institute (Chapter 13).

Colonized peoples often had to wrangle with their alien rulers for educational resources, or provide their own. Colonial rule often first introduced the conflict between traditional learning and Western knowledge. A few decades into colonial rule, employment opportunities (as physicians, lawyers, teachers, or state employees) made the local population aware of the value of modern education. They thus asked for access to education

[22] James R. Bartholomew, *The Formation of Science in Japan: Building a Research Tradition* (New Haven, 1989), 68–87.

for their children. First motivated by exploitation of human and material resources, colonial rulers dispensed very limited educational resources for their subjects. Their instinct was always to train servants instead of independent thinkers in colonies. In India and Korea, missionaries and the local elites established colleges in addition to the limited number of state-funded colleges or universities. The most ambitious of the traditional landed elite or newly rich sent their children to the metropole of the empire for higher education. Successful merchants, such as Kamsetji Tata (1839–1904), endowed the Indian Institute of Science, an institution for advanced research in natural sciences. In Korea and Taiwan, the local elite proposed to open a university with their own resources (Chapters 15 and 16). Only then did the colonial governments respond by opening the sixth and seventh imperial universities of Japan in Seoul and Taipei. Ironically, even thereafter racial discrimination made it harder for local students to enter colonial universities than universities in the metropole. Thus, well-to-do Korean and Taiwanese students continued to pursue higher education and even doctoral training in Japan. A small number even traveled to the West for this purpose.

Racial discrimination came together with the resistance of colonial subjects. As Mathew and Sohoni show, the few museums or other facilities in India with research functions were always staffed by the British at first. Over time, the Indian elite developed interest in sciences, and some successful entrepreneurs and philanthropists, such as Tata, endowed research institutions that were mean to promote Indian science and scientists. Indeed, local students of science with outstanding qualification, like Homi Bhabha, increasingly won research positions. In the interwar decades some of them worked with Indian nationalists for the project of an independent country.[23] The resistance in Korea was also strong. As Yeo shows in his chapter, the Korean resistance found shelter in the Severance Union Medical College, which, supported by Western missionaries, provided an alternative of new education, scientific research, or even modernity in general to the state-controlled imperial university.

Empires themselves invested resources in particular areas of research that sometimes created a double irony. Over the nineteenth and the first half of the twentieth centuries, states increasingly invested in research that benefited governance. The rulers in India, Korea, and Taiwan established institutes, in or independent of universities, to study the natural resources, languages, history, and society of the colonies (and even the empire's targets of expansion). Often the locals were trained and employed to help

[23] Pratik Chakrabarti, *Western Science in Modern India: Metropolitan Methods, Colonial Practices* (Delhi, 2004), 272–97.

with the taming or control of their own people, the first irony. After emancipation, these local employees often formed the nucleus of higher education research forces that trained new generations of researchers, the second irony.

Oppressive imperialism and rising nationalism in the colonies, which were prone to clash with each other, did not stop the flow of students to the metropoles. The flow of international students has been noted above. Colonial subjects often had little choice but to travel to the metropole of the empire for advanced study. Thus Indians headed for Britain, while Korean and Taiwanese students headed for Japan. Those who studied abroad often had the ambition to modernize their home society with their knowledge of science and institutions in advanced countries. They also aspired on a personal level to the elevation in social, economic, and even political status that returnees often enjoyed. These reasons made higher education remarkably global in the age of first globalization.

This age also witnessed a scale of international cooperation and foreign aids never seen before. Once imperialist powers had forced non-Western countries to open for trade and Christianity, missionaries established colleges and universities there, usually with funds from their home societies. Sometimes Western governments endowed scholarships for non-Western students, such as the study-abroad scholarship that was created with China's indemnity payments to the United States government for the Boxer Rebellion, which educated a generation of leading Chinese intellectuals in American universities. Western philanthropies were also active in non-Western countries. Yenching University enabled the education of the first generation of physicists, male and female, in Beijing (Chapter 13). The Rockefeller Foundation supported various programs in China (Chapter 13), Argentina (Chapter 10), and many other countries. Although these philanthropies had their own agendas, and were thus not simply altruistic, they supported local developments and to some degree international collaboration in education and research. Even world wars did not stop international collaboration. The International Federation of University Women was created right after the Great War to promote women's solidarity, mutual understanding, and intellectual exchange across national borders.[24]

The internationalization of academia and scientific research was to a great extent the result of the so-called first wave of globalization. Between 1880 and 1914, the world saw a historically unprecedented surge in integration due to a huge drop in transportation costs, a fall of tariffs, a

[24] Christine von Oertzen, *Science, Gender, and Internationalism: Women's Academic Networks, 1917–1955* (New York, 2014).

vast flow of capital, and massive migration of people to unpopulated regions across national borders.[25] The same factors supported the movements of foreign teachers and students, the multiplication of international scholarly organizations, increasingly frequent international congresses, the rising scale of international philanthropy, and the replication of advanced academic culture and institutions at home.

The internationalization of research education, however, differed from economic globalization in several regards. First of all, while the British Empire was the greatest promoter of the first globalization, Germany was the leader of scientific research during this period (Chapters 2, 3, 4, 8), the model to which Britain and France looked for higher education that pursued scientific research. Germany also invested much more heavily in universities than its peers, even though Britain and France industrialized earlier and accumulated greater wealth. Most American students or junior scholars travelled to Germany instead of Britain or France for research education. In addition, scientific globalization did not take place on a homogeneous ground. 'Empire effects' were significant in conditioning the flow of students and scholars and the organization of higher education.[26] Scientific internationalism continued even when trade barriers went up to stop the first globalization in the wake of the First World War. Universities that supported research and training in research did not arrive in some countries, Brazil for example, in the first age of globalization, although São Paolo was an important center of industrialization at the time.[27] Research education globalized, though not at the same pace with economic globalization.

A New Beginning

The period from 1845 to 1950 set the foundation for research education in many parts of the world. The case studies in this volume provide a general

[25] *Globalization, Growth, and Poverty* (New York, 2002), 23–6; Thomas Piketty, *Capital in the Twenty First Century*, trans. Arthur Goldhammer (Cambridge, MA, 2014), 395; Christopher M. Meissner, 'New Perspectives on the First Wave of Globalization', *NBER Reporter*, 1 (2015), 13–16; Luigi Pascali, 'The Wind of Change: Maritime Technology, Trade, and Economic Development', *American Economic Review*, 107/9 (September 2017), 2821–54.

[26] We are using Niall Ferguson and Moritz Schularick's term of 'Empire Effect' to mean a different effect, but comparable to what they describe. For the authors it was lower interest rates, accessible to colonies within the British empire, that facilitated the flow of capital to colonies. Niall Ferguson and Moritz Schularick, 'The Empire Effect: The Determinants of Country Risk in the First Age of Globalization, 1880–1913', *The Journal of Economic History*, 66/2 (2006), 283–312.

[27] Danilo Antón, 'Latin America: Five Centuries of Globalization', *Macalester International* 6 (1998), 30–1. Note that the author sees the globalization in the late nineteenth and early twentieth centuries as the second wave of globalization for Latin America.

picture over this time frame. Before 1848, philological and historical seminars, as well as a small number of research groups in the physical and biological sciences, had consolidated their places in German universities. Between 1848 and 1870 the chemical laboratory (e.g., Liebig at Giessen) and the mathematical seminar (e.g., Jacobi at Königsberg) transformed from what had been an exceptional presence to a regular one in German academia. From 1870 to World War I, France, Britain, the United States and the other Western countries worked to catch up in the humanities and experimental and theoretical sciences by reproducing the German model at home, though always with local adaptations. This was the first period of rapid expansion and specialization for higher education in Europe and the US. During the interwar period, the German hegemony in science waned due to the crippling postwar economy, while French, British, and especially American science flourished. British universities finally introduced the PhD at the end of the Great War, even though their humanists were slow to embrace the degree.

The non-Western countries were (and still are) too diverse to fit into a single picture. The Latin American countries, sometimes known as 'the other West',[28] had domesticated European higher education in their colonial period. Amid the protracted post-independence political and economic troubles, individual countries like Peru, Argentina, Mexico, and Brazil in turn introduced doctoral programs that required research, usually in moments of relative political stability and economic prosperity. In the mid-nineteenth-century British colony of India, colleges were established that emphasized literary education on the English model, while Japan mixed elements of diverse models into its own system that started as part of its program of Westernization in the 1870s. In these two countries, support for research and research education became regularly available in the first half of the twentieth century. This was reproduced in Japan's colonies in Korea and Taiwan in the 1920s. University education replaced the Civil Service Examination in China at the turn of the twentieth century and research education, though limited, was provided later in the century.

Thus, by 1950 all the countries surveyed in this volume had accepted the value of research for their best universities. Seeing original research as what distinguished themselves, these institutions provided research education, even if sometimes very limited, to the most promising students preparing for the academic profession. In some countries, China for example, doctoral programs were not available. There, academics admired

[28] Marcello Carmagnani, *The Other West: Latin America from Invasion to Globalization* (Berkeley, 2011).

Western higher education as it provided solid doctoral training, thus preferring Western doctorates for their new recruits. Most of the countries that had no universities before World War II opened their own soon after 1945. For these countries, the opening of a national university (or more) served as a declaration of their political and cultural autonomy. Their universities then followed the paths that their non-Western peers had heralded to support research education. As seen above, in these countries research education was often offered at the graduate level. Graduate education, especially doctoral, has become the highest education across the globe. Thus, World War II marked a new beginning, even though conditions that had started before the war continued partially thereafter for a short while, as in Taiwan and Brazil. Before 1945 doctoral or graduate education had almost universally remained a thoroughly elitist entity, and only a very small number of doctoral degrees were awarded annually. From about 1950 on, doctoral education experienced remarkable global expansion.

Today, research universities sometimes have more graduate students than undergraduates. Altogether the countries of the world award tens of thousands of doctorates a year, led by the United States and China. In the nineteenth century, a researcher in a museum, a scientific academy, or a factory may have completed their training and career all in one institution. Now, museums and the R&D departments of big corporations expect their positions for advanced research to be filled largely by those who have PhDs. The relationship between universities and industry are much closer than a century ago. It is also easier for women to lead an academic career. Scientific globalization has reached a new height. The global foundation for all these developments was laid in the period that is surveyed and analyzed in this volume.

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