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THE BRITISH AND AMERICAN GENETICS COMMUNITIES, 1900-1930: A QUANTITATIVE COMPARISON

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ABSTRACT

Although the United States became politically independent of Great Britain in 1776, through much of the nineteenth century its science, like its economy and high culture, remained something akin to a colonial dependency of the original mother country. The development of scientific independence varied with discipline. For evolutionary biology, the stirrings of independence began in the late nineteenth century, and by World War I, American genetics, a child of evolutionary biology, had achieved equal rank with its British counterpart.

This paper explores that change, principally via a quantitative assessment of genetics in the United States and Britain. Attention is given to the number of practitioners of the discipline, publication rates, the distribution of publishers in terms of productivity and institutional location, and the type of work done. A major conclusion is that American genetics came to challenge, and in certain ways to surpass, British genetics not only because of superiority in number of geneticists, institutions, and funds for research but because of the pluralist character of the American research system.

Despite the achievement of political independence in 1776, the United States remained, in certain essential respects, a de facto colonial dependency of Great Britain well into the nineteenth century. The new nation supplied raw materials, a burgeoning financial market, and a foreign policy that foreclosed the western hemisphere to conquest by Britain's continental rivals. The former mother country returned manufactured goods, development capital, and military protectionism by keeping the Atlantic a British lake. In science, the exchange was neither limited to Britain, nor was it so clear cut. The United States did not generally send raw talent to England, which was then returned as trained "finished goods"; that arrangement was more typical of the American scientific relationship with Germany, at least from the 1840s onward. Nor was there any direct investment in American scientific institutions by Britain or any other European power.

Nevertheless, several facts suggest that the United States was genuinely a colonial dependency of European, mainly both British and German, science. Americans published in native journals, but they preferred that their work appear in British or German publications. They welcomed election to the National Academy of Sciences, but a far more important hallmark of recognition was the kudos of foreign attention, notably by the Royal Society of London. More important, Americans took most of their scientific cues from abroad. The conceptual frameworks in which they operated originated for the most part on the other side of the Atlantic. Europeans established the paradigms, Americans explored them, tested them; Europeans in short set the program of American research. In a sense, Europeans provided

Americans with the intellectual capital of nineteenth century science, and Americans in return diligently supplied the labor of development. So it was with respect to Britain and Germany in physics, chemistry, geology, and biology. So it was, strongly, with regard to Britain in the field from which genetics emerged -- the biology of evolution.

Darwin's theory of evolution was of course a British product, and in the late nineteenth century Britain was the world headquarters of Darwinian science. Like scientists in other countries, American biologists set out to test the theory of evolution; indeed, the bulk of U.S. biological research in that period seems to have consisted of Darwinian studies. In the field or naturalist branch of the subject, Americans enjoyed a decided advantage; they had before them a vast continent, rich in flora, fauna, and, in the West, exposed geological strata and fossil record. Darwin himself called the finding of ancient horses and birds with teeth by Othniel C. Marsh, the Yale paleontologist, the most important confirmation of his theory to have appeared since the publication of his Origin of Species.[1]

By the late nineteenth century, the United States -- now with its own thriving industrial establishment, increasing reserves of indigenous capital, and imperial ambitions of naval strength -- was well on its way to breaking free of its longstanding general colonial dependency upon Britain. American science also showed harbingers of independence, particularly in its research branches of comparative

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[1]Charles Schuchert, "Othniel C. Marsh," Biographical Memoirs of the National Academy of Sciences, XX(1939), 22. We are glad to acknowledge the support of the National Science Foundation, grant number SOC 78-05767 for the research for this article.

advantage, geology, natural history, evolution. By the 1890s American biologists were caught up as coequals in the central questions of Darwinian debate: How did evolution proceed? By the selection of sports or of small variations? If upon sports, how so, since single sports would be swamped? If upon small variations, how so, since small variations did not seem to be heritable? Whichever the case, how did sports and heritable variations arise?

By the 1890s, many younger biologists in the United States, Britain, and elsewhere were growing restless with the traditional way of approaching these questions, i.e., through the descriptive methods characteristic of phylogenetic morphology or embryology. Eager to pursue more decisive lines of inquiry, the younger biologists --and some older ones -- called for programs of quantitative or experimental research in evolution addressed in particular to the problems of heredity and variation. In England, Francis Galton inspired the most important quantitative research program -- W.F.R. Weldon's statistical analyses, developed in collaboration with Karl Pearson, of variations in large populations. Another important departure was the program of hybridization experiments exemplified in the research of William Bateson. Pearson and Weldon helped establish the field of heredity studies known as biometry. The research of Bateson and others paved the way for the rediscovery in 1900 of the Mendelian paradigm.

In the swift development of genetics that followed, the United States overtook — and in a sense surpassed — Britain by 1915 as the world center of Mendelian research. In 1921, when Bateson was elected a foreign associate of the National Academy of Sciences, he

exclaimed: "In our line American opinion is the best attainable, so I really for once feel like somebody!"[2] Accounts of this change have focused on the celebrated vicious and intellectually retarding dispute in Britain between the biometricians and Mendelians. They have also called attention to Bateson's suspicion of, and longterm refusal to support, cytogenetics, which was essential to Thomas Hunt Morgan's fecund research program with Drosophila. Yet Morgan himself was skeptical about Mendelism until about 1909, and, if Bateson declined to pursue cytogenetics, did everyone else in Britain?

In a recent paper, one of us has suggested that a fuller understanding of the development of genetics in the United States and Britain requires attention to the history of the overall corps of men and women who did genetics in the two countries.[3] The existing historiography tends to focus on the principal actors, e.g., Morgan, Bateson, Pearson, but it leaves virtually unexplored the scientific commoners in research, who came to form the Anglo-American genetics communities. Without attention to their contextual story, it seems difficult, if not impossible, to assess with confidence the role and influence of the principal actors in the field or to analyze fully the relative strengths and weaknesses of genetics in the two countries. But an examination of the community context, i.e., the social and institutional base, of genetics through cross-national comparison,

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[2]Bateson to Raymond Pearl, n.d., Raymond Pearl Papers, American Philosophical Society Library, Bateson file.

[3]Daniel J. Kevles, "Genetics in the United States and Great Britain, 1890-1930: A Review with Speculations," Isis, 71(1980), 441-55.

promises to illuminate considerably the development of the field, including whether, and in what ways, American biology ascended, at least for genetics, from colonial to coequal or superior status with regard to its British counterpart.

To the end of such an examination, a few years ago we began to draw a contextual portrait of the Anglo-American genetics communities from 1900 to 1930. We started with a survey of the main British and American journals where articles on genetics and related subjects were published. The journals so far examined are, for the United States: American Breeders Magazine, American Naturalist, Anatomical Record, Biological Bulletin, Botanical Gazette, Genetics, Journal of Experimental Zoology, Journal of Heredity, Proceedings of the American Academy of Arts and Sciences, Proceedings of the National Academy of Sciences, and Science. For Britain, the publications were: Biometrika, Journal of Genetics, Journal of the Royal Horticultural Society, Nature, Philosophical Transactions of the Royal Society,B, Proceedings of the Cambridge Philosophical Society, Proceedings of the Royal Society of Edinburgh, and Proceedings of the Royal Society of London.

For each journal, we have identified every article in genetics, broadly defined, by author, subject, and date of publication. Our purpose here has been to discover who was publishing what and who were the major authors, at least in terms of productivity of publications. With this strategy we expect to discern who actually practiced genetic research and who loomed large in the discipline by contemporary standards rather than by the judgment of history alone.

We have also identified the major publishers (a phrase we have defined generously so as not to be too exclusive) with regard to their education and training, places of employment, and nationality if not British or American.[4]

Such data have proved relatively easy to obtain for American authors but very difficult for British. While American Men of Science, an excellent reference for these purposes, dates back to early in the century, there is no comparable set of directories for British science prior to the early 1960s. The biographical memoirs published by the Royal Society are excellent for the principal scientists in the field, yet the task of this project is precisely to go beyond leading figures to the rest of the community. To find biographical information on secondary British geneticists, we have had to turn to university alumni lists, Minerva, and, most fruitfully, to obituary notices in Nature, for which last we have found the index compiled by Roy MacLeod indispensable. The data gathering, I am pleased to say, is perhaps 85% complete. However, the analysis has only just begun. Eventually, once the data is cleaned and completely coded, the analysis will be prosecuted with crisp precision by computer. However, we have not yet reached that happy state of affairs. The data we present here, collated and analyzed by hand and hand-calculator, must be understood as rough, preliminary, likely in some error, but nevertheless, we think, reliably indicative.

[4]The criterion for inclusion was that the author must have published at least 4 articles between 1900 and 1930.

On the basis of these results, it is obvious that the American ascendancy in genetics resulted in part from the sheer size of the U.S. effort compared to that of the British. Between 1900 and 1930, there were 576 American compared to 241 British authors, for a ratio of more than two to one. American and British publication rates were similar — for Americans, slightly more than 3 articles per author, for the British slightly less — yet because of the larger size of the American community, U.S. geneticists produced some 1800 articles, the British only some 700. Of course, sheer quantity of productivity weighs no more heavily in significance in science than it does in art or literature. What counts is the quality of the work. In science, quality often goes together with a high productivity rate for a given scientist. Though such an indicator can be misleading, in the absence of any other we propose to use it here. Among the British, about 20% of the authors produced some 67% of the articles. Despite the considerably larger size of the U.S. community, the statistics are approximately the same.[5] In short, while American genetics had more than twice as many practitioners of the discipline, it was swamped no more than Britain by low producers. In fact, American genetics had proportionately just as many high producers -- and if the quantity-indicates-quality index is at all reliable — no comparative dearth of able geneticists.

As one might expect, American geneticists enjoyed a decided institutional advantage over the British. In late nineteenth century

[5]See Appendix, Table II

America, philanthropy had begun to channel surplus industrial capital into institutions of higher learning, first for general educational purposes, then, after the turn of the century, into the endowment of scientific research. The most striking post-1900 example was Andrew Carnegie's munificent gift of $10,000,000 to found the Carnegie Insitution of Washington, whose various departments soon included the Station for Experimental Evolution at Cold Spring Harbor, Long Island. After the turn of the century, too, support of research became an explicit policy of the vast American state university system. The Adams Act of 1906 opened wider the sluice of federal funding for research at the large number of agricultural experiment stations that had been brought under the patronage of the federal umbrella by the Eatch Act of 1887.

British scientists advocated the endowment of research. At University College London, Karl Pearson turned advocacy into vigourous entrepreneurial practice, raising money from the Worshipful Company of Drapers and by public subscription after Francis Galton's handsome bequest made him the first Galton Professor of Eugenics. William Bateson deftly redirected the new John Innes Horticultural Institution, created in 1910 with the bequest of a London merchant and landowner, into a center of genetics research. Then, too, genetics research benefited from small increments, a studentship here, a professorship there, notably the Balfour Professorship at Cambridge, the endowment of which was facilitated by Arthur J. Balfour, who had a strong interest in eugenics. Research funds also came from the Board of Agriculture and from the government grant for science. But there

were no British philanthropists comparable to Carnegie, Rockefeller, or Vanderbilt, who endowed new institutions of science or learning at a single stroke. Government funding of science was also small on an American scale, particularly when American state, rather than merely federal, appropriations are taken into account.

And while there was some institutional expansion in the British academic world, the number of scientific centers in Britain remained small. British geneticists who published between 1900 and 1915 were located at one time or another at only 13 institutions, while their American counerparts were to be found at more than 45 universities, various small colleges, and institutions of research such as Cold Spring Harbor, Woods Hole, and Scripps. The rest of British publishers, if not independent, were scattered in the Empire or held medical, governmental, or miscellaneous posts at home.[6]

To probe further the institutional arrangements of British and American genetics, we have examined the distribution of genetics researchers among institutions in each country for the period 1900-1915. We assigned each institution a man-year of credit for every year spent there by someone in the field. Thus, if a single researcher spent 1900-1915 at, say, Cambridge, that university would receive a credit of 15. For American geneticists, about 11% of the total man-years for the period was spent at the United States Department of Agriculture; about 35% at private universities, and about 26% at state colleges, universities, and agricultural experiment

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[6] See Appendix, Table III

stations. Another 14% were spent at various independent research institutions, including Cold Spring Harbor.[7] It therefore appears that American genetics knew a strong mixture of patronage — private philanthropists as well as state and federal governments -- which, combined, produced not only a large number of research institutions but also a healthy pluralism among them.

We say "healthy," because patronage no doubt shapes the research that is done. At the state colleges, universities, and experiment stations, we expect that emphasis went to genetics as it related to practical plant and animal breeding. In the private universities and independent research institutions, the weight of research fell on genetics as such. So at Columbia, Thomas Hunt Morgan could analyze Drosophila; at Harvard, William E. Castle,coat color in mice; at Johns Hopkins, Herbert S. Jennings,paramecium. At Cold Spring Harbor the staff could scrutinize whatever the director, Charles B. Davenport, thought appropriate. In the British case, by contrast, 11 essentially private universities and colleges accounted for some 53% of all genetic man-years between 1900 and 1915; the government, for only about 3%, and independent institutions for only about 6%.[8] With this result in mind, one would expect a much more limited range of subjects and approaches in British as compared to American genetics, and one in fact finds just that.

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[7] See Appendix, Table III

[8] See Appendix, Table III

We have classified the articles published by British and American authors according to subject with the following results:

Table I

Subject	Percentage of Total U.K.	U.S.
Group I		
Mendelism	22.3	26.6
Hybridization	4.0	3.6
Sex Determination	2.8	3.8
Variation:Qualitative	1.5	2.6
Evolution	12.6	14.1
Heredity:General	4.0	6.9
Group II		
Cytogenetics	8.3	17.3
Biometry	40.7	7.3
Variation:Numerical	1.0	2.7
Drosophila	0.4	3.3
X-ray Mutations	0.1	1.2
Eugenics, Human Heredity	1.8	9.4

For the subjects in Group I, it is evident that there was no significant distributional difference between the British and American genetics communities. However, for the subjects in Group II, there was a good deal of difference indeed. In the period 1900 to 1930, cytogenetics, Drosophila, and X-ray mutation were much less practiced as research fields in Britain than they were in the United States. (So apparently was eugenics, but we are not confident of that result because we have not yet looked at some pertinent British journals.) Conversely, biometry was pursued with much less intensity in the United States than in Britain. A full explanation of this

transAtlantic assymetry of effort must await further analysis of the data, particularly a correlational analysis of type of subject with institutional location of the research. However, we can speculate upon the matter, given what we already know about the distribution of manpower among institutions in Britain and America.

A key question to ask is: Even if British geneticists did not think to embark upon Thomas Hunt Morgan's or Hermann J. Muller's programs of research before they did, why did they not take up intensively cytogenetics, Drosophila, or x-ray mutations once the way had been shown? The answer, as some historians have suggested, lies in part in William Bateson's opposition to cytogenetics but it also lies in the enforcement given that opposition by the institutional arrangement of British genetics. For while British genetics research was spread through 13 institutions, 31% of the man-years in the field from 1900 to 1915 were spent at Cambridge, and another 1.4% at the John Innes Institution, both of which were controlled in genetics by Bateson directly or by his disciples. Another 6.7% of the man-years were located at University College London, and 3.4% more at Oxford, which is to say that about 10% of the total man-years for the period were occupied by Karl Pearson and Walter F.R. Weldon, both staunch opponents of Mendelism, let alone of cytogenetics.[9]

In the United States, no single institution so dominated genetics research as did Bateson's Cambridge. The top three institutions in terms of man-years were the U.S. Department of

[9]See Appendix, Table III

Agriculture, with 11%; Harvard, with about 9%; Cold Spring Harbor with slightly more than 7%, and Columbia, together with the American Museum of Natural History, each with about 4%. Another 19 institutions each fell in the range of 3.9% to 1.0%.[10] Thus, American genetics was characterized by sufficient institutional concentration to make for a few thriving local research groups, yet sufficient pluralism to prevent any one school from gaining an intellectual stranglehold on the field.

In British genetics the state of affairs would no doubt have been worse without Bateson and Cambridge, for then the field would have been left to Pearson, with his snarling anti-Mendelism. But if Pearson was wrong on the Mendelian side, he was utterly right on the side of biometry, of treating heredity statistically across large populations. Here Pearson's unchallenged, dictatorial dominance of the Galton Laboratory at University College and its resources worked strongly to the advantage of British science in spawning a vigorous school of biometric studies. If often wrong in substance, the school was for the most part right in the fostering of approach, method, and technique, and it laid the foundation, institutionally and otherwise, of future British strength in population genetics.

Just why biometry did not take hold in the United States must at this point remain a matter of speculation. The speculation suggests that hardly everything can be explained in terms of institutional patterns or any other general force. The fact of the

[10]See Appendix, Table III

matter is that no American biologist or mathematician happened into the warm and intellectually fruitful relationship of Pearson and Weldon, and that no biometrically oriented American scientist had Pearson's zeal for the subject. Charles B. Davenport commanded even more resources at Cold Spring Harbor than Pearson did at London, but Davenport by no means possessed Pearson's intellectual power, mathematical skill, or commitment. While Davenport early encouraged statistical studies of variation -- Table I reflects that early emphasis at the Station for Experimental Evolution -- he rapidly lost interest in the subject in favor of Mendelism, then eugenics.

By the 1920s, then, American genetics was indeed no longer a colonial outpost of Great Britain. About 11% of the authors who appeared in American journals were foreign, over half of them British. American journals were, in short, good places to publish. And American universities were also good places to study. In a large sample group of productive American geneticists who published between 1900 and 1915, there were 67 Ph.D.s. Only 3% of them were taken in foreign institutions. Where American genetics was strong, British was relatively weak, but so too for the converse. In absolute terms, more foreign authors -- 91 as compared to 74 -- published in British than in American journals. And about 27% of all the authors in British journals were foreigners, only slightly more than a quarter of them Americans.[11] In 1930 Britain, it appears, was more of an international genetics center than the United States. In part the reason was no

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[11] See Appendix, Table IV.

doubt Britain's greater proximity to the Continent. In part it was also the degree to which Bateson, who yielded on cytogenetics in the early 1920s, made both Cambridge and the John Innes Institution a mecca for foreign visitors like Vavilov. Whatever the case, by the 1920s the United States had gained coequal status with Britain in genetics, but it had not achieved complete independence. Even the strongest scientific nations rarely, if ever, do, pluralism in science being as fundamentally necessary on the international as on the national scale.

Appendix

Table II
Distribution of Articles Per Author
1900-1930

	British Authors	American Authors
Total Articles	693	1816
Total Authors	241	567

Articles Per Author	Cumulative Percentage British	
	Authors	Articles
1	57.7	20.1
2	71.4	29.6
3	80.9	32.5
4	84.6	44.7
5	89.2	52.6
6	90.4	55.2
7	90.8	58.1
8	91.0	63.9
9	92.2	67.8
10	93.9	73.6
11	94.75	86.8
12	95.16	78.5
14	95.99	82.5
16	96.82	87.1
19	97.65	94.6
64	98.06	101.6

Percentages do not add to 100 because of rounding off.

Table II
(continued)

Articles Per Author	Cumulative Percentage American	
	Articles	Authors
1	66.6	20.8
2	72.8	24.7
3	78.8	30.3
4	83.4	35.9
5	86.0	40.0
6	89.9	47.3
7	91.7	51.2
8	93.1	54.7
9	93.3	55.2
10	94.0	57.4
11	94.9	60.4
12	95.3	61.7
13	95.8	63.8
14	96.0	64.6
15	96.2	65.4
16	96.4	66.2
17	96.8	68.1
18	97.3	71.2
19	97.5	72.2
20	97.7	73.3
21	98.1	75.6
22	98.3	76.8
23	98.8	80.6
24	99.0	81.9
28	99.2	83.4
30	99.4	85.1
37	99.6	87.1
40	99.8	89.1
45	100.0	91.8
54	100.2	94.8
76	100.4	99.0

Percentages do not add to 100 because of rounding off.

Table III
Employment Distribution
1900-1915

By Category of Institution

Type of Institution	Great Britain	United States
Private Universities	52.6%	35%
State Universities, Colleges, and Experiment Stations	—	26.3%
Department or Board of Agriculture	2.8%	11.1%
Independent Research Institutions	5.6%	14.2%
Small Colleges	—	4.6%
Medical Practice	0.6%	15.7%
Imperial Posts	9.0%	1.5%
Miscellaneous	6.4%	3.9%
Unaffiliated	7.8%	2.8%

Table III
(continued)

By Institution

Britain (Total: 357 man years)		United States (Total: 882 man years)	
Cambridge	31.0%	U.S. Department of Agriculture	11.1%
University College, London	6.7	Harvard	9.3
Aberdeen	4.2	Cold Spring Harbor	7.3
Burbage Nursery	4.2	Columbia	4.2
Oxford	3.4	American Museum of Natural History	4.0
University College, South Wales	2.8	Stanford	3.9
Royal College of Science	1.7	Wisconsin	3.4
John Innes	1.4	Penn	2.9
Edinburgh	1.1	Kansas State	2.9
Manchester	0.6	Michigan	2.9
Imperial College	0.6	Chicago	2.7
London Technical Institute	0.3	Bryn Mawr	2.3
Glasgow	0.3	Wistar Institute	1.8
		Connecticut College and Experiment Station	1.8
		Cornell	1.7
		Syracuse	1.7
		Berkeley	1.7
		Nebraska	1.6
		MIT	1.4
		Cincinatti	1.2
		U. of Colorado	1.2
		John Hopkins	1.1
		Princeton	1.1
		U. of Virginia	1.0
		Washington U.	0.91
		Florida Experiment Station	0.91
		Arizona Experiment Station	0.91
		Rhode Island College and Experiment Station	0.91

(continued next page)

Maine Experiment Station	0.91
Woods Hole	0.91
Iowa State	0.91
Others(*)	5.89

*includes 15 universities, but not the small colleges

Table IV
Foreign Authors in British and American Journals

Country	Number in British Journals	Number in American Journals
Great Britain	—	39
USA	20	—
Russia	6	4
Holland	3	2
France	4	1
Germany	5	3
Italy	1	1
Denmark	5	3
Norway	2	1
Japan	2	3
China	1	—
Argentina	1	—
Australia	2	—
S. Africa	2	2
Egypt	1	—
W. Indies	1	—
Singapore	1	—
Canada	—	5
Spain	—	2
Sweden	—	2
Poland	—	1
Czeckoslovakia	—	1
Austria	—	1
Yugoslavia	—	1
Brazil	—	1
India	—	1
As percentage of total authors	27.4%	11.4%